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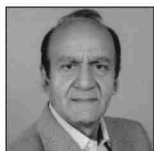
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From the Desk of Editor – in - Chief

Dear Friends

Present time is of fast paced transformation of both, the society and technology. To match it, the education sector was also required to gear up and respond and fortunately, higher education sector has already kick started year 2020 like 2020 cricket; with elements like speed, aggression, excitement, outcome orientation and quality at the helm. Since independence, educational landscape of India remained a jigsaw puzzle with a set of mosaic pieces in different hands and each of them thinking that with just few pieces in hands, each one of them independently could complete the full picture, with the result the whole picture remained messed up. This is probably, for the first time that effort has been made to join all the pieces and bring all the people together to produce, a good picture comprising the entire spectrum of education; primary to higher education, skill development to entrepreneurship, research activities to extension work and innovation to employment, in a single composite frame. The New Education Policy-2019 (NEP-19), which has a national vision and a complete road map with detailed implementation mechanism for world class quality education, is the new canvas for this big picture. This Policy Document is likely to be tabled in parliament shortly for approval. Government has already identified 10 institutes of higher education with assurance to provide all kind of support to them to come in world ranking. It has initiated several action plans to address to quality and skill deficit in education. On governance front, a common Higher Education Commission as an apex authority is likely to be established which will resolve various problems as regard to conflict of several regulatory bodies pulling in different directions. Mrs. Nirmala Sitaraman, the Finance Minister GoI, made it very clear in her budget speech, recently, that education is government's top priority, and it is in real 2020 mood to bring in speedy quality improvement in education. FICCI has predicted that, looking at government's initiatives and mood, hopefully there could be at least 23 higher education institutions in top 200 world ranking by the year 2030.

Action plan, for a speedy revolution in education, has come with many layers. A whooping Rs. 99,300 crore for education and Rs. 3,000 crore for skill development have been allocated to education sector for 2020-21. This is 3.8% of the GDP. This will be further supplemented substantially by FDI and foreign borrowings, which are being opened for the first time as per the announcement made during the budget presentation. This will provide triple benefits; first the foreign funding itself, second low interest foreign borrowings and third, after quality improvement and foreign collaborations, world class Indian institutions are likely to attract students planning to otherwise go abroad for education, thereby retaining their fees within India which otherwise would have drained abroad. Currently about 7.5 lakh students go abroad every year and a large sum of almost Rs. 45 thousand crore spent which is much more than entire annual budget of higher education in India. Even if we could prevent 20 to 25% of these students

from going abroad, it will be a sizable foreign fund saving. On research front, establishment of an autonomous organization with slated 0.1 percent of GDP as seed money for research promotion is a significant step. This organization, namely Research for Resurgence Foundation (RFRF), has already started functioning with its HQ, at Nagpur and after a workshop conducted recently by them; research projects are being short listed for funding.

The most important reason for poor quality education is the poor quality of teachers and inefficient teaching – learning system in many of the institutions of education. Overall shortage of quality teachers and lack of adequate facilities for their training and development are the biggest cause of concern at every level. It is hoped that this issue will be addressed at highest policy making level with highest priority. The best course could be, to build a separate cadre for higher education teachers for each discipline separately, at national level like many other central services eg. railways, police, administration, revenue etc. through all India examination and all institutions could be forced to appoint/select teachers only from this cadre. Also many academies could be opened to look after developmental and training needs of teaching fraternity. In young country like India 65% people are below 35 years of average age. With CEO of Indian industries of 43 years average age, is there a need to infuse young blood at top leadership level in higher education? This is seventh generation of students in higher education since independence. There is a sea change in technology in last 3 student generations but has the top academic leadership also changed or they are still with three to four decade old mind set? This is off course a point to ponder!

I am confident that year 2020 will be a turning point in education history of India. With so many initiatives by the Government, higher education will be certainly ready to fulfill the aspirations of the Industry 4.0. Also it will be hopefully ready to match needs of industries of subsequent generations as well, on time, as and when such generation change comes in the industry and I am sure, education sector will provide industry ready students every time to the industry in the future.



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Managing the Growth of Private Universities in India Challenges and Opportunities

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ABSTRACT

Central and state government universities in India have been quite inadequate in numbers against the educational needs of the large population and so the Gross Enrolment Ratio (GER) of higher education also remained much lesser than required. In order to cope up with the situation, government decided to allow opening of private universities and achieve 30% GER by 2020, with the result a number of private universities opened in last two decades and now the GER has gone up to about 28% as compared to about 18% in 2000 and Private Universities constitute 40% of the total number of universities in India and their number still continues to increase. Positive growth of private universities is, therefore, now an important issue for India if it has to achieve bigger targets of quality and quantity in higher education. Development of a private university is not only in the hands of the Management of that university but depends on many other stake holders like Regulatory Bodies, State & Central Government, Students Industries and Society by and large, who are also responsible. However the initiative always lies with the management of the University. If all stake holders also contribute positively then private universities can perform even better than their government counterparts as, in the case of private universities, decision taking and implementation mechanism could be a little faster due to inherent nature of a private set up. Appointment of right kind of human resources i.e. Vice-Chancellor, Registrar, Dean academic, Teaching Staff etc is a key issue which provides a base or foundation for quality teaching learning. Growth is further dependent on faculty development, facilities, infrastructure like library, ICT structure, labs and other facilities, academic and research culture, environment and motivation available. Branding gets a boost also by the kind of innovation Ecosystem University has, entrepreneurial development it provides, skills and employability it generates and image of the University created among alumni, students and staff. HRD Ministry has drawn 5 years Vision Plan on Quality Education (EQUIP) which focuses on 10 areas and an environment of transforming higher education for new India is building in which private universities are expected to play a key role. However, there are lots of challenges for a private university, if it has to contribute significantly in improving educational landscape. This paper gives some salient aspects of these challenges and how can private universities turn them into opportunities.

Keywords- GER, ICT, Growth, Regulatory Bodies, EQUIP, Higher Education, Private Universities

I INTRODUCTION

Till eleventh century BC India was the world leader in higher education with universities like Nalanda, Vikramshila and Takshila attracting students and scholars from all over the world for quality education and research. Bakhtiyar Khilji destroyed these monuments of education in 1193. Thereafter higher education in India could not look up again and kept deteriorating with continuous invasions. At the time of independence India had only 20 universities and about 600 higher education institutes. Expansion of education and improvement in accessibility of education was one of the priorities of the government in independent India. In 1995, it was realized that desired expansion and up scaling of higher education is not possible without participation of private sector and consequently first private university was established in 1995 and now we have 398 private universities in India out of total 996 universities. In accessibility also we are close to target set at 30% for 2020. However, there is a need for drastic improvement in quality of higher education so that some of our universities could come up in world ranking and also there is need to take GER to next level and match the GER level of advanced countries which is in the range of over 60 to 90%, Ministry of

HRD has taken many initiatives and drawn 5 years quality improvement vision plan (EQUIP) focusing on 10 areas namely accessibility through opening new universities, Teaching Learning process, Excellence in quality education, Improving quality of Teachers, Reforms in Governance, Research, Innovation Employability and Entrepreneurship development Internationalization of education and Financing of universities. In ten years, opening of large number of IITs, IIMs, central institutes and research establishments and marked increase in the capacity of existing institutions of excellence, indicate seriousness of the Government for quality as well as accessibility and affordability of education. The intention is to motivate, students for admission and studies within the country instead of going abroad. Presently what these students pay abroad is more than the entire budget of higher education in India.

The New Education Policy NEP-2019 is being implemented to cater to the needs of above the focus areas. Establishment of a new funding agency RFRF (Research for Resurgence Foundation) with Rs. 1000 Crore has been set up to promote research and 10 Universities have already been earmarked for support by Government to bring them at world ranking. In all these initiatives, private universities

are a part and they will have to play an important role. Growth of private universities is therefore a key issue if India has to achieve targets in quality and quantity in education, research, innovation entrepreneurship and skill development.

II HUMAN RESOURCES – THE MAGIC OF QUANTITY AND QUALITY

Right quantity and quality of teachers in a university can be a real game changer. As a matter of fact Human Resources in the form of teachers and officials like Deans, HoDs, Registrar, VC and also supporting staff are the life line of the educational system in a university. Deficit in quantity and quality of teachers, now days, is the main worry of all the educational institutions. Even in the government institutions almost 30 to 40% of the posts for teachers are lying vacant. Private Universities, in such backdrop, are facing dual challenge; to get not only human resources right from Vice Chancellor to teachers and Registrars to supporting staff in right quantity but, also of right quality with experience and expertise as per the norms. Government University teachers have luxury of over security, lower accountability and better remuneration. For private universities therefore it becomes more difficult to attract good quality human resources as private universities have to depend on self finance and at the same time face tough competition. Still, if a private university has to build a brand, and develop in to a sought after quality destination, then it must carefully select its human resources.

Vice Chancellor is the head of the university and provides the leadership. His careful selection sets the tone for quality in general and the growth. The search committee for VC should zero on to at least 10 renowned persons by screening and short listing after detailed investigations. Good academic leaders and administrators with foresight and vision, capable of becoming Vice Chancellor should be short listed. Normally such short listed people should have long experience in teaching and research. Appointment of Registrar is also an important factor since Vice-Chancellor and Registrar are two wheels of the same vehicle. An outstanding rapport is expected between both of them. Hence any person who is academician, worked as Assistant/Associate Professor, with good number of research papers published, has administrative capability, has knowledge about rules and regulations framed by UGC/AICTE/University, general financial rules and also purchase procedure could fit the bill. Non interference by Administrative Staff in academics and letting a congenial administrative environment build in the university with extended support to teaching staff without bossing over them, can provide good growth to a private university. Appointments of Deans and HoDs in a private university are key to building a good academic and research environment. For Deans and

HoDs academic leadership and academic administrative capacity are important qualities. In addition, dedication and orientation of HoDs and Deans towards research and innovation can provide an edge to a university. **Good quality teachers can really provide a good academic image to a private university. In addition to good qualifications like PhD and NET clearance, core knowledge and hands on experience are the most important things which can make really big difference. In a teacher communication skill and concern for students are equally desired.** The problem in a private university is normally three fold. First there is tendency at administrative level to recruit lower quality people as they are available on lower remuneration; second, instead of selecting qualified people with right caliber as per laid down norms, tendency to recruit under qualified people through biased selection with personal likes/disciplines/references and thirdly; administration's undue interference in faculty selection. For a positive growth, private universities must overcome above three problems in which management has to play a key role. **The lasting solution can come only if an All India Higher Education Teachers Cader similar to other services like Railways, Revenue, Police, Administration etc is created through all India examination and teachers are appointed only from this cader.** Also it is the most important need that the human resources in the university are provided with continuous capacity up gradation, training, up scaling and value addition through various Faculty Development Programmes, Summer/Winter courses and Exchange Programmes For the basic training and subsequent refresher courses for the teachers, a number of academies could be opened TTIs that too for only Technical Teachers are unable and inadequate in numbers to discharge this task. A periodic assessment of teacher also though written test can do well. **A number of academies need to be set up for training and development of teacher for all streams.**

III TEACHING – LEARNING SYSTEM - SPIRIT OF GROWTH

Teaching learning is the main function of any university and all other functions must be in supportive role. But, in present scenario, it appears just the reverse. Admission and Examination now a days consume maximum time, efforts and energy. Quality of teaching-learning, which decides the quality of student output is currently given lower priority. Current report of CII and other employer forums put, gap between quality of students pass outs and expectation of industry around 70%. For this large employability deficit of 70%, the main contributor is poor quality of teaching-learning process. Poor quality of teachers, outdated curriculum, lack of value addition, lack of hands

on/practicals etc are key factors for poor quality of teaching- learning system. Curriculum is the base of any teaching learning system which currently is not matching the demand of the industry/employer who wants that curriculum must be updated as per the prevailing technology which is changing very fast. Employer wants that a student approaching for job should not only have core knowledge of the subject, must be aware of the current development and possess soft and hard skills like communication skill, computer skills, hands on knowledge on machines/practicals and as a matter of fact, is industry ready. To cater to this demand, not only competent teachers are required but also an efficient and dynamic teaching- learning pedagogy. Some actions initiated at AISECT group of universities enumerated below, have given positive results contributing to the growth of the university:-

- (a) A Curriculum Development/Revision Committee (CDC) was formed in each department which revise curriculum every year based on feedback from all stake holders i.e. industry, recruiters who come for campus interview, IQAC, students, alumni and experts visiting for guest lectures. Revision report prepared by this committee is put to BoS which has couple of industry representatives also. Once BoS approves it goes to AC and IQAC then implemented.
- (b) It is not possible to include everything in syllabus. CDC may recommend some value addition courses/training/workshops in every semester to cater to fast growing technology.
- (c) Academic Callander is made by the department and sent to IQAC in which value addition, skill development, training needs are included.
- (d) Faculty is allocated subjects at least 3 months in advance who prepares soft/hard versions of teaching-learning plan and notes on subject file which is property of the department. Faculty enriches the file with notes, lesson plans, question papers, industry scenario etc. Year after year file is enriched and gives very good material to the faculty on the subject.
- (e) There is a weekly academic meeting of the department where all aspects of teaching-learning progress is discussed.
- (f) ICT is heavily used as part of teaching learning pedagogy. Each faculty normally uses smart board, chalk and talk, MOOCS and other internet content for teaching- learning in right ratios. Each faculty develops recorded version of his/her lecture in AISECT studio. Faculty is asked to put emphasis on practicals and providing hands on experience to the students.
- (g) Test/assignment/Quiz after each unit is organized and performance index (PI) of each student is displayed every month on a continuous basis.
- (h) A Class Mentor for each class, a Tutor Guardian for every 20 students take regular feedback and HoD/Dean/VC take periodic feedback on teaching learning out comes to initiate remedial measures.

If a private university has to attain long term positive growth then it must focus on improving teaching- learning system with a Road Map and implementation mechanism monitored by the VC on a regular basis.

IV RESEARCH AND INNOVATION – THE BRAND VALUE

Poor research and innovation environment is one of the reasons that none of the Indian Universities comes in the world top ranking. Research is a field which needs heavy investments in terms of time and money and returns are uncertain, with lot of gestation period. For a private university which has to depend on its own financial resources, promotion of research becomes a tough option. Government of India has now put its focus on research and innovation in higher education. In the current year (2020-21) it has allocated significant funds for research promotion. An independent organization i.e. Research Funding for Resurgence Foundation (RFRF) has been set up at Nagpur. Recently they conducted a two days workshop to short list topics for research with social relevance which they will be allotting and funding, to the selected investigating universities including private ones. This is a silver line for private universities. A private university must identify its focus areas for research. Accordingly it must build human and material resources and explore funding options. Choice of emerging areas like IoT, Block Chain, AI, Big Data, Food processing, Water & Environmental, Pollution, Energy etc could be potential fields. Alternately it may be area of Government plans like smart technology, digitalization, cleanliness, space, agriculture etc. A private university may consider following aspects to build research environment in the University.

- (a) Identify research area, get qualified people recruited and set up a University Research Dept/Cell (URD). Let the cell explore all options as regard to options available in the selected areas and funding agencies and start applying. There should be a person deputed to explore all potential funding agencies on a continuous basis and inform concerned Departmental Research Cell (DRC). The university may also think of developing autonomous Centers of Research Excellence in chosen area and develop them through internal funding. This has been successfully done at AISECT Group of Universities.

- (b) **To build a research orientation and culture a Research Policy must be drawn. A financial motivation policy must be made and factually implemented by the VC so that faculty takes up research work.**
- (c) Approved policy in the university must consider research papers, research projects and work done by faculty for promotion/increment and rewards.
- (d) One department one project and one faculty one research paper per year could be made a policy in the University.
- (e) Private Universities must organise research events and collaborate with other universities effectively and not leave at MoUs only on paper.
- (f) VC must insist on a presentation by all Departmental HoDs, IQAC Coordinator, URD, DRC, Exam Controller etc every month to brief on progress in all the area of their operation including research, innovation and entrepreneurship which should make a road map for innovative work with the help of all Department.
- (g) An innovation cell could be opened within IQAC to promote innovation.

V TRAINING PLACEMENT AND SOCIAL CONNECT – THE SCORE BOARD

Though knowledge should be the main concern for students and parents, and job should be a byproduct, but unfortunately the situation is other way round. In the present era, parents and students are attracted by the kind of average package students pass outs are getting in the campus recruitment, kind of companies coming for campus selection and percentage of placement. However a private university must put its main focus on quality education. At the same time due importance must be given to the byproduct i.e. jobs and employment also. For improving job opportunity, University Training & Placement Department (TPD) and Industry Academia Cell in the University play most important role. Their achievement has a close link with quality of teaching-learning and research in the institute. In absence of quality output, any amount of effort by TPD or Industry Academia Cell will not yield good result. On the other hand if student output is good then also it may not work if TPD is not making adequate efforts. Also, how a student, is socially concerned and how his/her overall development has taken place, matters a lot. Following are some of the aspects which may be looked into, in order to improve overall score on placements:-

- (a) **T PD should have adequate competent staff who should build a good rapport with employers. Industry Academic Cell also should be manned by competent people. Both these departments must work in close coordination. Entrepreneur Development Cell**

(ED Cell) also must work in close cooperation with TPD for effective outcome.

- (b) Training Cell and Industry Academia Cell (IA Cell) must organise training of students and provide proper exposure and training aligning with the industry needs.
- (c) TPD must organise workshops, training sessions, mock drills, interactions, expert lectures etc for preparing students on a continuous basis to face recruitment challenges.
- (d) Right from first year, students must get training on communication skills, rational skill, logics, computer skills, personality grooming, GD, interviews, presentation etc and it must be closely monitored/documented by TPD and IA Cell.
- (e) TPD should have yearly plan and callander for training and placement activities and develop it in close coordination with HoDs such that academic schedule is not disturbed.
- (f) There is tendency for TPD and SAC to come up suddenly with an event. At times university administration may also come up with some events disturbing academic schedule. This should be avoided.
- (g) ED Cell must identify potential entrepreneurs by psychometric tests in first year of degree course and provide training, knowhow and plug & play facility right from the initial years so that there are some real start ups by the time students reach final year.
- (h) Through SAC, NSS, NCC should organise activities in the villages adopted if any should be organised by the university. Students must be provided social connect and encouraged to take up social work through these activities. This will develop social concern and help in overall development of the students and finally help in better placement as well.
- (i) TPD must ensure activities in coordination with other departments for holistic development and character building of students such as team events, sports, yoga, social service etc.

VI INFRASTRUCTURE & FACILITIES- LASTING IMPACT

Infrastructure, building, and facilities in a University provide the first impression to a visitor and the visitor has a tendency to make a judgment about the University by the first impression. **Huge size and large quantity may not impress a person but the quality, adequacy, functionality and authentic sense may certainly impress.** Some of the aspects which need attention are-

- (a) **A good ERP is a mirror which reflects the image of a University. There is a need to have a good ERP for a University to display culture, content, capability and growth and create a brand value.**

- (b) Lay out and building plan must be readily displayed in the campus. Direction boards and displays must be simple, elegant and meaningful. Smart and cheerful reception staff, security persons, public relation people will reflect a good image of the university. This needs real training and monitoring.
- (c) Campus should give a green look with cleanliness; energy and water conservation consciousness visible all around.
- (d) Use of solar energy, cashless and paperless environment, and concern for pollution, add positivity to the visitor.
- (e) Normally there is a general complaint in all universities about the rude behavior of non-teaching and lab staff. Private Universities can make a real difference by ensuring that accounts, admin, library and lab staff is trained on their behavior pattern and generate a high happiness index in the visitors and students.
- (f) Modern class rooms with ICT infra, well equipped labs, workshops, state of the art auditorium, seminar halls are mark of a quality teaching learning set up.
- (g) Sports facilities, recreational support, canteen, common rooms, toilets, gym, roads, parking area hostels etc make a lasting impact. Their quality will help in branding of the University. Private universities can make a real edge in facilities.
- (h) The most important feature of good infra and facilities is their upkeep, maintenance and serviceability trend. A fast response maintenance team must be developed and deployed to ensure a fully functional set up.

VII INTERNATIONALISATION, TIEUPS, MOUs AND COLLABORATIONS- A GLOBAL OUT LOOK

Quality and growth in a University can get a real boost by internationalization. In the central government budget for 2020-21, the Finance Minister clearly indicated that government is very keen to open doors for FDIs and foreign universities to collaborate with Indian Universities for offshore campus and centers. Private Universities are better positioned to grab the opportunity. **Dual degree programmes, student and faculty exchange and transportability of courses through credit system in addition to off share campus, can provide good platform to private universities to expand and grow.** There are now opportunities for private universities to execute MoUs with foreign universities to takeup collaborative project work jointly in different areas, exchange faculty and students and do joint research work. Private Universities can build network with foreign universities which will pave way for foreign funding.

VIII REFORMS IN GOVERNANCE – THE CUTTING EDGE

Private universities are supposed to primarily operate as per the provisions of Ordinances and Statutes of the University. Though the society or the trust who have established the University has only promotional role, it is quite logical that promoter or the Chair person of the society/trust would like to play a big decisive role in the management. Normally the VC who is head of the University is only for a period of 2 to 4 years maximum, there is a tendency in private universities for the senior administrative staff who are there for a much longer duration and also responsible for administration and financial dealings, to directly take control and interfere in overall operation of the University which at times may suit promoters also. In such a situation the official hierarchy and protocol starts getting diluted, leading to group politics with academics and research taking back seat. For VC, it becomes difficult to exercise proper control on academic administration and develop a good faculty structure. In such cases selection of faculty, their development and promotional avenues also get adversely affected. This tendency of interferences gets slowly in many areas of operation like examination, setting up and equipping labs, library and other academic support services. Such interference may provide short term financial benefits, but **if a private university is to grow positively such interference in academics must be avoided** and, some of the following reforms must be thought of:-

- (a) Plan to implement vision & mission, must be transparent and made known to everyone. Accordingly strategic plan and detailed development plan should be jointly made and implemented with VC fully involved and in control.
- (b) In matters like faculty selection, promotion, development, academics, research, examination, only VC should have final say.
- (c) **E-Governance should be used extensively. There should be an effort for automation of all the areas of operation right from admission to results, examination to continuous assessment, finances to record maintenance. ICT need to be promoted in a big way for teaching – learning. Outsourcing if required need to be resorted to and should not be avoided on pretext of savings.**
- (d) Governance should be on principles of participative management where all stake holders i.e. faculty, students, employers, parents, management and alumni have a say, know what is happening and feel the ownership.
- (e) There is a need to rejuvenate BoS, Academic Council, Governing Body and all other committees to function on a routine basis and not through retrospective recording for building documents at the time of need only.

- (f) IQAC (Internal Quality Assessment Cell) must be properly formed in all private universities and quality control monitoring and governance in all the area of operation i.e. academic, administration, infra and finance must be done by IQAC effectively under direct control of the VC. Self assessment on quantity basis must be done by IQAC on monthly or quarterly basis.
- (g) Academic and Administrative audits must be done effectively every year to overcome deficiencies/shortages.
- (h) **Discipline and punctuality are the most important areas in a university which provide the pulse to know health of the organization, and quality of students, faculty and management.**

Though, there may be a natural hesitation/reservation on part of the promoters/sponsors to make things transparent and provide liberty to VC to operate exactly as per the ordinances, but if it is done, even at reasonable proportion in a congenial and respectful environment, such reforms shall certainly pay rich dividends in long run. Promoters must ensure reforms in governance in such a way that academic and administrative staffs operate in harmony with VC as head of institution and Registrar in a supportive role.

IX LACK OF LEVEL PLAYING FIELD- WHERE THE SHOE PINCHES

The biggest problem in development of a private university is discrimination by regulating bodies, controlling and monitoring agencies of the government. There are various types of universities like central, state, deemed, open and private universities. Though all types of universities discharge almost same kind of functions, private universities are sufferer of discriminatory treatment. May be, it is due to the fact that private university is a relatively newer phenomenon, and rules and regulations may take time to refine and settle down amicably. Private sector normally suffers from suspicion though in education sector both private and public sectors have similar good and bad features. Following aspects are worth consideration:-

- (a) A government university is provided approval under 2(f) from day one whereas for private university it takes quite some time. Same is the case for AIU membership. As a matter of fact for everything a private university has to undergo suspicious scrutiny and overregulation every time. There are many such rules which need reconsideration.
- (b) For funding, a private university has almost no support from Government even for development. There are no soft loans available and it has to resort to loans at commercial rates. If, for agriculture, for small scale industries etc, there is provision for soft loans why not for private

universities. After all, they are engaged on a very important national mission.

- (c) For research, private universities are hardly given grants. If the quantum of government funding provided to various universities is examined it will reveal that the share of private universities is quite meager and disproportionate to their strength and potential. There is need for review of the policies.
- (d) Government Universities can have affiliated colleges from day one where as private university has to wait for 5 years to open off campus share centers.
- (e) Committees and bodies set up for framing policies by the Government have not adequate representation from private universities. There is certainly need for review.

However things are now changing for better. There is a realization at various levels of regulation and policy making. Provisions in NEP-2019 are indicators of a silver line. Still private universities will have to go a mile extra and work hard to provide quality and prove them to force policy makers to provide a level playing field. It is said that only crying baby gets milk. Private Universities will have to continue their efforts on regular basis. There is need for private universities to create a vibrant platform where all private universities could come together to take up various issues for common benefits. **There is need to create a network of all private universities and ensure better cooperation, synergy and exchange initiatives. Collaborative approach can really help in solving many problems.** With concerted efforts things are bound to change for better. During presentation of budget for Fy 20-21 the Finance Minister has clearly indicated that Education sector will be one of the governments priority and finance will not pose any hurdle for quality targets that government has set.

X CONCLUSION

The educational landscape in India is simmering and bubbling with the need for redefining and redesigning educational structure and system as the transformation is taking place in all other fields also. Educational institutes obviously have to play the most crucial role. Private institutions are now contributing to almost 60 percent of student registrations and as private universities are continuously increasing in number, at never before pace; their share of participation will keep increasing and they will have to take a decisive lead. Private Universities will have to ensure that quality and accessibility of education and research, meet the aspirations and targets set by the nation. **Battle for private universities is going to be tough and needs to be fought simultaneously on three fronts. On first front, they have to improve and grow in quality in all spheres of education and research. Second front is the discriminating policy front**

where they have to continue their struggle for a level playing field in terms of claiming equal treatment in regulations, control and governance etc. Thirdly and most importantly, they have to conclusively dispel the false impression that there is lot of scope of mal practices, short cuts and misappropriation in education sector. Private

universities will have to take a lead to reestablish education sector as an example of efficiency, quality and very high moral standards and bring back the glory to teaching- learning profession as the most Nobel and sacred occupation.

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Development of Working Model of a Vertical Axis Sail-Type Wind Pump for Standalone Irrigation

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ABSTRACT

The global warming is leading to climate change which has emerged as one of the most severe challenges of 21st century. The main cause of global warming is the emission of green house gases (GHG) in the atmosphere when fossil fuels are burnt and another issue is the fast depletion of fossil fuel deposits. The solution lies in avoiding/minimizing the use of fossil fuels as a source of energy by promoting and adopting the use of renewable sources of energy. Also, there is tremendous scope of research in the field of renewable energy for various applications. In view of this, a research project was undertaken in the Rabindranath Tagore University to develop a working model of a standalone windmill driven pumping system to lift water for optimum irrigation. The development was comprised of the centrifugal pump in the first stage and reciprocating pump in the second stage and then compares the outcome of two types of pumps. The emphasis is to develop the cost effective pumping system based on simple technology.

I INTRODUCTION

Indian economy is largely based on the farming and agriculture. Effective farming and agriculture depend on irrigation system through water stored in dams, wherever available. The non-canalized farms are dependent on irrigation by using diesel engine or electric motor driven pump for pumping water from the wells, ponds, rivers, nallas etc. In view of this, standalone in-house development of windmill was taken-up and it was aimed to make the developed wind mill the focus was on the development of simple technology to suit the rural entrepreneurs for manufacture and service.

II MAIN SUB-ASSEMBLIES USED

The wind mill and pumps used/considered in the process of development of working model of wind mill are described below:

- (a) **Sail-type wind mill** - The wind mill is based on the technology of sailing boats. It has furling wings instead of the traditional blades as shown in Figure 1. Its design overcomes the performance and structural limitations of conventional vertical axis wind turbines as the surface area of the sails can be varied according to wind speed. The surface area of the sail reduces on the upwind stretch of the rotational cycle. It is an altogether different concept to capture wind energy.



Fig No. 1: Sail type wind mill

The wings of wind-mill orient flat to the wind during downwind cycle and when it starts orienting itself to be an aerofoil during the upwind cycle. Thus, rotational force is obtained during the downwind cycle as well as upwind cycle. Thus, rotational force is obtained on the upwind cycle as well as the downwind cycle.

Thus, large sail area faces the wind when the wind is low, but also the sails are oriented on the downwind cycle. It is how torque is generated in the upwind as well as downwind cycles.

A lower height, say 10 to 15 m may serve the purpose which is considerably shorter than the average horizontal axis wind mill. The wind mill may start rotating at a wind speed of 2.5 to 3 m/s.

Installation at a lower height and slow rotation results in very little noise and the visual as well as environmental impact of wind mill is highly reduced. The fact that is slow moving also reduces the amount of stress on the mechanics of the device that is composed of components, 80% of which may be available off the shelf. Its manufacturing technology is well established and wind mills are readily available around the world.

The wind mill can also be used as a turbine for generating electricity.

(b) **Centrifugal pump** - In the cage or body of the pump there is an impeller (rotor) which rotates at a high speed by the available driving force. When impeller rotates, the suction is created at the suction end, and due to centrifugal force at the centre of the impeller, water starts flowing radially outwards and moves-up from the discharge end of the pump. Higher the speed of rotation, higher the centrifugal force results in higher lift of water from the discharge end of the pump. Hence, to drive the centrifugal pump at high speed to deliver water at higher heads, it is generally coupled with either electric motor or diesel engines. A centrifugal pump is shown in Figure-2.

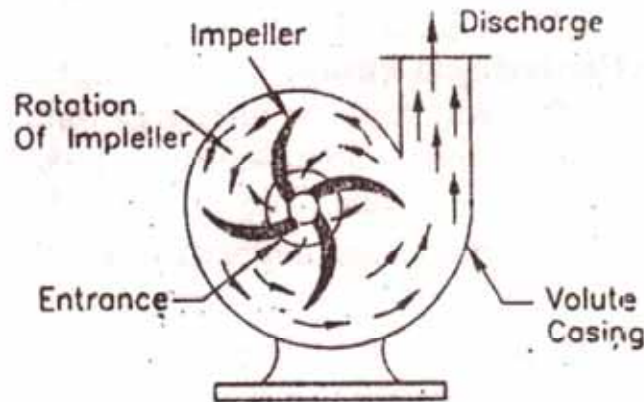


Fig No.-2: Centrifugal pump

(c) **Reciprocating pump** - The reciprocating pump is popularly known as a hand pump. This has a cylinder and inside the cylinder there is piston with piston valve (check valve) and a foot valve (check valve) at bottom of the cylinder. When piston of the pump moves up from the bottom dead centre, the foot valve opens to enter the water in pump below piston while suction of water starts as piston valve remains closed. In

continuation of the process foot valve starts closing while piston valve starts opening and allow water to enter in the space above the piston and at the same time foot valve is closed. In this way the process of opening and closing of both the valves continue and in repetition pump is fully filled and water flows from the outlet of the pump cylinder. Refer Figure-3.

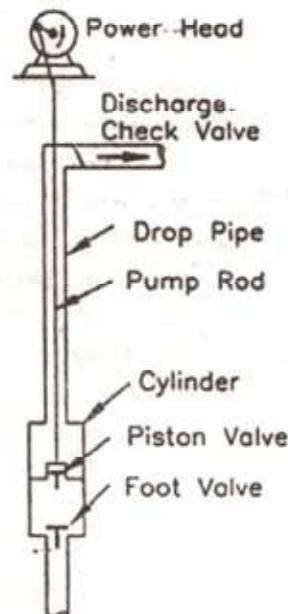


Fig No.-3: Reciprocating pump

III DEVELOPMENT OF INITIAL MODELS (VARIANTS-I & II)

The project to develop working model of sail-type wind mill to pump for standalone irrigation was undertaken in the university workshop. The process of development passes through following stages:

Variant-I: Figure 4

Variant-II: Figure 5

Final Windmill Assembly: Figure 7

(a) **Drawings** - The first step in the manufacturing, especially first time development, was the clarity on the wind mill to be developed for which dimensional drawings were necessary. A drawing of wind mill for pumping was prepared manually to show various parts and sub-assemblies. There were brain storming sessions and accordingly modifications were carried out in the drawing and finally the test set-up drawing took the final shape.

The arrangement drawings of wind mill assembly were drawn on computer using 'Corel DRAW' tool in order to maximize the clarity.

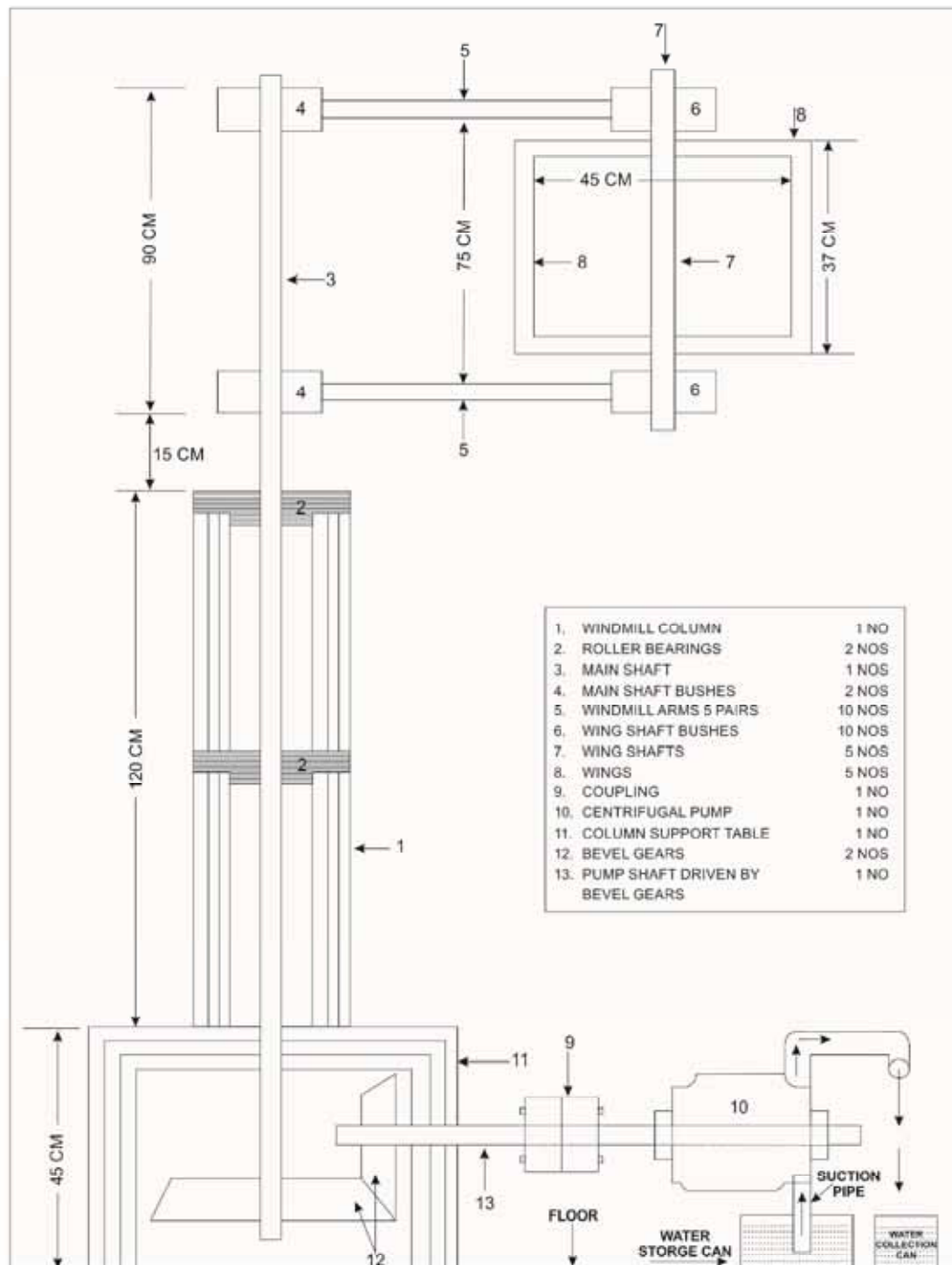


Fig No.-4: Windmill with bevel gear arrangement of torque transmission (Variant-I)

- (b) **Norms for selection of materials/components:**
Selection of various materials and components was done as per the following priority:

Priority-A: Use available materials which may be even from scrap.

(c) **Manufacturing Activities**

The in-house workshop activities associated with the wind mill models are as given next:

- (i) Cutting of angles, bars, rods, pipes etc. using hexa-blades, hand cutters and power cutters.
- (ii) Cutting of metal sheets for wings. Subsequently, the metal sheets were replaced by the plastic sheets.
- (iii) Fabrication of steel plates, rod etc. to manufacture main shaft, windmill column and column support table in Variants-I & II.
- (iv) Dressing to remove burs and smoothen the welded surfaces by manual filing in Variants I, II and final assembly.
- (v) Wing assembly: Each wing assembly comprises of wing, wind shaft, bushes and wing assembly arms in Variants-I and II.
- (vi) Mounting of wing assemblies on main shaft was done using fasteners (nuts/bolts) in Variants-I & II.
- (vii) Main shaft assembly: It comprises of main shaft, roller bearings and steel plate in Variants-I & II.
- (viii) Protective coating: Application of 2 coats of primer and 2 coats of paint.
- (ix) Assembly of flexible pipes and taps for delivery of water at different heights in final assembly.
- (x) Provision of cans for storage and collection of water in final assembly.
- (xi) Provision of air supply for testing of the model in Variants-I, II and final assembly.

Priority-B: Procure the second hand materials from 'Kabadkhana' shops/market.
Priority-C: Procure new materials.

- (xii) Flexible and G.I. pipes and fittings for water flow and discharge in final assembly.

(d) **Wind Mill Initial Model Variant-II-** For coupling between windmill and pump, the bevel gears provided for torque transmission were replaced by the spur gear-pinion arrangement. See Figure-5. Spur gear large (1 no., 192 teeth): A mild steel plate was cut in the workshop and dressed. The formation of gear teeth on steel plate was outsourced.

(i) **Test run of wind mill and pump** - After satisfactory development of the parts as described above, the sub-assemblies were installed to obtain total assembly. The spur gear was fixed on the main shaft. The pump was connected to the wind mill using pinion on the shaft. The arrangement of test set-up for variant-II is shown in Figure.5

(ii) **Test run** - The test set-up is shown in Figure-6. During testing of the model, wind was blown from the air cooler to the wind mill. The distance of 1.6 m was maintained between the centre line of wind mill and the face of air cooler. The wind speed of 5 m/s was maintained. The wind-mill in conjunction with the pump operated smoothly. The wind mill speed of 20 rpm was increased to 260 rpm of pump shaft by using spur-gears. However, the quantity of water pumped was very less at low pressure.

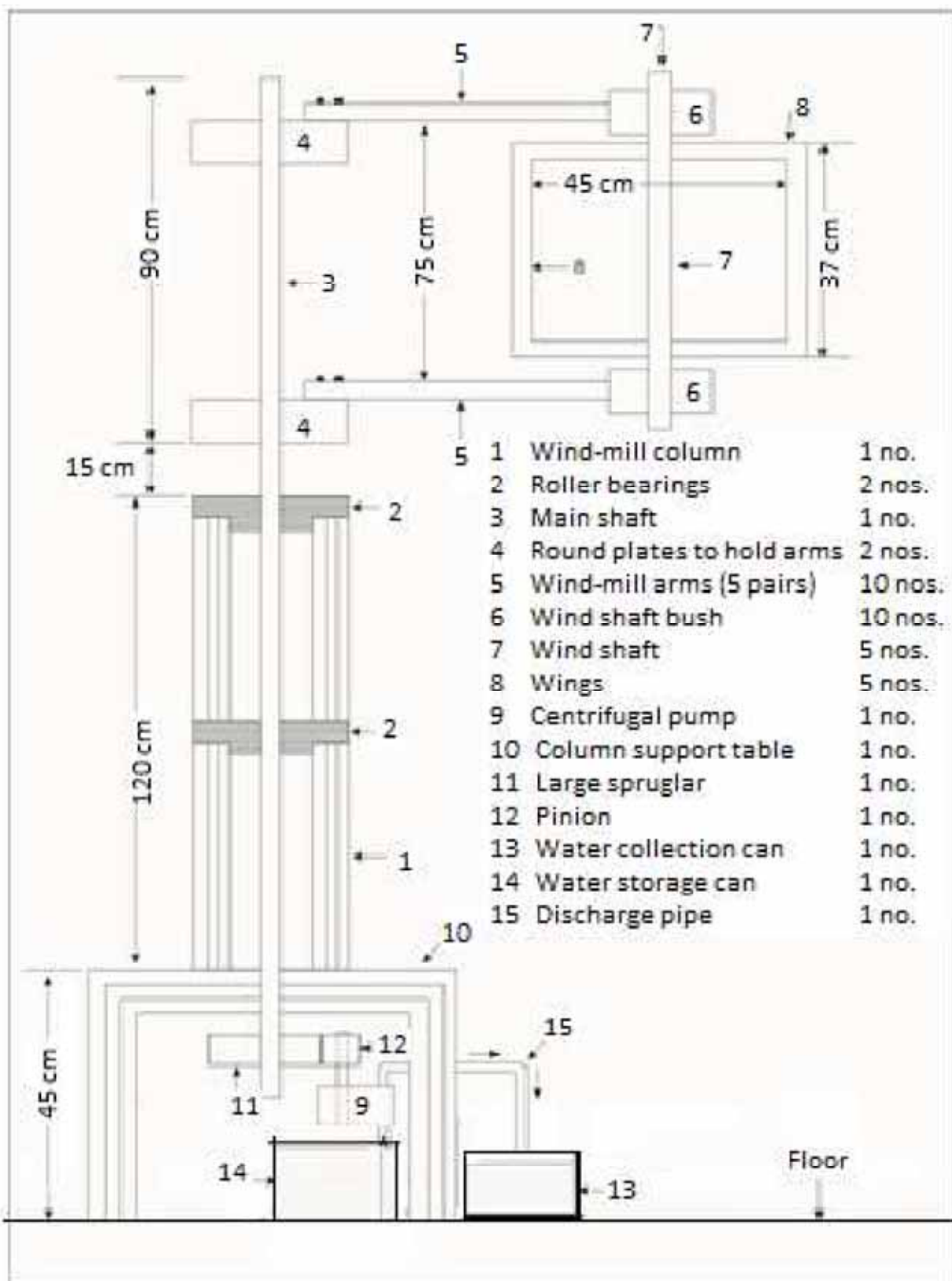


Fig No. 5: Arrangement of windmill for performance testing (Variant-II)



Fig No. 6: Initial model of windmill with centrifugal pump (Variant-II)

- (iii) **Performance test** - With the developed configuration, the test set-up was done in the workshop. The readings recorded are given in Table-1.

Table No.1
Water discharge with INITIAL wind mill
(Torque from mill shaft to the shaft of centrifugal pump is transmitted through spur gear mesh)

Wind speed	Gear wheel	Gear ratio	Revolution of windmill, rpm	Revolution of pump, rpm	Discharge head, mm	Time, minutes
5 m/s at a distance of 1.6 m	Spur gears	15 /100	20	135	Negligible	---
---Do---	---Do---	15 /192	20	260	150 mm	Very low discharge, not recorded

- (iv) **Result:** The pumping was inadequate.

- (v) **Analysis:** Table-1 for initial model (variant-II) revealed that with the developed model of wind mill, the speed of 260 rpm of pump shaft was inadequate to discharge water by the centrifugal pump. In fact, centrifugal pump is a rotary machine which performs well at high speed. Therefore, there was a mismatch between wind mill and centrifugal pump. This is the reason that rotary machines are generally driven by electric motors or diesel engines.

In view of the experience gained, the next step was to replace the centrifugal pump by the reciprocating pump which can perform satisfactorily with the low speed wind mill. Further, the torque was transmitted through gear drive and there was not much scope to increase the speed of pump by increasing the number of teeth of large driving gear of the windmill. Hence, there was no use to go ahead with the developed version. However, the efforts made provided good exposure which was useful in the development of a modified and final model in conjunction

with the reciprocating pump to suit the low speed vertical axis windmill.

- (vi) **Conclusion** - In view of inadequate pumping by centrifugal pump, a modified final model using reciprocating pump was developed.

IV DEVELOPMENT OF FINAL MODEL

On the basis of experience gained and after discussion and study, modified new and final model was taken-up on following lines:

- Design and develop a new version of a wind mill with wings of larger size.
- Use reciprocating pump which works on to and fro linear movement.
- Provide suitable mechanism using crank to convert the torque of rotary motion of wind mill shaft into linear motion using sprocket.

A comparison of the initial and final models is given in Table-2.

Table No. 2
Comparison between the initial and final models

Parameter	Initial model	Final model
Type of pump	Centrifugal	Reciprocating
Main shaft orientation	Vertical	Vertical
No. of wings	5	3
Size of each wing	37 cm (H) x 45 cm (L)	90 cm (H) x 75 cm (L)
Torque transmission	Spur gear and pinion mechanism for rotary to rotary torque transmission	Sprocket and crank mechanism to convert rotating motion into the linear motion

(a) Major items/sub-assemblies of the final model

- (i) Three large size sailing wings.
- (ii) Robust column and support structure having 2 roller bearings with a main shaft for transmission of torque to the sprocket mesh (used in place of bevel gear).
- (iii) Crank mechanism to convert rotary motion of main shaft into linear motion of piston rod of pump.
- (iv) Reciprocating type hand pump.

A general arrangement of the final model of wind mill for pumping is shown in Figure-7.

(b) Assembly of final model: Final model comprises of 3 wings, a robust column and support structure with 2 roller bearings and a shaft for transmission of power to the small and large sprocket mesh (this mesh is used in place

of bevel gears mesh generally used). Small sprocket is driven by the shaft which further drives large sprocket. The large sprocket is attached to a crank mechanism which converts rotary motion of the shaft into linear movement of the piston rod of the reciprocating pump for lifting the water. As the vertical shaft of the mill rotates by flowing air, the small sprocket (having 17 teeth) is driven which drives the large sprocket (with 44 teeth) mounted on horizontal shaft. It is next attached to a crank mechanism which converts rotary motion of vertical shaft into linear motion of piston rod of reciprocating pump. Water is pumped in every rotation of the crank and in every linear water is delivered

(c) Test set-up of Final wind mill model for pumping - The performance test model of the wind mill for pumping is shown in Figure-8.



Fig No.-7: Set-up of final model for performance testing

(d) Performance testing of final model - The readings of the performance test are given in Table-4. **Note:** The regulator of the air cooler is

used to obtain 3 speeds. The desired speeds were obtained by adjusting the applied voltage with the help of rheostat.

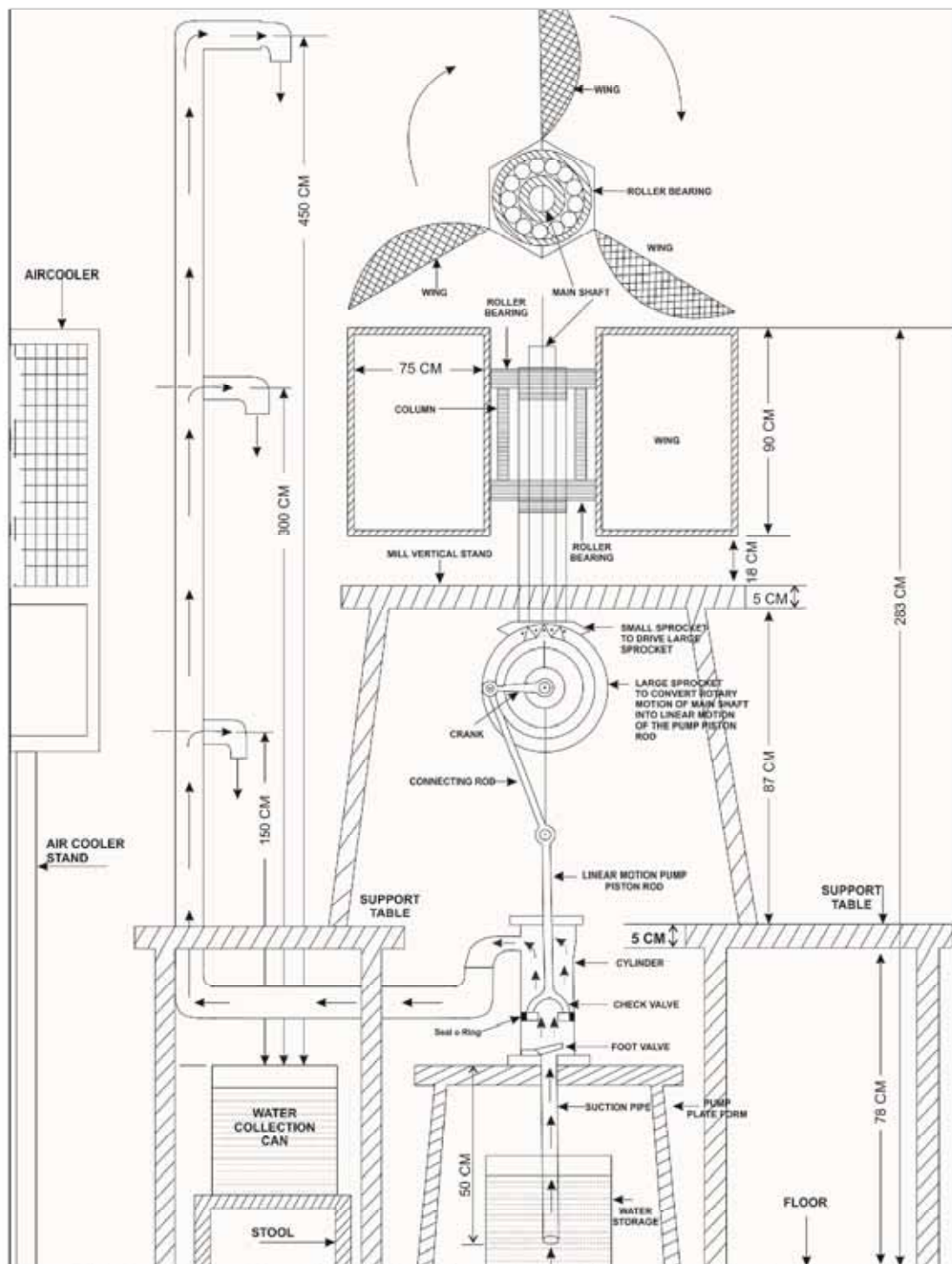


Fig No. 8: Assembly of final windmill pumping FINAL model for performance test

Table No. 3
Discharge parameters of final model

S. No.	Air cooler Operation at low, medium and high speeds*		Wind speed, m/s	Wind mill revolution, rpm	Water discharge height, m	WATER DISCHARGE		REMARKS
	Speed setting	Voltage, Volts				Quantity, litre	Time, minute	
1A.	LOW	185	5.0	7	1.5	20	9	
1.B	MED	200	5.9	9	1.5	20	7	
1.C	HIGH	270	7.0	12	1.5	20	6	
2.A	LOW	185	5.0	7	3.0	20	9	
2.B	MED	200	5.9	9	3.0	20	8	
2.C	HIGH	270	7.0	12	3.0	20	8	
3.A	LOW	185	5.0	7	4.5	20	15	
3.B	MED	200	5.9	9	4.5	20	9	
3.C	HIGH	270	7.0	12	4.5	20	7	

*Distance between air cooler face and centerline of windmill = 1.47 m

V CONCLUSION

(a) **Conclusion**—Considering the objectives of the project, efforts have been made in developing a cost effective and easy to construct working model of sail type wind mill pumping system. The selection of material/ components was done judiciously in developing specifications and preparation of drawings of the working model. The whole process of development of the project passed through 3 phases of Variant-I, Variant-II and final model of the project. Though success could not be achieved in Variant-I, Variant-II models but this provided a very good exposure and guidelines for taking correcting measured and develop modified model costing just Rs. 10,000/-. The final model performed satisfactorily. The reciprocating pump delivered 20 litres water in 7 minutes to a height of 4.5 m.

The main objective of the research was to encourage/promote the use of environment friendly wind energy based standalone and cost-effective pumping system. It is easy to build/construct/manufacture and economically viable for irrigation in the rural areas. The technology is very simple to manufacture and can be assimilated by rural segment. It is likely to require little maintenance and minor repair.

(b) Future scope

Field trial: The requirement of water for irrigation depends on the soil and crop. The optimum irrigation can be achieved by providing moisture sensor in the field soil at appropriate locations. However, before field trial a suitable braking system will be necessary for protection of wind mill against over speed of wind.

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Numerical Analysis of Multi Jet Pelton Turbine Model

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ABSTRACT

Every turbine is designed for specific site condition (head, discharge and speed). For high heads and low discharge values, Pelton turbines are mostly used. Variation in head and discharge causes variation in performance of turbines. Earlier only experimental techniques were used to optimize the design of turbo-machine and check their performance at designed and off design conditions. With the advances in numerical techniques and computational power, Computational Fluid Dynamics (CFD) has proved to be boon in designing and predicting the performance of turbo-machine at all possible operating regimes. With the help of CFD, not only global parameters can be found out but local parameters which are not possible experimentally can be found out. In present work, flow analysis of a six jet Pelton turbine model has been done using multi phase flow. Numerical results are compared with available model test results at the best efficiency point. The effect of mesh size, turbulence model and time step is also studied.

Keywords— Multi jet, CFD, numerical techniques, Pelton turbine, multi phase flow

I INTRODUCTION

Earlier, for predicting the performance of turbo-machines model testing was the only way. In the last few decades, with the advances in computational power and numerical methods, Computational Fluid Dynamics (CFD) has emerged as a very powerful tool to optimize turbo-machine in design phase only. CFD has been extensively used for design optimization of turbo-machines involving one fluid flow since many decades. But now with advent of Volume of Fluid and 2-phase homogeneous model etc., CFD can also be used for determination of performance of Pelton turbine.

For simulating flow around a Pelton turbine runner, transient analysis needs to be performed by considering multiphase flow. Simulating flow around Pelton runner is complex and it requires a lot of computation time.

Initially, only injector design optimisation and stress calculation on Pelton runner was done and it was first carried out by Francois [1]. The most detailed Computational Fluid Dynamics (CFD) analysis of rotating Pelton turbine was done by Perrig et al. [2] by considering five buckets (one-quarter of the runner) and the computed results were compared with experimental results at best efficiency point (BEP). Zoppe et al. [3] performed flow analysis inside stationary Pelton turbine bucket using commercially available CFD code Fluent and validated the results experimentally. Gupta and Prasad [4] have presented effect of jet shape on water distribution in Pelton bucket. Parkinson et al. [5] have simulated unsteady analysis of Pelton runner. Gupta et. al.[4], Patel et al.

[6], Dynampally and Rao [7] have worked on effect of time step and grid refinement. Flow in stationary flat plate was simulated by Konnur et. al. [8]. Xiao [9] and Zhang [10, 11] have studied or simulated effect of friction on Pelton buckets. Zhang[12, 13,14], Binaya et.al [15], Santolin [16] have worked for impact, flow dynamics and pressure distribution in Pelton bucket. Gupta et al.[17-23] have worked for different shapes of jets on stationary plate or Pelton bucket. They did detailed multiphase flow analysis in Pelton turbine and also found the importance of nozzle distance from bucket on the performance of Pelton turbine.

The main points of focus for analyzing a Pelton turbine are torque and efficiency and hence the value of torque and efficiency were found out at Best Efficiency Point (B.E.P.). The runner diameter to bucket width ratio is considered 3.4 in present analysis.

II GEOMETRIC MODELING

The existing Pelton model has six jets. The jet diameter and pitch circle diameter are 32.4 mm and 175.5 mm respectively. The runner of Pelton is symmetric and hence geometry of half of runner has been considered for simulation. The buckets are also symmetrical about the splitter and therefore half jet and bucket are modelled due to limitation of computational facility. The modelling has been done in Workbench. The modelled geometry of stator domain (jet from nozzles) is shown in Figure 1 and rotor domain (Pelton runner) geometry is shown in Figure 2.

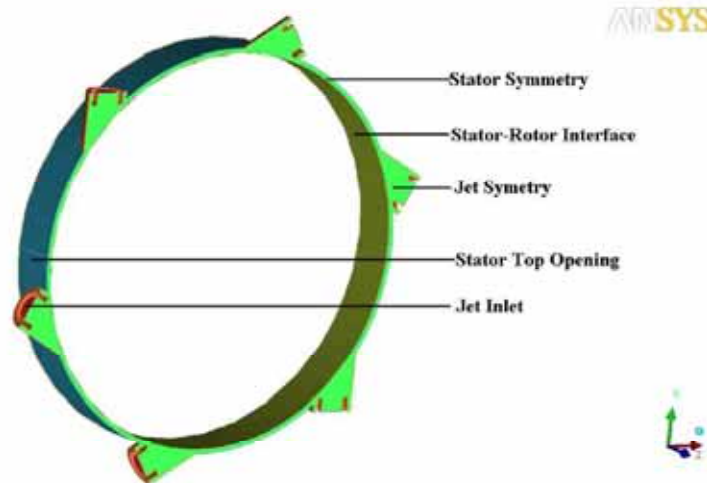


Fig No. 1 Geometry of Stator Domain

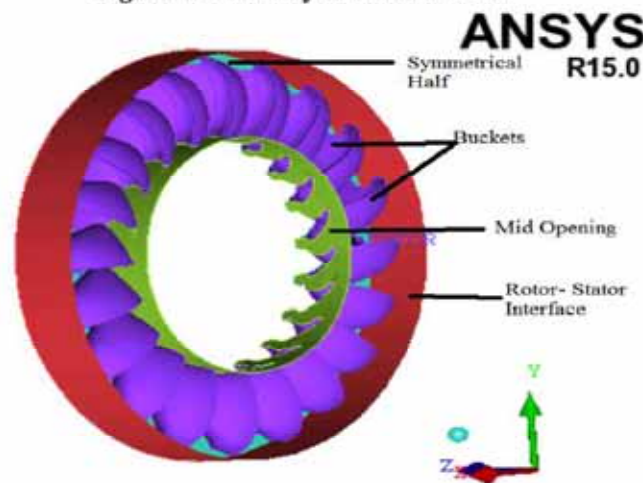


Fig No. 2 Geometry of Pelton Runner

III MESH GENERATION

The complete flow domain is discretised into tetrahedral and prismatic 3-D elements for simulation. The prismatic elements are used near to bucket

surface for proper resolution of boundary layer. Meshing of both the domains has been done separately. They are connected through proper interface before defining boundary conditions. Meshing of rotor domain is shown in Figure 3.

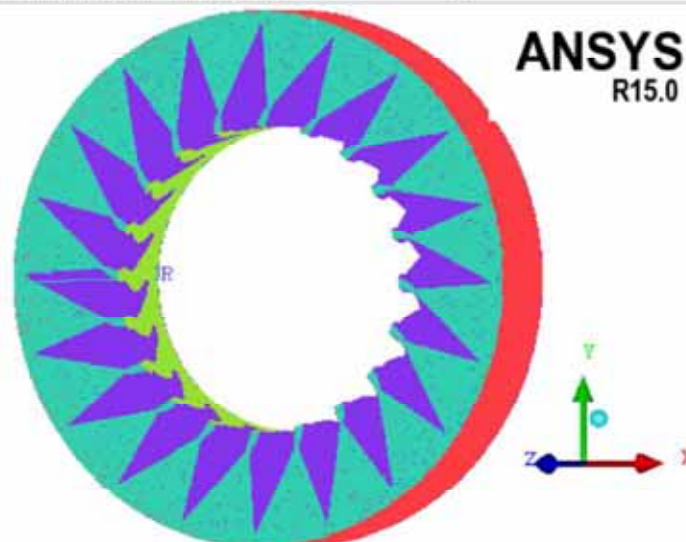


Fig No.3 Mesh of Runner

IV BOUNDARY CONDITIONS

Stator domain containing jet is kept stationary. Rotor domain has been set to speed at B.E.P. The analysis is carried out by taking SST turbulence model because of its ability to capture the flow with sharp curvatures and runner rotation.

Transient flow simulation is chosen with time step corresponding to 1° runner rotation for all the cases. Air and water are taken as working fluids with a reference pressure of 1 atmosphere. The jet inlet has been defined as inlet with water velocity corresponding to 50m head. Jet symmetry, stator symmetry and rotor symmetry have been defined as symmetry. The opening is specified all around stator and rotor. Transient rotor-stator interface is specified in between stator and rotor domains.

Continuity

$$\frac{\partial \rho_m}{\partial t} + \vec{\nabla} \cdot (\rho_m \vec{W}_m) = 0 \quad (1)$$

where the mixture density and the mixture relative flow velocity are defined as

$$\rho_m = \sum_{n=1}^2 \alpha_n \rho_n \quad (2)$$

and

$$\vec{W}_m = \frac{\sum_{n=1}^2 \alpha_n \rho_n \vec{W}_n}{\rho_m} \quad (3)$$

the volume fraction α_n is given by

$$\alpha_n = \frac{V_n}{\sum_{n=1}^2 V_n} \quad (4)$$

Momentum:

$$\frac{\partial}{\partial t} (\rho_m \vec{W}_m) + \rho_m (\vec{W}_m \cdot \vec{\nabla}) \vec{W}_m = -\vec{\nabla} p_m + \vec{\nabla} \cdot (\bar{\tau}_m + \bar{\tau}_{t_m}) - \rho_m \vec{\omega} \times (\vec{\omega} \times \vec{r}_m) - 2\vec{\omega} \times \vec{W}_m + \vec{f}_m \quad (5)$$

VI FORMULAE USED

Water power available at nozzle outlet

$$P_I = \rho \times g \times Q \times H \quad (6)$$

Numerically calculated power is given by

$$P_O = \frac{2 \times \pi \times n \times T}{60} \quad (7)$$

Efficiency

$$\eta_n = \frac{P_O \times 100\%}{P_I} \quad (8)$$

Time step corresponding to 1° runner rotation:

$$\Delta t = \frac{60}{360 \times n} \quad (9)$$

Torque Coefficient

$$K_r = \frac{T}{\rho \times C_1^2 \times B \times L \times D} \quad (10)$$

Normalised Efficiency

$$\partial = \frac{\text{Efficiency}}{\text{Efficiency at B.E.P.}} \quad (11)$$

VII GRID INDEPENDENCY STUDY

The mesh size affects the results obtained from simulation and hence grid independency test was

done for both stator and rotor.. It was found that 547940 nodes and 2589738 elements were required for stator. For studying the effect of mesh size of rotor, three cases were considered.

Table No. 1
Effect of Mesh on Efficiency

S.No	Mesh	No. of Nodes in Rotor	Efficiency	Time Duration
1.	Coarse	46936	68.02%	19 hours
2.	Fine	1141518	77.23%	52 hours
3.	Finer	1480537	77.76%	62 hours

It is found that for increase in mesh size from 1141518 to 1480537 elements, computational time increases by 10 hours and the deviation in efficiency is only 0.53% so fine mesh is chosen for further study.

(a) **Study on Turbulence Model** - Two equation turbulence models are mostly used for modeling turbulence. (e M with scalable wall function and SST model with automatic wall function have been considered.

Table No. 2
Effect of Turbulence Model

S.No	Turbulence model	Efficiency
1.	(e M with scalable wall function	77.23%
2.	SST with automatic wall function	77.93%

Table 2 shows that SST model gives 0.7% higher efficiency at B.E.P. The reason for this can be that SST model accounts for the transport of shear stress accurately than (e M model. (e M model over predicts the production of turbulent kinetic energy near stagnation points and in adverse pressure gradient flows leading to lower efficiency. For further study, SST turbulent model has been used.

(b) **Study on Advection Scheme** - Numerical errors for a given mesh size are directly proportional to the order of discretisation scheme. The above results were obtained for first order upwind scheme. More simulations were carried for High resolution and Blend factor of 1.

Table No. 3
Effect of Turbulence Model

S.No.	Turbulence model	Efficiency
1.	Upwind	77.93
2.	High Resolution	78.94
3.	Blend Factor 1	80.60

(c) **Time Step Study**-For any transient simulation, time step plays a vital role. Smaller is the time step, better are the results obtained but at the cost of high

computational time. In present case, three time steps corresponding to 0.5°, 1° and 2° runner rotation have been considered. Table 4 shows the obtained results.

Table No. 4
Effect of Time Step

S. No.	Time Step	Normalised efficiency	Time Taken
1.	0.5°	0.91	118 hours
2.	1°	0.88	60 hours
3.	2°	0.80	31 hours

Due to limitation of time and computational power, time step lesser than 0.5° could not be used. At larger time steps, the deviation in efficiency is high. This may be due to the fact that at larger time steps, time scales may not be properly resolved.

VIII DISCUSSIONS

- (a) **Variation in Torque with Respect to Degree of Rotation of Runner** Initially, water starts to get out of nozzle but it does not hit the runner. So the value of torque observed is zero. As water starts hitting the buckets, torque is found out to have some value and then start increasing till the buckets successively comes in front of jet and have almost uniform value of torque as shown in Figure 4.

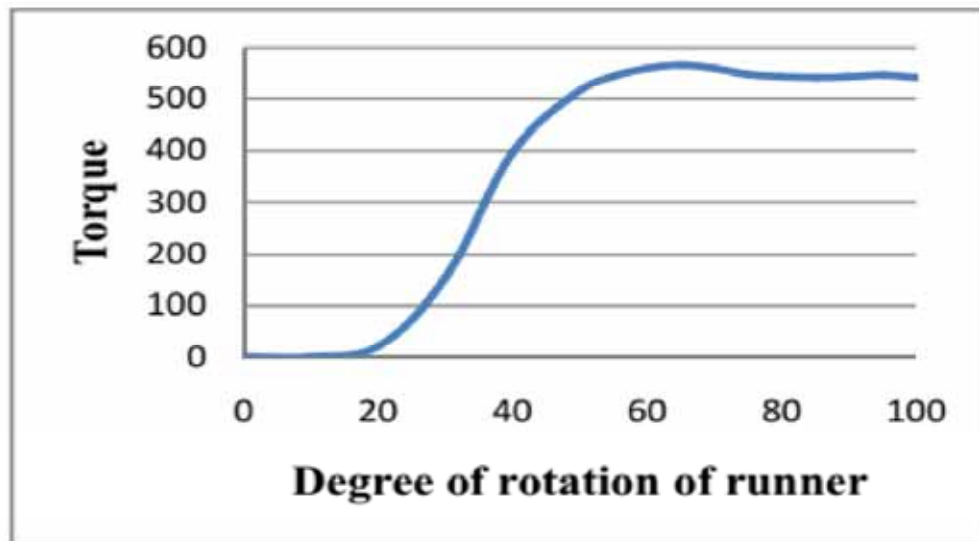


Fig No. 4 Variation in Torque with Degree of Runner Rotation

Slightly higher value of torque is observed when the water jet starts hitting the runner. During later stages, torque becomes uniform.

- (b) **Flow Visualisation** - Figure 5 shows flow within the region of interest at BEP. It can be observed that jet strikes almost normal to all the

buckets. The preceding bucket does not obstruct the water and no water is left without striking the buckets. . So the design of runner is appropriate and any modification is not required.

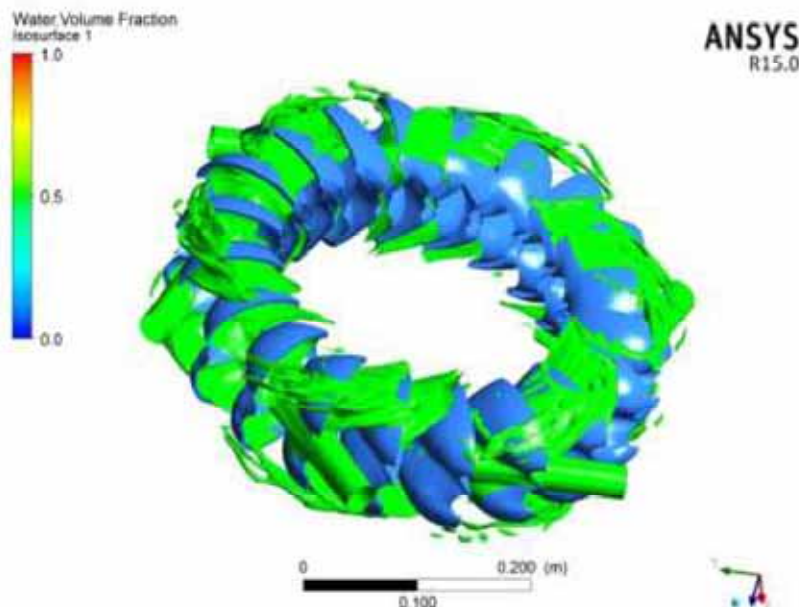


Fig No. 5 Flow Visualisation In Pelton Runner

(c) **Effect of Variation in Speed** - The variation in torque with runner rotation at different speed is shown in Figure 6. Higher values of torque at runner are observed at lower speed and at higher speed; runner experiences lower value of torque for given flow rate which resembles the characteristics of Pelton wheel. At lower speeds,

uniform value of torque is observed whereas as the speed of runner increases, more fluctuations in value of torque are there. The torque is maximum when bucket is normal to the jet and decreases when bucket either reaching to or moving away from normal to jet position.

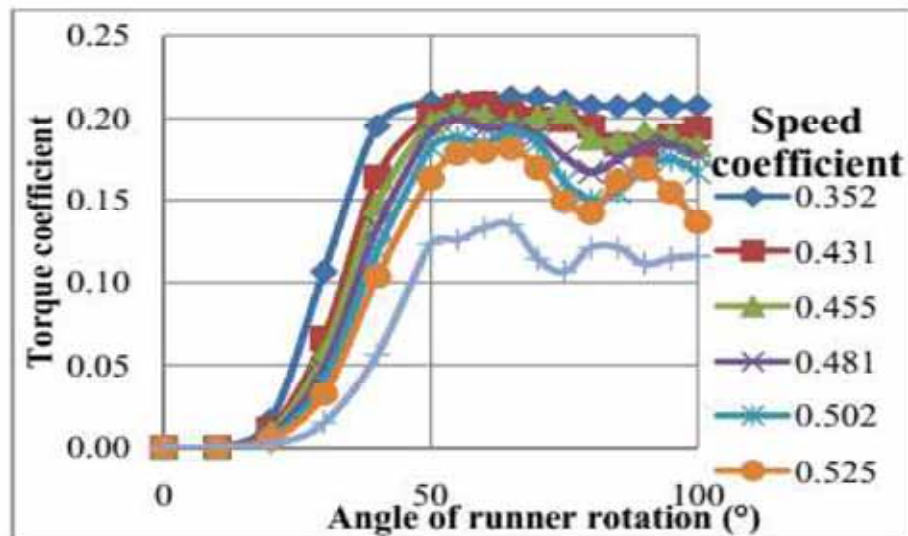


Fig No. 6 Variation in Torque Coefficient with Angle of Runner Rotation

IX CONCLUSION

Numerical simulation for predicting the efficiency, flow visualisation has been done for variation in grid size, turbulence model, advection scheme at BEP. The results are compared with available model test results. The results obtained from CFD are very

useful to understand flow behaviour inside the Pelton runner. Flow can be easily visualised using volume fraction in CFD which is very difficult in experiment. The torque experienced by runner is found to be increasing with decrease in rotational speed. The fluctuations are minimum at lower speed and increase with speed.

g- acceleration due to gravity (9.8 m/s²)
H- head (m)
N- rotational speed of rotor (rpm)
PO- numerical Power Output (Watt)
PI- power input (Watt)
Q- volume flow rate of fluid at jet inlet (m³/s)

T- torque on runner (N-m)
(k density of water at 20°C (997 kg/m³)
(bE experimental efficiency (%)
(bH hydraulic efficiency (%)
P speed coefficient

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Optimal Load Shedding in Uncertain Power System to Improve Voltage Stability

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ABSTRACT

This paper presents an efficient technique for optimum load shedding in an uncertain or dynamic power system network. If the normal control actions to improve the voltage stability are exhausted then the load shedding option works as the last line of defence to get the desired stability margin in power systems, hence it enables the system to withstand under worst loading conditions. In this paper a sensitivity index has been used to get the optimal buses on which load to be shed at heavy load conditions to get the desired value of voltage stability. An optimization problem aiming to minimize the load shedding at selected buses while satisfying all the inequality constraints to ensure the optimal power flow in the system has been developed in this paper. The load shedding is done on such buses whose sensitivity is higher. Black Hole algorithm has been used for optimum load to be shed at selected load bus. The proposed technique is implemented on IEEE 30 bus test system.

Keywords: Uncertain loads; Dynamic voltage stability, Black hole algorithm.

I INTRODUCTION

Voltage instability, voltage collapse and blackout are the cascading phenomenon in the power system networks. Various blackouts have been observed in the power system in the last few decades due to the increasing demand of electricity and failure of available control actions [1]. The non-deterministic nature of load and their representation in power system have been presented in [2]. The available control actions to maintain the system voltage stability are the Reactive compensation, On-load tap changers, and the Generator bus voltages are the first line of defense to prevent system from voltage instability conditions. All these control variables have certain limits of operation under which they try to maintain system voltage stability and after the exhaustion of their range under the increasing load conditions it becomes tough for system to withstand under heavier loading conditions and the voltage collapse may occur when the system is trying to support much more load than it can support [3]. On such cases the load shedding is an option to maintain the system operations under such conditions. But the foremost objective of power system operators and planners is to maintain system security which is nothing but the availability of power supply to consumers under contingent conditions [4]. Hence there is a need to optimize the load shedding so that only the small amount of load can be curtailed. The system frequency may violate due to one of the following reasons (i) sudden loss of generation or increase in load demand, (ii) overloading of transmission network, these causes leads to under frequency conditions which can later be solved by load shedding. The voltage stability enhancement scheme following the disturbances by load shedding is presented in [3]. The selection of most appropriate

load shedding by Monte-Carlo scheme is given in [4,5]. Voltage stability enhancement and under frequency control techniques by optimal load shedding are given in [7,8,9]. For a given set of contingencies, a specified approach to enhance system characteristic by optimal load shedding scheme is given in [9,10]. In case of static voltage stability studies in power system the loading (real & reactive) of the system is increases in steps to the point of voltage collapse. The MW distance to this point may be a good measure of voltage stability limit of the system on the same time the minimum Eigen value of load flow jacobian approaches to zero at voltage collapse point which may also be treated as voltage collapse indicator. The one way to improve the system voltage stability at this point to increase the effective reactive reserve in the system by means of reactive power control variables or by reducing the reactive load demand of the system or by optimum load shedding. In this paper and optimization algorithm for optimum load shedding for improving the system voltage stability has been developed. Black Hole algorithm has been used for optimum load to be shed at selected load bus.

II BLACKHOLE OPTIMIZATION

A. Hatamlou [19] has proposed the modified population-based optimization technique inspired from the 'Black Hole' phenomenon. In the journey of a star towards the black hole, there may be a probability of crossing the event horizon. The stars or candidate solutions which cross the event horizon they are sucked by the black hole. The black hole optimization problem is formulated as follows:

$$r_i(k+1) = r_i(k) + rand(r_{BH} - r_i(k)) \quad (1)$$

Where $r_i(k+1)$ and $r_i(k)$ are the locations of the star at iterations 't' and 't+1', respectively and r_{BH} is the location of the black hole in the search space, 'rand' is a random number in the interval [0-1]. N is the number of stars (candidate solutions). Every time

a candidate (star) dies, it is sucked in by the black hole, another candidate solution (star) is born and distributed randomly in the search space and starts a new search. In the BHA algorithm the event horizon radius is calculated by following equation:

$$r = \frac{F_{BH}}{\sum_{i=1}^N F_i} \quad (2)$$

Where ' F_{BH} ' is the fitness value of the black hole

L-index

L-index varies between 0 to 1 [18]. If the index value of any bus approaches to unity means that bus is operating near its stability limit. The buses having the

$$Lindex_k = \max_{k \in \beta_L} \left| 1 - \frac{\sum_{i \in \beta_G} F_{ki} V_i}{V_k} \right| \quad (3)$$

Where:

β_L is the set of load buses and β_G is the set of generator buses and F_{ki} is the subset of hybrid matrix, which has been generated by Y-matrix. Stability condition lies between

$$0 < L-index < 1$$

III METHODOLOGY

- Read input data (line & bus data)
- Model the uncertain load
- Run the load flow program for all dynamic cases using N-R method

$$Lds16(p) = (lshmax - lshmin) * rand() + lshmin \quad (4)$$

- Where lshmin and lshmax are the lower and upper bounds of load shed. Which are the current positions of stars. Set these stars as load vectors
- Run the load flow for the initial populations and monitor all the inequality constraints those vectors which do not satisfy the constraints they will be treated as non-feasible vectors.
- Calculate objective function for the feasible vectors.

$$(p) [20] \quad r_i(k+1) = r_i(k) + rand(r_{BH} - r_i(k)) \quad (6)$$

Where and are the locations of the star at iterations 't' and 't+1', respectively and is the location of the black hole in the search space, ' ' is a random number in the interval [0-1].

higher values of indexes are chosen as candidate buses. L-index if the L-index approaches to unity means system is approaching towards voltage instability and consequently voltage collapse state.

- Obtain the variation of minimum eigen value of load flow jacobian for all dynamic cases
- Find the critical case by using the minimum Eigen value of load flow jacobian for all dynamic cases.
- Obtain the candidate buses on which the load to be shed by using the L-index given in section 2
- Fix the limits of the inequality constraints for the base case and critical load levels
- Set objective function as minimum load shedding
- Set iteration count as 1 and fix the no. of iterations
- Generate and initialize the initial population of load shedding (bus16 & 19) as follows

$$Lds19(p) = (lshmax$$

- Based on the value of objective function, identify the best solution vector.
- The stars or solutions which crosses the event horizon they are sucked by the black hole and another candidate solution (star) is born and distributed randomly in search space the updated position of star can be formulated as

- In the BHA algorithm the event horizon radius is calculated by following equation:

$$r = \frac{F_{BH}}{\sum_{i=1}^N F_i} \quad (7)$$

Where ' f_{BH} ' is the fitness value of the black hole and ' f_i ' is the fitness value of the ' i^{th} ' star. When the distance between a candidate solution and the black hole (best candidate) is less than R , that candidate is collapsed and a new candidate is created and distributed randomly in the search space.

- (r) If the results of 10 consecutive cases are same or maximum iterations reached then stop the iteration otherwise repeat the steps from 10.

IV PROBLEM FORMULATION

It is a well-known fact that minimum quantity of loads should to be shed at minimum number of buses. After the selection of candidate buses the upper and lower bounds of load shed must be decide by the operating and stability consideration of the system. An optimization problem aiming to minimize the

load shed at selected load bus can be formulated as follows:

Objective function

$F1 = \min \{\text{load shed}\}$

This objective function is subjected to following constraints

- Power flow constraints under the base operating point and critical load level
- L-index greater than 1
- minimum eigen value of load flow jacobian for base case and critical case greater than 1
- reactive generation for base case and critical case
- voltage limits
- Load shedding at selected load buses (80% Of total load and remaining 20 % for emergency load conditions)
- Uncertain load adjustment factor [20]

V RESULTS AND DISCUSSION

The uncertain load models are taken from [20]

Table No. 1

Base case results minimum eigen value = 0.1875

Bus no.	IVI (pu)	δ (degree)	P_G (MW)	Q_G (MVAR)	L-index
1	1.000	0.000	218.208	-46.644	-
2	1.000	-5.043	60.970	46.267	-
3	0.969	-9.983	-	-	0.0433
4	0.968	-11.468	-	-	0.0422
5	0.985	-9.332	-	-	0.0302
6	0.967	-12.513	-	-	0.0372
7	0.964	-11.859	-	-	0.0500
8	0.965	-12.795	-	-	0.0382
9	1.004	-18.634	-	-	0.0333
10	0.979	-23.657	-	-	0.0296
11	1.004	-18.634	-	-	0.0333
12	0.987	-18.901	-	-	0.0481
13	1.000	-15.892	37.000	10.382	-
14	0.977	-20.123	-	-	0.0574
15	0.978	-20.604	-	-	0.0465
16	0.949	-20.039	-	-	0.0618
17	0.962	-22.858	-	-	0.0478
18	0.963	-22.560	-	-	0.0620
19	0.959	-23.486	-	-	0.0656
20	0.963	-23.597	-	-	0.0581
21	0.993	-26.562	-	-	0.0101
22	1.000	-27.175	31.590	115.857	-
23	1.000	-20.866	22.200	4.963	-
24	0.988	-24.312	-	-	0.0147

25	0.990	-22.445	-	-	0.0128
26	0.974	-22.979	-	-	0.0319
27	1.000	-20.857	28.910	38.292	-
28	0.954	-13.687	-	-	0.0332
29	0.978	-22.232	-	-	0.0333
30	0.965	-23.267	-	-	0.0564
Total P_G =398.878 MW			Total Q_G = 169.117 MVAR		
Total P_D = 372.450MW			Total Q_D =138.460MVAR		
Total P_{loss} = 26.428MW			Total Q_{loss} =30.659MVAR		

Table No. 2
Critical case results
Minimum Eigen value = 0.181932

Bus no.	IVI (pu)	δ (degree)	PG (MW)	QG (MVAR)	L-index
1	1.000	0.000	223.152	-26.204	-
2	0.990	-5.024	60.970	35.183	-
3	0.959	-10.159	-	-	0.0440
4	0.956	-11.695	-	-	0.0430
5	0.972	-9.454	-	-	0.0309
6	0.952	-12.761	-	-	0.0380
7	0.949	-12.071	-	-	0.0513
8	0.950	-13.077	-	-	0.0391
9	0.976	-19.299	-	-	0.0349
10	0.942	-24.259	-	-	0.0316
11	0.976	-19.299	-	-	0.0349
12	0.978	-19.561	-	-	0.0468
13	1.000	-16.525	37.000	16.477	-
14	0.972	-20.836	-	-	0.0543
15	0.973	-21.233	-	-	0.0412
16	0.936	-20.373	-	-	0.0614
17	0.932	-23.353	-	-	0.0498
18	0.947	-23.170	-	-	0.0599
19	0.936	-24.109	-	-	0.0656
20	0.936	-24.219	-	-	0.0588
21	0.944	-27.357	-	-	0.0129
22	0.950	-27.922	31.590	88.164	-
23	1.000	-22.006	22.200	16.845	-
24	0.962	-25.290	-	-	0.0168
25	0.979	-23.572	-	-	0.0152
26	0.963	-24.118	-	-	0.0347
27	1.000	-21.945	28.910	46.294	-
28	0.940	-14.137	-	-	0.0340
29	0.978	-23.321	-	-	0.0333
30	0.965	-24.355	-	-	0.0564
Total P_G =403.822MW			Total Q_G = 176.760MVAR		
Total P_D = 376.609MW			Total Q_D = 141.074MVAR		
Total P_{loss} = 27.213MW			Total Q_{loss} = 35.686MVAR		

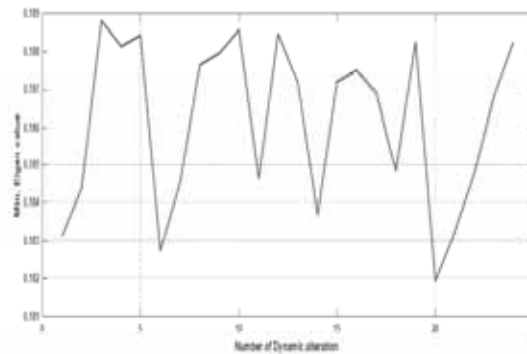


Fig No.1- variation of minimum eigen value of load flow jacobian

Table No. 3
Load shedding at selected buses

S.No.	Selected buses for load shed		Amount of load shed
1	16	Pd16	0.0062
		Qd16	0.3712
2	19	Pd19	0.1733
		Qd19	0.0581
Total load shed in pu			0.6088

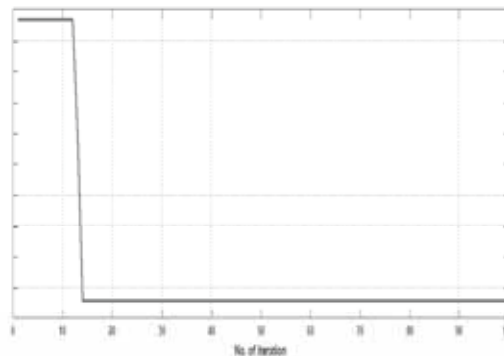


Fig No.2 Convergence of objective function

VI CONCLUSION

A black hole optimization algorithm technique has been used in this paper to get the optimal value of load shedding at selected buses in IEEE30 bus system to improve the voltage stability in uncertain load conditions.

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Effect of Staphylococcus aureus embedded on titanium foam which uses as biomedical implant

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ABSTRACT

The aim of this research is to investigate the impact of the Staphylococcus aureus, on the titanium foam. . It has been attempted to fabricate the foam with different pore size like 50%, 60%, 70% and 80% with different volume fraction of used space holder cenosphere through powder metallurgy route. According to many research papers porosity plays an important role as bio implant material. It has been prepared different size titanium pellets i.e.15mm and 12mm to see the effect of the surface area of the fabricated sample of implant material. Recently, In medical field, solid implant material is in use like Titanium, Steel, Ni-Titanium rod but due to the lack of porosity these implant material does not perform well osseointegration. It has been attempted to observe the roll of the bacteria Staphylococcus aureus in the above said fabricated titanium foam. It has been found that porosity in this foam played the key role as it worked as transporter. Foam has greater pores i.e.80% is more sensitive to develop the bacteria while 50% porous titanium foam is less sensitive meanwhile another sized porous titanium foam had been showed moderate capability of growing the bacteria. Through the all physical, mechanical, chemical and biological observation, titanium foam can be beneficial for the future use. It can be helpful in medical field as cheap and light weight implant material.

Keyword: - Biofilm, MTT Assay, Staphylococcus aureus ;Titanium foam

I INTRODUCTION

Bio implant is not only an emerging subject in the field of medical science [1-3]. In fact, it has become more prominent now. Porous material is becoming more promising compare to solid material due to tailor-made young modulus and cell or tissue proficiency, It has become more significant now [4]. Recently many researchers attempted to synthesize open cell foam by using polyurethane [5]. Titanium attached with the matrix of polyurethane and debind with the further heat treatment to compose grille of titanium. This worked better instead of solid form of metals [6]. There are many methods to prepare metal foam like Gas Injection (Hydro/Alcan) [7], Blowing Agents (Alporas) [8],Solid-Gas Eutectic Solidification (Gasar) [9], foaming of Powder Compacts (Foaminal/Alulight) [10,11], Foaming of Ingots containing blowing agents (Form grip/Foam cast) [12] etc. The new inventions daily revealing in this regard. Although some researchers have trust on this statement that one day will come when injured or crumbled body parts will grow automatically with the

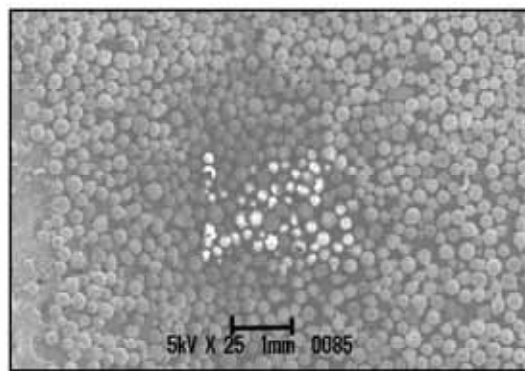
help of either implant or stem cells [13]. Research has been conducted to show the cell viability into the titanium foam [14-15]. Another research revealed the effect of Staphylococcus epidermidis on the titanium foam [16].Some previous research pursued on the relation between the titanium foam and the bacteria Staphylococcus epidermidis [17]. It was found that Titanium foam didn't help to induce the biofilm itself. It has been proved in another previous experiment. This may be due to the fact that Titanium is corrosion free material [18] in biofluid and helps in cell growth along the cell boundary.

In the present study, titanium foam is prepared through spaceholder technique using cenosphere as spaceholder which has not been studied earlier. The cenosphere might give extra strength to titanium foam and provides porosity for cell adherences. But the cenospheres contain silicate particles and hence it is required to study the cell proliferations in such foams and the influence of Staphylococcus aureus on cell growth and biofilm formation.

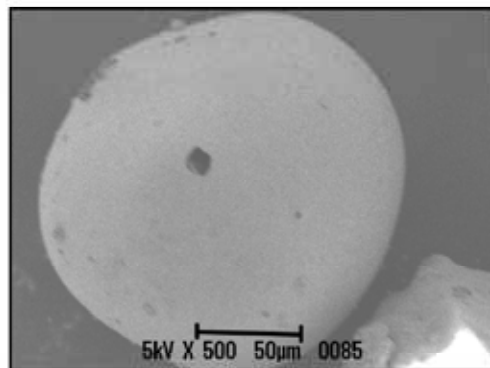
while different sized Cenosphere i.e. $90.0 \pm 8\mu\text{m}$, $145.0 \pm 11\mu\text{m}$, $185.0 \pm 15\mu\text{m}$, $212.0 \pm 18\mu\text{m}$ (supplied from M/s Cenosphere India) used as a space holder, to create porosity in the titanium foam. Micro structure of cenosphere of $90.0 \pm 8\mu\text{m}$ shown in Fig.No.1(a) while Fig.No.1 (b) presents its higher magnification micro graph

II MATERIALS AND METHODS

(a) **Preparation of the Titanium Foam** - Titanium foam prepared through powder metallurgy route [19]. In this method Spherical shaped Titanium powder (99.9% pure & average size $22 \pm 3\mu\text{m}$) supplied from Alfa Aesar used as a primary material



(a)



(b)

Fig.No.1(a) Microstructure of cenosphere $90.0 \pm 8 \mu\text{m}$ (b) Microstructure of cenosphere in large view

The powder of pure titanium combined with spaceholder (cenosphere) by using 2 wt.% of diluted PVA (mixture of 95 wt.% of water and 5 wt.% of poly vinyl alcohol). This mixture poured into the cylindrical die, pre wrapped with Zinc Stearate. The size of die was 15 mm in diameter and 80 mm in height. The die was coated with zinc stearate so that flow ability can be increased at the time of cold compaction. In cold compaction method 75 MPa pressure applied at a cross head speed of 0.1mm/s in a cylindrical die by using 50 ton hydraulic press (M/s Columbia Engineering, Gaziabad, India) for

2-3 minutes. Green samples of 15 mm diameter and 10 mm height prepared through the cold compaction. The flow chart for foam preparation is shown in Fig.No.2. Initially these green samples incubated for 2 hrs after obtaining the 200°C temperature in hot air oven so that moisture and organic binder is expelled. By using Vacuum sintering furnace (Vacuum Tech, Bangalore, India) these green samples are sintered under the condition of 1100°C temperature and 10^{-4} mbar vacuum for 2 hrs. Green samples of titanium foam will kept in the closed stainless steel tube to protect the samples from the graphite fumes and the any kind of dust of generated from the green samples of furnace during sintering.

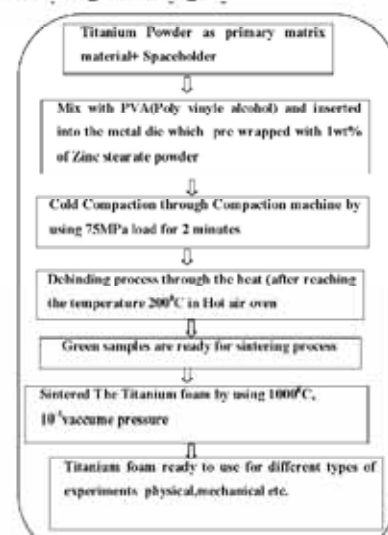


Fig. No.2 Flow chart to prepare the Titanium Foam through Powder Metallurgy path

Prepared titanium foam sample sectioned from 10 mm (height) X15 mm (diameter) sized to 2mm (height) X15 mm (diameter) size through diamond cutter (LECO VC 50) shown in Fig.No. 3.



Fig. No. 3 Prepared titanium foam made by using +100 μm cenosphere mess size as spaceholder 50%,60%,70% and 80% volume fraction respectively

Sintered samples polished through standard metallographic practice followed by cloth polish and finally etched with Keller's reagent (20 ml distilled H_2O , 20 ml HNO_3 (concentration of 70%), 20 ml HCl (concentration of 38%) and 20ml HF (concentration of 40%). Etched sample of Titanium foam examined

through the physical (micro structure), mechanical (compression Test), chemical (corrosion Test, EDS) tests. Corrosion is the significant characteristics of metallic foam, because corrosion free character of this titanium foam will give the strength to approach for human being. Hank's solution used to test the

corrosion of the titanium foam. The composition of Hank's solution used for this study is shown in Table

No.1.

Table No. 1
Composition of the Hank's solution

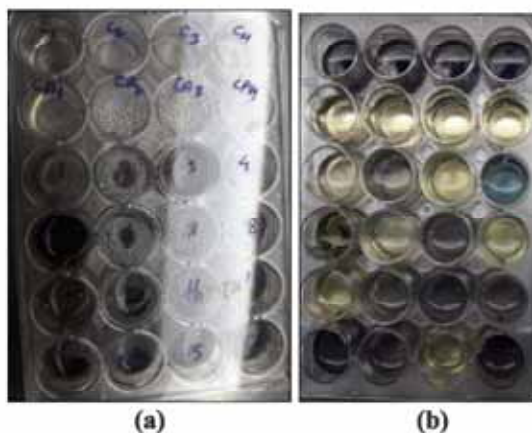
S.No.	Name of the component	Quantity
Q	CaCl ₂	0.185g/l
2.	KCl	0.4g/l
3.	KH ₂ PO ₄	0.06g/l
4.	MgCl ₂ ·6H ₂ O	0.1g/l
5.	MgSO ₄ ·H ₂ O	0.1g/l
6.	NaHCO ₃	0.35g/l
7.	Na ₂ HPO ₄	0.48g/l
8.	D-glucose	1.00g/l
9.	Nacl	8g/l
10.	Distl Water	1000ml

Through experiment we obtained that the corrosion is very negligible in this foam. Ultra sonication test performed by using solvent ethanol (70%) at >20KHZ, so that all debris can ran off which may be present inside the titanium foam prior to the corrosion tests and after corrosion tests.

(b) Bacteriological Test on Titanium foam

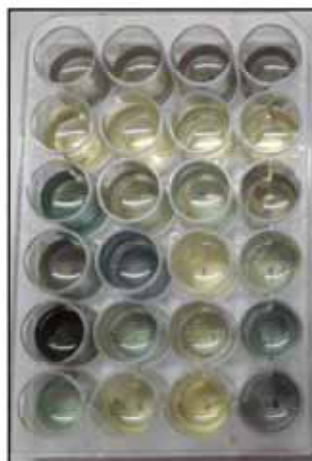
Biological test was carried out on titanium foam with the help of cultured bacteria of *Staphylococcus aureus* (procured *Staphylococcus aureus* ATCC culture 9144 from Himedia India). In this process bacteria *Staphylococcus aureus* (10⁶ bacterial cells/ml) is inoculated into each 24 well culture plate which is made up with sterile polystyrene and treated with trypsin. Then titanium foam is dipped into the

bacteria into culture solution. Titanium foams of various cenosphere contents (like 50%, 60%, 70% & 80%) were used in this investigation. Incubated the system is for 24 hrs., 48 hrs. and 72 hrs. in the bacterial incubator, where a temperature maintained at 37°C. The status of the live bacteria through colorimetric technique MTT Assay followed by spectrophotometer at 490nm web length is evaluated. A physical examination is performed through the naked eye and the required specific media was provided so that bacteria can be developed without any interruption. *Staphylococcus aureus* is a biofilm-producing gram positive coccus bacteria. One column of culture plate is occupied with the positive control of antibacterial gentamycin of 10mg/ml. used shown in Fig.No.4.



(a)

(b)



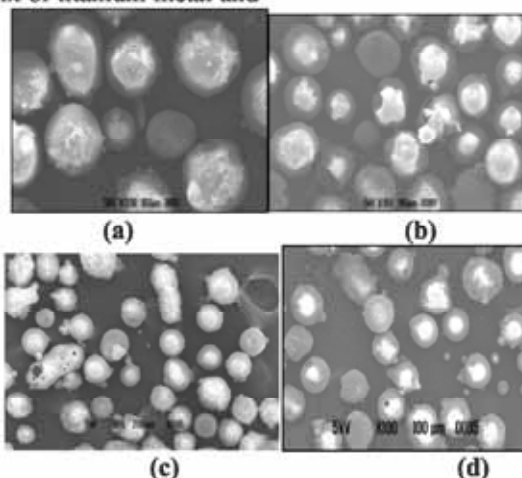
(c)

Fig. No. 4 In-vitro bacterial experiment (a) After 24 hrs (b) After 48 hrs (c) After 72 hrs

III RESULT

(a) **Micro structure-** Titanium foam is physically observed through SEM (Scanning Electron Microscope) and the matrix of titanium metal and

porous structure of Titanium foam found. The micro structure of titanium foam exhibits the cell size of the foam (size of used space holder i.e. cenosphere) shown in Fig.No.5.



(a)

(b)

(c)

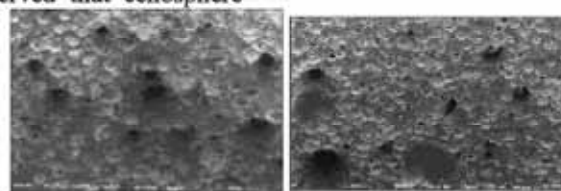
(d)

Fig.No.5 Compilation of various types of used cenosphere as spaceholder (a) $212.0 \pm 18 \mu\text{m}$ (b) $185.0 \pm 15 \mu\text{m}$

(c) $145.0 \pm 11 \mu\text{m}$ (d) $90 \pm 8 \mu\text{m}$

Micro structure of titanium foam also observed through FESEM (Field Emission Scanning Electron Microscope)(Nova Nano Sem 430 Model) which had accommodated with an EDX machine facility(Model No.IE Synergy 250,with a detector of 50 mm^2 ability of detecting beryllium and above). Elemental analysis of titanium foam pellets observed that cenosphere

micro balloons present in the titanium matrix. This characteristic play significant role in this investigation as it showed the porous structure of titanium foam in Fig. No.6 (a),6 (b) & 6 (c). It is noted from Fig.No.6 that the cenospheres are uniformly distributed in the matrix and a fraction of cenospheres get crushed during compaction and sintering.



(a)

(b)

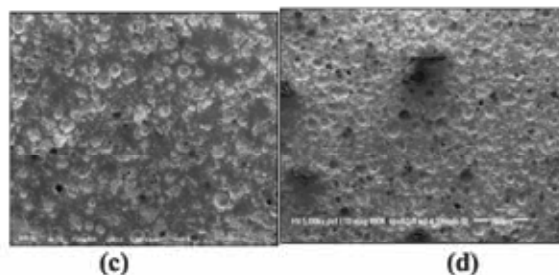


Fig. No. 6 Compilation of FESEM images of Titanium foam (a) $212.0 \pm 18 \mu\text{m}$ size, 50% (b) $185.0 \pm 15 \mu\text{m}$ size, 50% (c) $145.0 \pm 11 \mu\text{m}$ size, 50% (d) $90 \pm 8 \mu\text{m}$ size, 60%

(b) EDS Analysis

EDS analysis of Titanium foam sample EDS analysis is presented in Fig.No.7. The presence of titanium and titanium oxide is observed. Fig.No.7 (a) showed the EDX analysis of the holes which showed the presence of Al, Si, Ti and O indicating that these holes are nothing but cenospheres. Fig.No.7 (b) showed the EDX at the matrix (between neighbouring

cenospheres). It depicts the presence of Ti O. It indicates that the matrix is consist of Ti primarily and a fraction of Ti get oxidized. Oxidation of Titanium takes place due to its high reactivity with oxygen.

Even at a vacuum of 10^{-4} mbar, fractions of Titanium get oxydized. It is represented that around 5 to 8 % Titanium

Thus get oxydized.

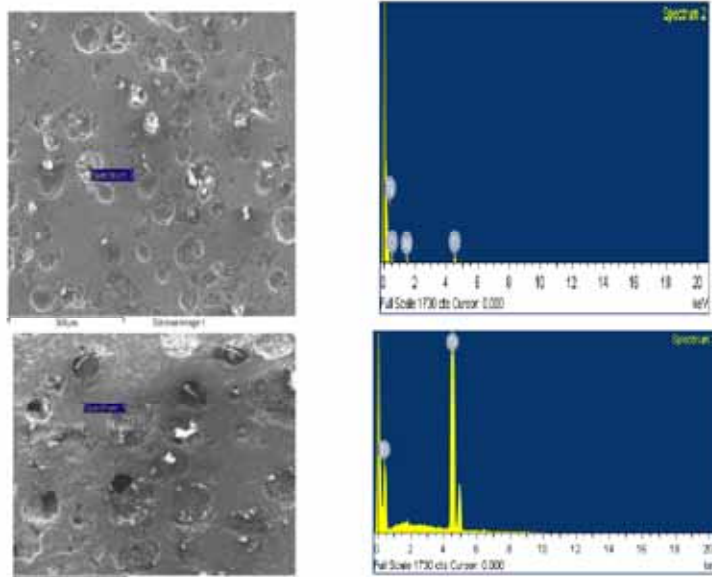


Fig. No. 7 EDX analysis (a) at the holes and (b) in the matrix

(c) Mechanical Experiment

(i) Compression test

Strength of Titanium foam inspected through compressive deformation characteristic by using Universal Testing Machine (Instron Model:8801) at strain rate of 0.01/s at room temperature. The deformative behaviour of the titanium foam depend on the used spacerholder (cenosphere) size 90.0 ± 8 ,

145.0 ± 11 , 185.0 ± 15 , 212.0 ± 18 and volume fraction i.e. 50%, 60%, 70% and 80%. The compressive strength as a function of cenosphere size and cenosphere content is shown in Table No. 2. It is noted that the foam with 60% cenosphere having its size of 145.0 ± 11 exhibited the best mechanical strength.

Table No. 2
Compressive Stress (MPa) of different volume fraction and different size of cenosphere

volume fraction	Cenosphere size	Compressive Stress(MPa)
50%	215±18µm	79±6.3
	185±15µm	71±5.9
	145±11µm	115±8.5
	90±8µm	63±5.3
60%	215±18µm	79±8.2
	185±15µm	50±4.0
	145±11µm	135±9.6
	90±8µm	79±7.2
70%	185±15µm	45±3.9
	145±11µm	31±3.2
	90±8µm	48±4.3
80%	215±18µm	65±6.0
	185±15µm	158±13.2
	90±8µm	43±3.6

Table No. 3
Corrosion rate as per the volume fraction of the titanium foam after 30 days, 60days, 90days and 120 days

Cenos phere size	Volu me Fract ion	Corrosion Rate (mm/Y)			
			60da ys	90da ys	120days
+212± 18µm	50%	- 0.02 1±0. 02	0.310 ±0.0 13	- 0.08 ±0.0 07	- 0.015±0. 002
	60%	0.05 1±0. 005	0.120 ±0.0 14	0.025 ±0.0 02	0.003±0. 002
	70%	- 0.01 1±0. 002	0.290 ±0.0 15	0.003 ±0.0 01	- 0.08±0.0 02
	80%	- 0.06 1±0. 005	0.440 ±0.0 34	- 0.015 ±0.0 02	- 0.0344± 0.001

(d) Chemical Experiment - Immersion test of a set of foam samples are examined through the balanced salt solution i.e. Hank's solution. Cenosphere size of 215±18µm were conducted using balanced salt solution i.e. Hank's solution. The results are shown in Table No. 3. It is noted from this tests that the foam with 60% cenosphere exhibits least corrosion. This may be because of uniform distribution and strong bonding with matrix.

(e) Biological Analysis

(i) Bacteriological Analysis - Bio film production found in Titanium foam with 80% porosity due to the wide size of the foam. Bacteria flourished very well. A thin layer of biofilm occurred below the lower surface of foam and the surface of the culture plate. While in 70% porous titanium foam biofilm production was poor. We found small surface area of titanium foam; having 12mm size was not prone to enhancement of bacteria while wider size surface area of titanium foam was more prone to growth of the bacteria.

Observation took place in 50% volume fraction porous titanium foam in which bacterial culture not promoted after 24 hrs, after 48 hrs observation; it was constant after 72 hrs. The minimal growth found in this type of foam. It may be possible due to the succinct pore. Thus we can say 50% of porous titanium foam can be helpful in medical field. Spaceholder also played important role. Cenosphere present in less quality in the foam not helpful to the growth of bacteria. The cenosphere size which used were 90.0 ± 8 , 145.0 ± 11 , 185.0 ± 15 , 212.0 ± 18 . The size of

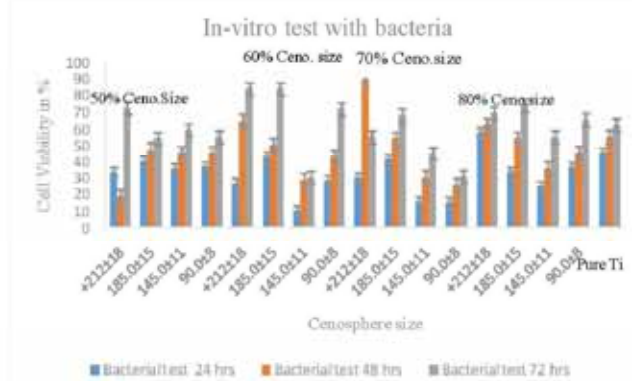
cenosphere 145.0 ± 11 and 185.0 ± 15 , showed intermediate performance means it was not helpful to develop the bacteria (*Staphylococcus aureus*) shown in Table No.4 and bar chart 1. But foam with 90.0 ± 8 cenosphere size with 60 to 70% porosity exhibits higher degree of resistance against bacterial growth. It is further noted that the resistance to bacterial growth of these foam is even better than that of pure dense titanium. While the foam is coated with HAP its resistance is also improved against bacterial growth.

Table No.4

The table show bacterial growth kinetics profile with respect to time period i.e.24 hrs,48 hrs and 72 hrs

Volume Fraction	Cenosphere Size	Cell Viability in %		
		24hrs	48hrs	72hrs
50%	+212±18	33.33	18.57	72.46
	185.0±15	40.11	47.35	54.35
	145.0±11	35.6	45.3	59.42
	90.0±8	36.74	45.2	55.075
60%	+212±18	26.44	64.76	84.06
	185.0±15	43.15	50.51	84.06
	145.0±11	10.5	28.48	30.2
	90.0±8	28.32	43.08	71.74
70%	+212±18	29.89	89.52	55.07
	185.0±15	41.38	54.3	68.12
	145.0±11	15.6	30.2	44.93
	90.0±8	15.2	25.3	30.5
80%	+212±18	58.16	62.3	69.6
	185.0±15	33.42	54.38	73.92
	145.0±11	24.6	35.6	55.1

	90.0±8	36.6	45.6	65.6
Pure Titanium		45.56	55.3	62.4
HAP coated sample		37.93	41.9	51.2
		33.33	42.7	52.3



Bar chart 1 : Bacterial cell viability (%) in different titanium foam

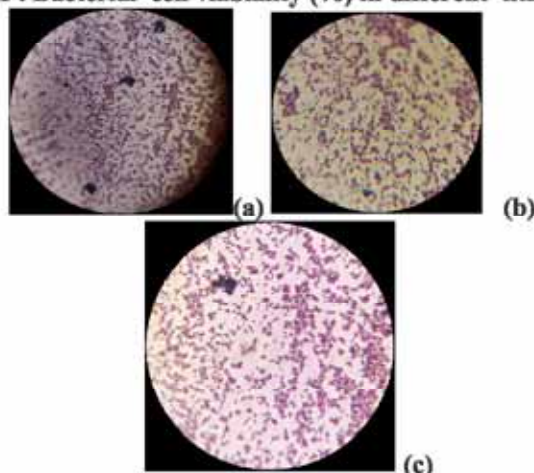


Fig. No.(8) Microscopic images of S.aureus

V DISCUSSION

We concluded that Titanium foam with finer cenosphere and having 50 to 60% cenosphere can be helpful as implant. Another point which should be mention here is that antibacterial dose should also apply during the experiment. The only titanium foam could not helpful substance as antibacterial. The HAP coated titanium foam also showed significant bacterial growth. Wide surface area of titanium foam is more prone to growth of bacteria and bacterial production while finer size of cenosphere containing titanium foam is less susceptible for the bacterial growth. Another factor can be the cenosphere size of which we used for making titanium foam. It is recommended that titanium foam with cenosphere size 90.0±8 to 185.0±15 may be useful as bioimplant. Before going to apply into the human, antibacterial dose are required for further experiment. For better understanding further experimentation using different level of antibacterial doses may be

concluded. The growth of bacterial film on titanium foams with various cenosphere size and cenosphere volume is shown in Fig.No. 8. It may be noted that from these figures that highly dense bacteria are grown in the film generated over titanium foam with coarser cenosphere size and higher cenosphere volume fraction Fig.No.8 (a). But the biofilm grow over the foam with fewer cenosphere size contain less bacterial density indicating slower growth of bacteria in such kind of foam Fig.No. 8 (b). In case of finer cenosphere size, liquid or bacterial proliferation in the foam may be less Fig.No. 8 (c). But in case of coarser cenosphere, bacterial proliferation is easier and it inoculated and grows easily.

VI CONCLUSION

The following conclusion may be drawn from the present study:

- (a) Cenospheres of different size ranges can be used for making titanium foam with different density and pore sizes.
- (b) The bacterial growth depends on cenosphere size and cenosphere volume fraction. It is linear in case of finer cenosphere size and lower cenosphere content.
- (c) Even HAP coated titanium foam also led to significant bacterial growth.
- (d) It may be higher as compared to that in titanium foam with 90.0±8 size cenosphere having its volume fraction of 60 to 70%.
- (e) For bioimplant application to prevent bacterial growth doses of antibacteria are required.

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An Approach on Mining Micro Array Data for Drug Treatment by Data Mining Techniques

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ABSTRACT

Current microarray information mining techniques, for example, grouping, characterization and affiliation investigation vigorously depend on measurable and machine learning calculations for examination of vast arrangements of quality articulation information. Lately, there has been a developing enthusiasm for techniques that endeavors find designs considering numerous however related information sources. As of late, there has been relating to nursing blast inside the rate of obtaining of biomedical information. In this paper, we have a top to bottom investigation of the fluctuated information mining systems. It can demonstrate how hereditary calculations can be utilized to streamline the information mining calculations. The report at that point gives a prologue to sub-atomic science and Bioinformatics. At that point the investigation of the microarray exploratory examination and the utilization of grouping methods will retrieve the microarray information. The report fundamentally illustrates the part of the bunching examination to bunch qualities into gatherings of comparable character. A huge number of tests for every quality are produced by microarray try and bunching of these qualities can be viably used to assemble these qualities into ailment causing qualities and typical qualities and to think about the different attributes of various qualities under various conditions. Those qualities can be utilized for sedate treatment after acknowledging the reaction of the qualities, attributes to drugs, making ready for conclusion of hopeless infections like Alzheimer's ailment, AIDS, etc. This can be an advantage on utilizing recognized systems hidden organic procedures, for example, development and maturing and to track the procedure of our advancement. The investigation of microarray trial examination and the utilization of grouping procedures may mine microarray information. Those reports fundamentally illustrate the part of the bunching examination to bunch qualities into gatherings of comparative character. Analyzed microarray out-turn created by a huge number of tests for every quality, bunching can be adequately used to amass these qualities into infection causing qualities and typical qualities and to consider the different attributes of various qualities under various conditions. Those qualities can be utilized for sedate treatment after acknowledging the reaction of the qualities of drugs preparing for the findings of the sicknesses hopeless till date.

Keywords: Microarray, Data mining techniques, Bioinformatics.

I INTRODUCTION

The enormous amount of information is inserted in documents and in databases and different archives, it becomes important, if adequate information will be able to grow capable means to process which is needed for investigation as well as a translation of the information. Those extracted information will be much helpful in basic leadership. And for this, the extraction of fascinating learning could help in basic leadership. Likewise, Data Mining prominently known as Knowledge Discovery in Databases (KDD) [4], imply to as "a huge procedure of recognizing legitimate, unique, possibly helpful and at the last justifiable example in information". The iterative procedure [1] comprises of the accompanying advances:

- (a) **Information cleaning:** Also known as an information purifying stage, which expelled the uproarious and superfluous information from the gathering.
- (b) **Information coordination:** Afterwards, numerous heterogeneous source of information is consolidated into standardized source in this stage.

- (c) **Information determination:** In this stage, pertinent information which is required for examination is recovered from information gathering.
- (d) **Information mining:** At this progression astute procedures are connected to extricate information designs possibly valuable.
- (e) **Example assessment,** entirely fascinating examples are distinguished of speaking to learning in respect of giving view measures.

What's more, Knowledge portrayal belongs to a definitive stage where found learning is outwardly spoken to the client. The KDD is an iterative procedure demonstrated by basic advance, making use of representation method to make the client understand about the information which came after mining. The evaluation measures can be enhanced, the mining can be additionally processed, crisp information can be chosen or further modified, or new source of information can be assimilated, recognizing the goal to get different and more proper outcomes, when the found learning is introduced to the client.

II DATA MINING TECHNIQUES

Expectation and depiction are two major objectives of information mining by Researchers, distinguish Prediction influences utilization of existing factors in the database, keeping in mind the end goal to anticipate up and coming estimations of intrigue and portrayal centres around discovering designs portraying the information and the ensuing introduction for client elucidation. The relative worry of both forecast and a portrayal fluctuate concerning hidden application and the system. There are a few information mining classes [5] that satisfy these targets: affiliation governs mining, grouping, and arrangement mining utilizing the strategies, for example, choice tree, machine learning, hereditary calculations and neural systems. The accompanying information mining classes were contemplated and broke down.

III INTRODUCTION TO BIOINFORMATICS

Bio-informatics includes the control, seeking and mining information on DNA succession information. The improvement of methods to hunt DNA sequences and store have prompted broadly applied propels in the field of software engineering, particularly machine learning, string seeking calculations and database hypothesis. In different application, for example, content tools, even straightforward calculations for this issue typically do the trick, yet DNA groupings in light of the fact that these calculations to show close most pessimistic scenario conduct because of their modest number of particular characters. Informational collections speaking to whole genomes of DNA successions, for example, those created by the Human Genome Project, which are hard to use without comments, which name the areas of qualities and administrative components on each and every chromosome. DNA arrangement districts having the trademark designs related to protein or RNA coding qualities can be distinguished by quality discovering algorithms, which enable analysts to anticipate the nearness of specific quality items in a creature even before they have been detached tentatively.

IV DATA MINING SOFTWARE

Information mining calculations are certain which are difficult to design and utilize. Keeping in mind the end goal to make the procedure of Data Mining more profitable, numerous apparatuses excited the market in the 1990s. Those devices, other than supporting a vast range of reason calculations, coordinate them in an

inviting and simple to utilize condition that enables the client to grow full information mining arrangements. The most generally known business information mining programming devices are f Clementine(SPSS), Enterprise Miner(SAS), Intelligent Miner(IBM) and Statistica(StatSoft). Data Mining arrangement called Weka is the only open source which can be effectively extended – its Java source code which is accessible – yet it isn't benevolent and has genuine execution issues. SQL Server 2005 and Oracle 10g are the Business databases which have worked in information mining instruments. Considering from programming point of view, there are the R dialect and Matlab which belongs to open source, in spite of the fact that these two doesn't belong to precisely Data Mining bundles, but rather programming conditions is difficult to create mining calculations. (Some are as of now executed) For this task we have picked Clementine (form 9.06) due to its general great quality, convenience and is the device the creator was more acquainted with. While the accompanying segments are bland to most information mining devices, they are roused by the creator's involvement with Clementine.

Information mining conceivable outcomes there are a few approaches to accomplish the objective of information mining that leads to removal of new data from existing information. We will notice that there are two ways to deal with satisfying that objective, one is regulated learning and another one is unsupervised learning. In the case of regulated learning approach, coveted yield is known for each information, but in the case of unsupervised learning, the calculation arranges the contribution all alone.

Order/Estimation: Both grouping and estimation requires a preparation stage where the ascribe to anticipate is learnt. The distinction amongst estimation and order is that the main manages constant esteems and the last with ordinal esteems. In arrangement the yield is class (that as of now is preparing which existed). In case of estimation, the yield is a genuine number. Some of the time it is intriguing to lessen an estimation issue to an arrangement issue. That can be done through binning techniques (Among the few binning techniques, a basic one function is to allot a class to values coming under a specified range). A case of an arrangement calculation belongs to choice tree similarly like C5.0. A case of estimation calculation is a relapse display. A few calculations, as neural Data Mining diagram systems or order and relapse trees, can do both arrangement and estimation.

(a) **Grouping:** Clustering comprises in fragmenting a populace into a few distinct subgroups called bunches. The contrast

amongst bunching and characterization is that the previous does not have any unequivocal data to which amass the records have a place as completes an order calculation. In bunching, the records are assembled together by a vicinity basis. It is the activity of the examiner to decide whether they found groups have any hidden significance. Thus, a group demonstrates is regularly utilized as a part of information investigation stage and once in a while an end without anyone else. At times a prescient model can be fundamentally enhanced by including a bunch enrollment quality or just by applying it to individuals from a similar group.

- (b) **Partner Rules:** The errand of partner rules is to figure out which things go together (e.g. More often than not goes together in a shopping basket at the store). Partner tenets can likewise be utilized to distinguish strategically pitching openings and to plan appealing bundles or groupings of items and administrations.
- (c) **Perception:** Sometimes the motivation behind information mining is just to portray what is happening in an intricate database, in a way that builds our comprehension of the general population, the items, or the procedures that delivered the information in any case. A sufficient portrayal of a conduct will frequently recommend a clarification for it also, or if nothing elsewhere to begin searching for it. Utilizing a portion of the above systems we can make prescient models. The prescient models utilize involvement to appoint scores and certainty levels in order to get some significant result later on irrespective of the application being used. The key to success is having enough information about the result definitely known which is needed to prepare the model. Mainly two activities are involved with prescient models: Primary stage involves preparing, where the model is made utilizing information from the past. And the second one is scoring, where the made model is tried with concealed information in order to determine by what means it scored. One ought to always remember that the most vital is to perform well in the concealed information and not in the preparation information. Over fitting is the circumstance that happens when the model clarifies the preparation information, however, can't sum up to test information. To implement a prescient model, we are accepting that piece of the information is a decent indicator for the rest of the information (or in time arrangement that the present is a decent indicator without bounds). We additionally expect that the

examples that are watched can be clarified, at any rate somewhat, by the qualities we are thinking about.

Microarrays are a progressive innovation with pleasant potential to supply rectify restorative claim to fame, encourage understanding the right treatment and curing for a few infections and supplying a top to bottom broad atomic picture of cell states. DNA Microarray might be a progressive innovation and microarray tests turn out fundamentally extra data than various systems. Integration natural marvels data with various therapeutic strength assets can offer new unthinking or organic speculations. Be that as it may, creative, connected math methods and figuring code zone unit fundamental for the flourishing examination of microarray data. This survey demonstrates the present bioinformatics instruments and furthermore the promising applications for breaking down data from microarray tests. The various data examination perspectives and programming specified in the paper can encourage the natural experience as a not too bad establishment for process investigation of microarray data.

V PROPOSED METHODOLOGY

- (a) **Presentation-Late,** but quick improvements have seen in the field of genomics and proteomics, which produces lots of natural information. Advanced computational investigations required to reach a determination from the information. Bioinformatics, or computational science, acts associative art of utilizing data innovation came from deciphering natural information and software engineering. This new field importance will develop as we proceed to create and incorporate vast amounts of proteomic, genomic and other information.

A specific dynamic territory of research in the field of bioinformatics deals with the application and advancement of information mining methods which take care of organic issues. Breaking down huge natural informational collections requires comprehending the information by surmising structure or speculations from the information. Cases of this sort of investigation incorporate protein structure forecast, quality arrangement, malignancy order in view of microarray information, grouping of quality articulation information, factual displaying about protein-protein connection, and so on. In this way, we notice an awesome potential to build an association between Bioinformatics and the information mining.

- (b) **Bioinformatics**- The term bioinformatics was coined by Paulien Hogeweg in 1979 for the investigation of information processes in biological frameworks. In the late 1980s, it has essentially been utilized in genomics and hereditary qualities, especially in areas of genomics which mostly deals with DNA sequencing.

Bioinformatics can be characterized as the use of PC innovation to the administration of organic data. Bioinformatics is the study of extricating, putting away, sorting out, deciphering, examining and using data from natural successions and atoms. It has been for the most part powered by progresses in DNA sequencing and mapping strategies. In the recent decades, quick advancements in the field of genomic and other sub-atomic research innovations and improvements in data advances have consolidated to deliver a colossal measure of identifying data with the sub-atomic science. The Bioinformatics essential objective deals with expanding the comprehension of organic procedures.

Some of the superb area of research in the field of Bioinformatics includes:

- (i) **Sequence analysis**- Grouping investigation is the crudest task in computational science. This task compose of determining the part of the natural grouping which are similar and which part differs amid restorative investigation and with genome mapping forms. The grouping investigation infers subjecting a DNA or peptide succession to arrangement databases, rehashed grouping looks, or different Bioinformatics strategies on a PC.
- (ii) **Genome comment** - With regards to genomics, explanation is the path towards indicating the qualities and other organic highlights of DNA succession. In 1995, Dr. Owen White composed the main genome comment programming framework.
- (iii) **Examination of quality articulation**- Mentioning the different procedures of mRNA levels can control the outflow of numerous qualities. For example, microarrays, communicated serial examination of quality articulation (SAGE) tag sequencing, cDNA arrangement tag (EST) sequencing, hugely parallel mark sequencing (MPSS), or different uses of multiplexed in-situ hybridization and so forth. These strategies are surprisingly under the commotion inclined and inclination of original estimates. Here the significant research territory includes creating factual apparatuses to isolate motion from commotion in high-throughput quality articulation ponders.
- (iv) **Investigation of protein articulation**- Quality articulation is estimated from different perspectives, including protein articulation and mRNA, however protein articulation standout amongst other pieces of information about real quality movement since last impetuses of cell action is generally proteins. High throughput (HT) mass spectrometry (MS) and Protein microarrays can give a preview of the proteins exhibit in an organic. Example. Bioinformatics is particularly associated with understanding microarray of protein and information related to HT MS.
- (v) **Investigation of transformations in malignancy**- In tumours, the genomes of influence cells are improved in mind boggling or even eccentric ways. Enormous sequencing endeavors are utilized to distinguish beforehand obscure point changes in an assortment of qualities in malignancy. Bio-informaticians keeps on producing specific computerized frameworks in order to deal with the sheer volume of arrangement of information delivered, and they can make new calculations and programming by using that information in order to contrast the sequence comes about with the increased developing gathering of human genome groupings and germ line polymorphisms. New discovery of physical advances is utilized, for eg., oligonucleotide microarrays to distinguish between chromosomal increases, misfortunes and single-nucleotide polymorphism make clusters of identifying known point changes. Another kind of information which is beneficial requires novel informatics improvement that deals with the investigation of sores observed to be repetitive in nature among several tumours.
- (vi) **Protein structure expectation** - The amino corrosive grouping of protein (so - called, essential structure) can be determined from the succession of quality for which coding is done. The case in maximum part, this essential protein structure, especially determines about structure while being in local condition. Learning about this structure helps in fundamental understanding of the capacity of protein. In the absence of better terms, basic data are generally delegated optional, tertiary and quaternary structure. Expectation in protein structure stands to be remarkable amongst the utmost vital in the case of sedate outline and for the planning of novel catalysts. An answer of such forecasts still left with an issue unsolved for the analysts for further findings.
- (vii) **Similar genomics** - Similar genomics deals in the investigation of genome structure relationships and capacity crosswise over diversified organic species. Similar genomics can only be clustered using quality finding

which is a disclosure of new, non-coded utilitarian components of the genome. Two similitude's and contrasts in the RNA, proteins and administrative districts of various living beings are misused by relative genomics. The computational methods that relate to genome correlation have changed late in a specific research topic in software engineering.

(viii) **Displaying natural frameworks** - Displaying natural frameworks is a huge errand of frameworks science and scientific science. Computational frameworks science expects to create and utilize productive calculations, information structures, representation and specialized apparatuses for the incorporation of extensive amounts of natural information with the objective of PC displaying.

Bioinformatics Research Area	Tool (Application)	References
Sequence alignment	BLAST	http://blast.ncbi.nlm.nih.gov/Blast.cgi
	CS-BLAST	ftp://toolkit.lmb.uni-muenchen.de/csblast/
	HMMER	http://hmmer.janelia.org/
	FASTA	www.ebi.ac.uk/fasta33
Multiple sequence alignment	MSAProbs	http://msaprobs.sourceforge.net/
	DNA Alignment	http://www.fluxus-engineering.com/align.htm
	MultAlin	http://multalin.toulouse.inra.fr/multalin/multalin.html
	DiAlign	http://bibiserv.techfak.uni-bielefeld.de/dialign/
Gene Finding	GenScan	genes.mit.edu/GENSCAN.html
	GenomeScan	http://genes.mit.edu/genomescan.html
	GeneMark	http://exon.biology.gatech.edu/
Protein Domain Analysis	Pfam	http://pfam.sanger.ac.uk/
	BLOCKS	http://blocks.fhcrc.org/
	ProDom	http://prodom.prabi.fr/prodom/current/html/home.php
Pattern Identification	Gibbs Sampler	http://bayesweb.wadsworth.org/gibbs/gibbs.html
	AlignACE	http://atlas.mcd.harvard.edu/
	MEME	http://meme.sdsc.edu/
Genomic Analysis	SLAM	http://bio.math.berkeley.edu/slam/
	Multiz	http://www.bx.psu.edu/miller_lab/
Motif finding	MEME/MAST	http://meme.sdsc.edu
	eMOTIF	http://motif.stanford.edu

VI DATA MINING

(qualities, drugs, pathways, tissues, and so on.)
of a particular ailment, is as yet vague.

Information mining alludes to extricating or "mining" learning from a lot of information. Information Mining (DM) deals with investigation of discovering new, intriguing examples and the relationship among the colossal measure of information. It is characterized as "the procedure of discovering significant new relationships, examples, and patterns by examining with abundant information which is kept in stockrooms". In some cases, Information mining can be termed as Knowledge Discovery in Databases (KDD). Particularly, Information mining is not related to any industry, but it requires keen advancements and the competence to investigate the likelihood of concealed learning that resides in information.

Information mining approach appears suitable for Bioinformatics in a perfect world, since it is rich in information, however, does not have a complete hypothesis of life's association at the sub-atomic level. The extensive databases of natural data, create two difficulties and open doors for the improvement of novel KDD strategies. Mining eliminates valuable education in the large data sets accumulated in organic information science and in other related life science areas, for example, medicine and neuroscience.

VII CONCLUSION

The Research may give a prologue to atomic science and Bioinformatics. At that point the investigation of microarray test examination and the utilization of bunching systems may helpful in mining microarray information. Report originally underlines part of the bunching test to compare group properties, in comparable character gatherings. Microarray test offers many great examples for every quality, bunching can be viably used to assemble these qualities into illness causing qualities and ordinary qualities and to consider the different attributes of various qualities under various conditions. It can be used to treat sedate treatment in response to the properties of medicines, which are ready for the conclusion of serious diseases till date.

We expect to assist soon with the development of such approaches, and an attractive commitment from the Bioinformatics group would be the improvement of simple-to-utilize and unreservedly open apparatuses, for example, GeneWizard. To date, the feasibility of universally useful methodologies and instruments, when contrasted with space devices, for example, CoPub for liver pathologies, that incorporate all the data identified with the diverse natural angles

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Feasibility of Pressure Balanced Joint using Single wire GMAW and Tandem GMAW

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ABSTRACT

Currently, plastic lined pipes are used for water injection lines. The pipes are welded using the "weld link" method and are installed by the reeling method. However, for deep water, reeling method is not efficient and if using the "weld link" method for pipe line techniques the production time and installation cost will dramatically increase because there is a joint every 25m - 50m. The PBJ to allow shorter pipe sections to be joined at a faster rate and to reduce the installation cost. The results also revealed that both Single wire GMAW and Tandem GMAW can be used to weld the steel pipe incorporating the PBJ with Aero gel blanket of 2.5mm and 5.5mm nominal thickness without deforming the PBJ under the conditions used in the trials.

I LITERATURE REVIEW

(a) **Introduction** - Over the years, pipelines have been used as transportation systems, for transporting materials such as slurries, sewage, oil, refined products, gas and chemicals. The pipelines are made of materials such as composite, plastic, alloy steel, carbon steel, ductile iron, and concrete. [1]. currently, their consideration for use as hydrocarbon pipeline is gradually increasing because of the cost benefits involved. Plastic-lined pipes for WI lines have been installed by the reeling method. The reeling method is limited to smaller diameter pipes (16 inches diameter as upper limit). In deep water and sites distant from infrastructures, reeling installation of pipelines is inefficient and uneconomical. The increasing demand for plastic-lined pipelines with diameters greater than 18 inches, and the need to install the pipelines in deep water and long-distance, prompted companies to search for the most economic and efficient installation technique. To reduce the installation cost of plastic-lined

pipeline, Boreas Consultants [5] developed and patented Pressure Balanced Joint (PBJ). This allowed shorter pipe sections to be joined at a faster and cheaper rate. The PBJ proved to be more cost effective than the weld link and also demonstrated its ability to maintain a stable corrosion barrier at the welded joints in plastic-lined pipelines. At present, the PBJ is targeted for WI lines.

(b) **Swage lining Process** - The swage lining process is the technology employed for the lining of existing pipe with tight fitting poly ethylene (PE) pipe. The swage lining die temporarily reduces the outer diameter of the PE pipe to allow the PE pipe to be pulled easily through the steel pipe. Upon removal of the pulling force, the plastic pipe relaxes and expands, pressing tightly against the internal surface of the steel pipe. The pipes are lined in length of 1650-ft using the swage lining process (see fig.1), and the weldlink fittings (see 4) are welded at the end of each stalk [4].

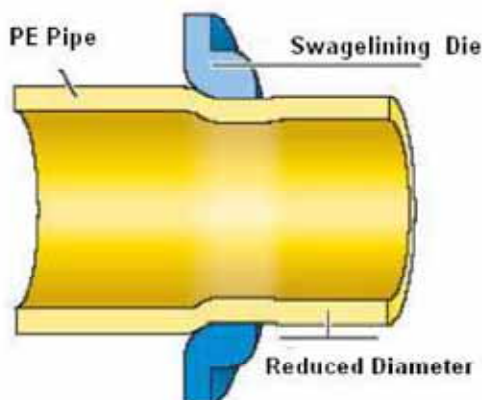


Fig No. 1 Swage lining Die



Fig No. 2 Reduced Plastic liner pulled from swaging block via a towing head about to go into the pipe



Fig No. 3: Plastic liner pulled through the steel pipe with the Weld link welded to the end of the stalk



Fig No. 4: End of a stalk with weld link assembly

(c) **Pressure Balanced Joint (PBJ)** - In 2003, Boreas developed and patented the PBJ for joining lined pipes for steel pipe welding methods. The development was as a result of the demand for a cost effective joining technique for plastic lined water injection lines for deep water projects. The PBJ (see Figure 5) is a short plastic

pipe with a distinct profile machined on its exterior surface with a linavent inserted in the mid-length to facilitate pressure balancing between the bore and the annulus. Its essential purpose is to provide a corrosion barrier, deterring the flow of the fluid in the bore to the wall of the steel pipe at the welded joint^[7] t.

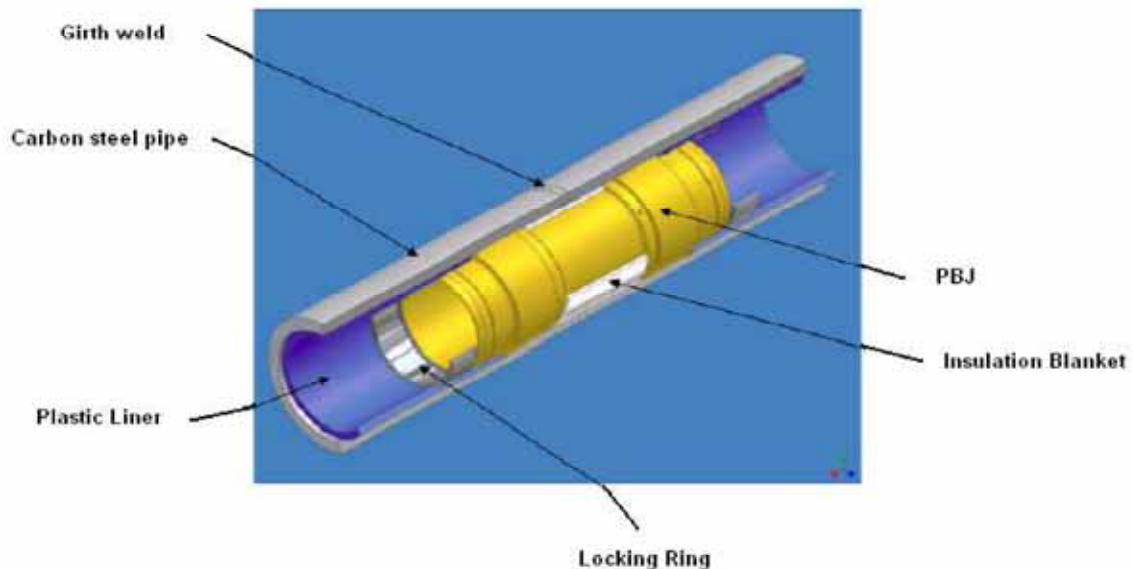


Fig No. 5: PBJ Assembly

(d) **Welding Processes for Pipelines.**

(i) **GMAW - Gas Metal Arc Welding** (GMAW), by definition, is an arc welding process which produces the coalescence of metals by heating them with an arc between a continuously fed filler metal electrode and the work. The process uses shielding from an externally supplied gas to protect the molten weld pool. The application of GMAW generally requires DC+ (reverse) polarity to the electrode. In non-standard terminology, GMAW is commonly known

as MIG (Metal Inert Gas) welding and it is less commonly known as MAG (Metal Active Gas) welding. In either case, the GMAW process lends itself to weld a wide range of both solid carbon steel and tubular metal-cored electrodes. The alloy material range for GMAW includes: carbon steel, stainless steel, aluminum, magnesium, copper, nickel, silicon bronze and tubular metal-cored surfacing alloys^{[2] [3]}.

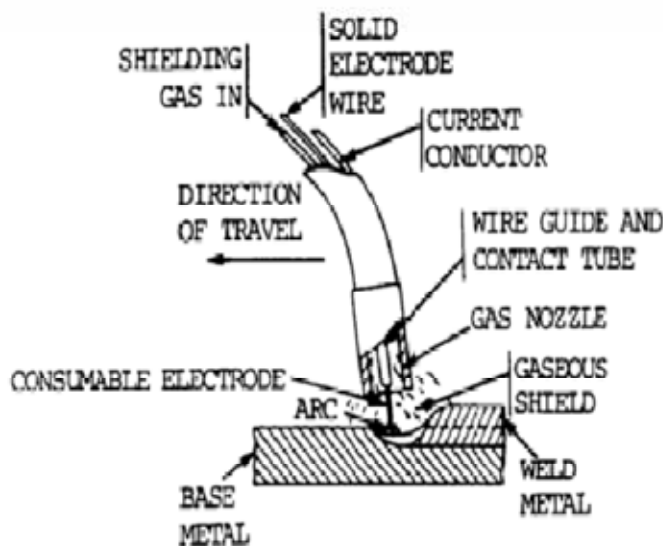


Fig No. 6: Gas metal arc welding process

(ii) **Single wire GMAW** - Initially, pipelines are welded using oxy-acetylene process in the early 1920's prior to the advent of the MMAW in the late 1920's. In the 1940's, a continuously fed filler wire welding process, referred to as the GMAW (single wire GMAW) was introduced. It is normally operated on the DCEP mode due to improved arc stability. Currently, GMAW process is predominantly used for pipeline construction^[4].

- **Advantages**

- Reduced weld completion time.
- Low cost of consumables.
- Improved mechanical properties.
- Low risk of slag inclusion.
- Reduced pre heating.
- Reduced skill requirements
- Low risk of hydrogen induced cracking

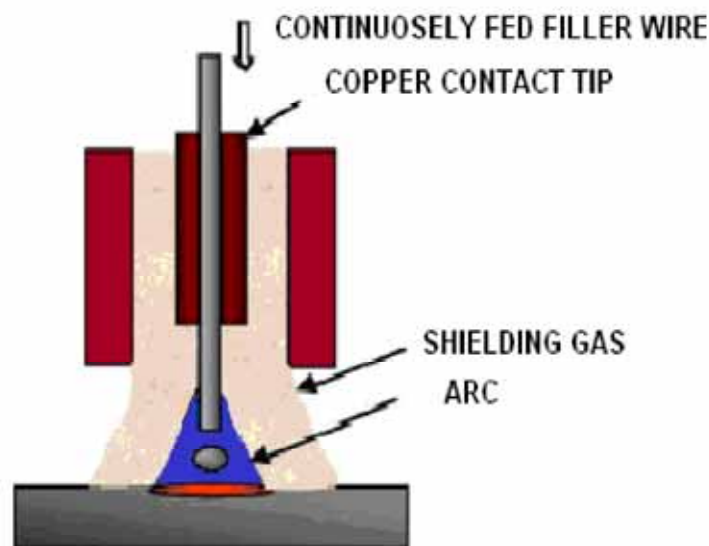


Fig No. 7: Principles of GMAW

Typical GMAW power sources have constant voltage output characteristics (see Fig.7) and normally produce direct current (DC) output. This allows the arc length to remain constant due to an electrical characteristic known as self-adjustment. If the arc length varies, an equivalent variation in arc current will take place such that the melting rate will change to resist any alteration of the original arc length. This provides improved process stability

The fundamental task of the GMAW torch is to guide the wire, shielding gas and current to the welding zone. They must be strong enough to bear the rough handling by the welder and also survive the high temperature of the arc. However, they must be flexible, weightless and comfortable for use^[8].

(iii) **Tandem GMAW** In the mid 90's, the Tandem GMAW was introduced to further increase productivity, part throughput as well as reduced cost of pipeline construction. It is a twin wire that uses waveform control technology to synchronize two independently generated arcs (the lead arc and trail arc). The process utilizes two welding power sources and two wire feeders operating in tandem to deliver two filler wires via a single torch.

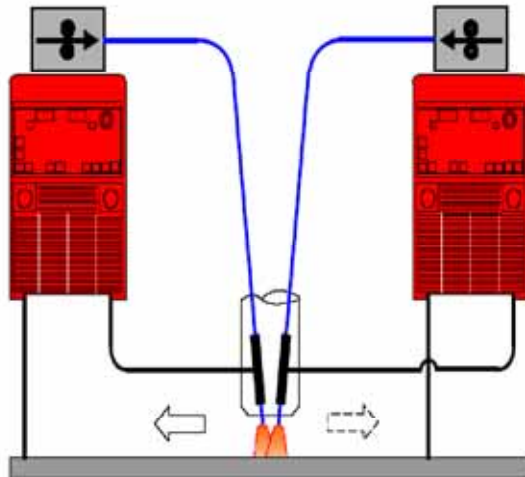


Fig No. 8: Tandem welding with two tubes electrically insulated from each other

- **Advantages**
 - High welding speeds.
 - Faster cycle times.
 - Reduced heat input.
 - Resists burn-through on thin materials.
 - Low spatter levels.
 - Good penetration on thick materials.
- **Disadvantages**
 - Major disadvantage is cannot be used in the vertical or over head welding position due to high heat input.
 - The equipment is very complex.

The welding arcs operate simultaneously in the same weld puddle, separated by not more than 0.5 inch. The thermal and fluid dynamics of the weld puddle are influenced by the independent control of the two welding arcs to help improve welding performance.

The Tandem GMAW offers high deposition rate, up to 24Kg/hr at a travel speed of 0.8m/min and travel speeds more than twice that of single wire GMAW (up to 5 m/min for a 2mm lap joint)^{[6] [10]}.



Fig No. 9: Tandem Wire GMAW with two wires in the same

III MATERIALS, EQUIPMENT AND EXPERIMENTAL TECHNIQUES

(a) Materials

- (i) **Pipe Materials** - Pipes of grade X65 with 12 inches outside diameter and 22/24mm wall thickness were used for the trials. The pipes were received in 150mm long with J-bevel of angle 50 at one end of each pipe. Pipeline Technique Ltd prepared the bevels utilizing a pipe facing machine.
- (ii) **Pressure Balanced Joint** - The PBJ is a HDPE machined out of a blue plastic pipe with specially machined profile. It incorporates a groove at the mid-length to accommodate the aerogel blanket. It has softening temperature of about 80 C.



Fig No. 10: Pipe storage.



Fig No. 11: PBJ

(iii) **Aerogel Insulation-** Aerogel insulation, a patent of Aspen Aerogels, Inc., is a nanotechnology- enabled product with high insulating properties. It a ready-to-use blanket infused with silica nanostructures that make it easy to conserve energy ^[9].

- **Feature**
 - Aero gel has excellent temperature resistance.
 - Light weight.
 - No requirement for vacuum sealing.
 - Easy of installation



Fig No. 12: Aerogel Blanket

(b) Equipment

(i) Power Source

The power source used is the Lincoln Electric power wave 455 STT with the specification:

- Welding current range : 5-500Amps
- Maximum OCV : 75Vdc
- Pulse frequency : 0.15- 1000Hz
- Pulse voltage range : 5- 55Vdc
- Pulse and background time range : 100μ sec. -3.3 sec.
- Input voltage : 400V ± 15%
- Input frequency : 50/60 Hz

The power source operates on the synergic and non-synergic welding modes. It allows the operator to set a required wire feed speed and the machine will select the correct current voltage and current.

The power wave is a semi-automatic, high performance, digitally controlled inverter welding power source capable of complex, high speed waveform control; designed to be a part of a modular, multi-process welding system. Depending on the configuration, it can support CC, CV, GMAW, PGMAW, FCAW, GTAW, CAC, pulse welding and STT mode.



Fig No. 13: Power Source

(ii) Welding Torch - The Fronius tandem torch with dual wire was used. The two wires are contained in contact tubes which are electrically insulated from

one another. They also run through a common gas nozzle which entails that the two wires must share common welding torch.



Fig No. 14: Tandem torch mounted on bug

(iii) **Temperature Measurement** - Temperature measurements at different positions were conducted using the K-type thermocouples (Chromel +ve -

Alumel -ve). The thermocouples were situated at different positions on both the carbon steel pipe and on the PBJ. Eight K-type thermocouples were used.

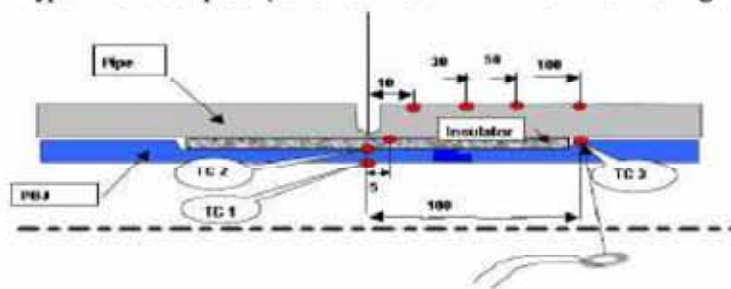


Fig No. 15: Locations of Thermocouples.

(iv) **Temperature Measurement Equipment** - The temperature readings were obtained from the K-type thermocouples using the National Instruments modules allowing 16 channel

temperature measurements. One high accuracy isothermal block module (SCXI-1328) accommodated up to 8 thermocouples, for 8 temperature measurement channels.



Fig No. 16: Temperature data capture monitor

(c) Experimental processure.

- | | |
|--|--|
| <ul style="list-style-type: none"> (i) Pipe Cleaning (Grinding and wire brushing) (ii) Tack welding of two of the pipes using GMAW. (iii) Placing the thermocouples on the pipe by capacitor discharge welding. (iv) Placing the thermocouples on the PBJ with soldering iron by melting the plastic and | <ul style="list-style-type: none"> plunging the thermocouple into the melted plastic. (v) Wrapping the PBJ with the aerogel blanket. (vi) Placing the pipe on the rotator. (vii) Inserting the PBJ in the pipe. (viii) Welding of the pipe. (ix) Cutting of the specimen for macro structural examination. |
|--|--|



Fig No. 17: Ground and wire brushed pipe



Fig No. 18: Aligned pipes with tack welds



Fig No. 19: Thermocouples located on the outer surface of pipe



Fig No. 20: Thermocouple located on the inner surface of pipe

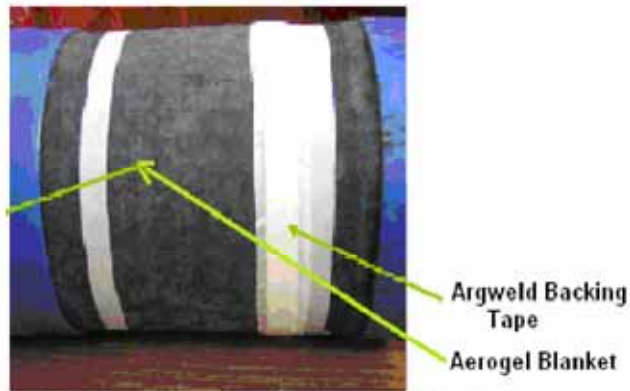


Fig No. 21: PBJ wrapped with aerogel before inserting it in the pipe



Fig No. 22: Thermocouples located on the outer surface of PBJ



Fig No. 23: PBJ inserted in the pipe

IV RESULTS & ANALYSIS

(a) Results

- (i) **Data for Single wire pipe weld with 2.5 mm nominal thickness of aerogel blanket-** The arc on time measured was about 15 minutes and the total welding period measured was about 50 minutes. An average

deposition rate of 2.04 kg/hr was calculated for the single wire MIG.

- (ii) **Data for tandem pipe weld Trials-** The arc on time measured was about 15 minutes and the total welding period measured was about 50 minutes. An average deposition rate of 3.78 Kg/hr was calculated for the tandem MIG.

Table No. 4.1
Welding Parameters for Single wire Welding

WELDING PARAMETER							
DESCRIPTION		MATERIAL GRADE - X65					
TANDEM WIRE WELD		DIA - 18"					
		WALL THICK - 22/24mm					
PASS	PROCESS	ELECTRODE				SHIELDING GAS	
		POLARITY	BRAND	BATCH	SIZE MIN	TYPE	FLOW L/MIN
ROOT	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO ₂ / 5 %He	25
HOT PASS	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO ₂ / 5%He	25
FILL 1	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO ₂ / 5%He	25
FILL 2	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO ₂ / 5%He	25
FILL 3	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO ₂ / 5%He	25

TEMP C	WFS m/min	Amp I	Volts V	FRQ Hz	TRAVEL SPEED run/min	HEAT INPUT kj/min	DEPOSITION RATE Kg/Hr
50	6.5	105	20.5	90	444	0.30	3.76
60	7.5	115	20.6	130	536	0.47	3.82
70	7.8	121	20.8	150	636	0.48	3.90
79	7.9	129	21.8	180	728	0.55	4.01
80	7.9	130	22.1	183	730	0.56	4.05

Table No. 4.2
Welding Parameters for Tandem Welding

WELDING PARAMETER							
DESCRIPTION		MATERIAL GRADE - X65					
SINGLE WIRE WELD		DIA - 18"					
		WALL THICK - 22/24mm					
PASS	PROCESS	ELECTRODE				SHIELDING GAS	
		POLARITY	BRAND	BATCH	SIZE MIN	TYPE	FLOW L/MIN
ROOT	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO ₂ / 5%He	25
HOT PASS	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO ₂ / 5%He	25

FILL 1	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO 2 / 5%He	25
FILL 2	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO 2 / 5%He	25
FILL 3	GMAW	DC +VE	LA 100	EDPN 9241	1.0	82.5%Ar/12.5%CO 2 / 5%He	25

TEMP C	WFS m/min	Amp I	Volts V	FRQ Hz	TRAVEL SPEED run/min	HEAT INPUT kj/min	DEPOSITION RATE Kg/ Hr
50	6.5	115	20.8	100	444	0.32	2.02
55	6.7	122	21.5	120	444	0.34	2.03
62	6.9	124	21.6	135	444	0.34	2.04
64	7.0	125	21.7	140	444	0.34	2.05
70	7.5	130	21.7	190	444	0.34	2.06

(b) Analysis

(i) **Temperature Profiles** - The trial was to evaluate the maximum temperature

generated on the PBJ with an aerogel blanket of 5.5 mm nominal thickness as compare to 2.5mm nominal thickness.

2.5 mm thickness of Aerogel Blanket for PBJ

	Min temp °C	Max temp °C
Single wire	50	80
Tandem wire	50	75

5.5 mm thickness of Aerogel Blanket for PBJ

	Min temp °C	Max temp °C
Single wire	50	90
Tandem wire	50	81

The results of the trials revealed that the estimated deposition rate for the tandem GMAW is about twice that of the single wire MIG. The arc on time for the tandem GMAW and single wire GMAW was 50 minutes. This showed that the productivity of the tandem is higher than that of the single wire MIG.

• Tandem wire GMAW maximum temperature of 75 °C.

(iii) The feasibility of the tandem GMAW is about twice that of the single wire GMAW.

V CONCLUSIONS & FURTHER SCOPE

(a) Conclusions

- (i) Under the conditions used for the trials, the results revealed that with the 2.5 mm nominal thickness aerogel blanket, the PBJ can withstand the welding conditions without being deformed, even though the PBJ was hotter.
- (ii) A complete weld was obtained using for the PBJ with insulation blanket of 2.5mm thickness for
 - Single wire GMAW maximum temperature of 80 °C.

(b) Recommendation for Further Work

- (i) 2.5 mm aerogel blanket can be used in place of 5.5 mm aerogel blanket.

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Criterion for Selection of Turbines for Hydroelectric Power Project

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ABSTRACT

The hydro-turbines are used in hydropower plants to convert the hydraulic energy into mechanical energy. There are different types of turbines, mainly Pelton, Kaplan, and Francis. Further, there are some variants of each type of turbine. The hydraulic parameters, power grid requirement geological conditions etc. differ from one site to another which makes each hydropower project, a unique. Hence, selection of turbine to suit a specific site is a specialized job and need utmost considerations. The selection criterion of hydro turbine are discussed in this paper.

Keywords- Hydro turbines Peloton turbine, Kalplan Turbine, Francis Turbine

I INTRODUCTION

Hydraulic turbines are the highest efficiency prime movers used for power generation. They convert hydraulic energy contained in water to mechanical energy. A turbine is coupled to the generator which

converts mechanical energy into electrical energy. The hydropower projects are generally multi-purpose for use in irrigation, water supply, flood control, fisheries etc. In some projects it is used only for power generation. A typical layout of a hydro power Plant is shown in Figure 1.

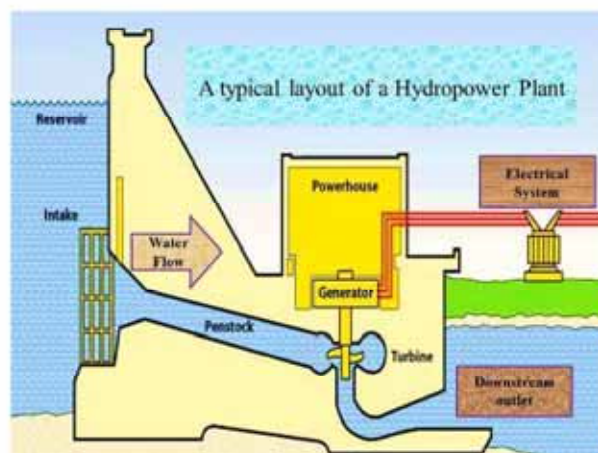


Fig No. 1: Typical layout of a hydro power plant [1]

II CLASSIFICATION OF TURBINES

The conversion of energy in a turbine takes place on the principle of impulse or reaction and hence, the hydro turbines are broadly classified as impulse and reaction types. Pelton turbine is an impulse type turbine whereas Francis and Kaplan turbines are reaction type.

The hydro turbines and their variants are given below:

Impulse: Pelton type tangential flow turbine

Pelton turbine

Turgo impulse turbine

Cross flow turbine

Reaction: Francis type mixed flow turbine

Francis turbine (adjustable guide vanes)

Deriaz turbine

Pumped storage (reversible) pump-turbine (adjustable guide vanes)

Reaction: Kaplan type axial flow turbine

Kaplan: Vertical & horizontal (adjustable blades & adjustable GV)

Propeller: Vertical & horizontal (fixed runner blades and adjustable GV)

Semi-Kaplan: Vertical and horizontal (adjustable runner blades but fixed GV)

Tubular (S-type): Horizontal (Kaplan or semi Kaplan or propeller)

Bulb: Horizontal (Kaplan or semi-Kaplan or propeller)

Straflo: Horizontal (Kaplan or semi-Kaplan or propeller)

(a) **Orientation of turbines** -The hydro turbines are horizontal or vertical axis type. Inclined axis turbines are also offered by some suppliers. The vertical axis arrangement of generating unit i.e. turbine and generator is generally suitable for higher rating turbines whereas horizontal axis arrangement suits low rating turbines, say up to 1 to 2 MW. However, there are some

exceptions also. Some large rating hydro turbines with horizontal axis orientation are in operation, e.g. 4×12.65 MW Ramam HEP in West Bengal. A horizontal axis Pelton and vertical axis Francis & Kaplan turbines are shown in Figure 2.

In general higher capacity horizontal units are provided with Pelton turbines. The centre line of large capacity reaction turbines is set invariably below minimum tail water level. Therefore, power plants with reaction turbines mostly have vertical configuration, mainly due to economic reasons.

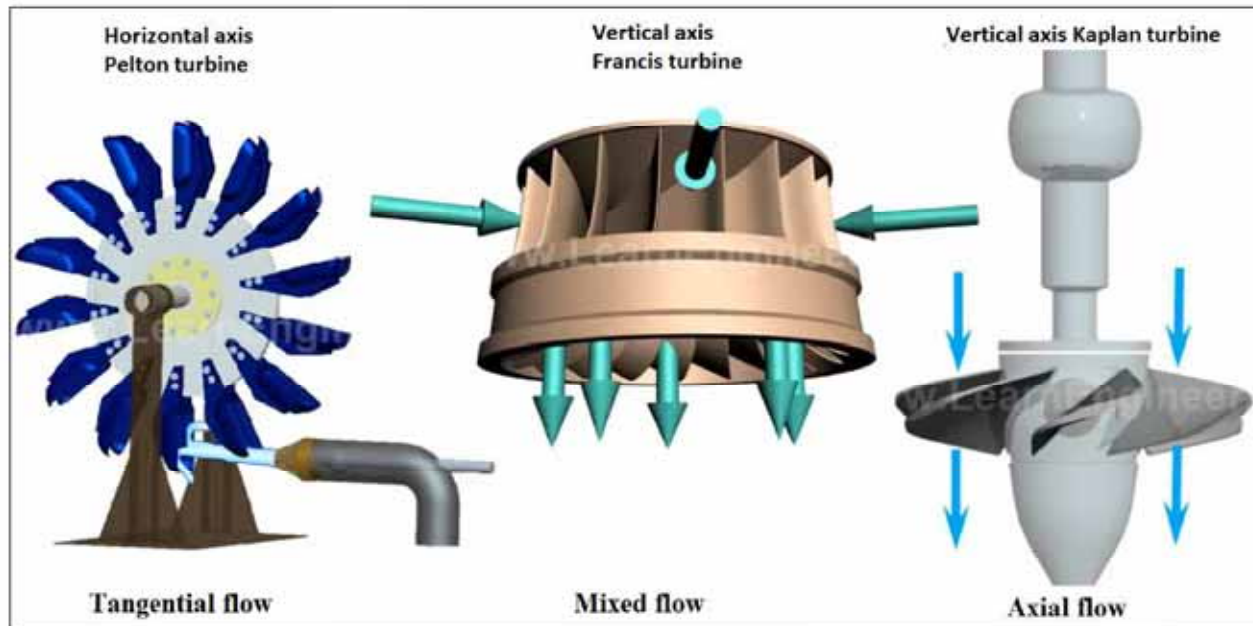


Fig No. 2: Hydro turbines [2]

The decision on the orientation of turbine depends mainly on the recommendation of turbine supplier and cost economics. In general, vertical axis large Francis and Kaplan turbines make the best use of head and space which makes the project economically viable.

(b) Impulse and reaction turbines: A comparison

The salient features of impulse and reaction turbines are compared in Table 1. **Comparison between impulse and reaction turbines**

Table No. 1

Impulse turbine	Reaction turbine
The potential energy of water is converted into kinetic energy by nozzle that forms a free jet	A part of potential energy in water is converted into kinetic energy before water enters the runner
The jet is at atmospheric pressure while passing through the runner and thereafter	The pressurized (with pressure almost equal to the pressure created by the head prevailing at a moment) water enters the runner and then both the velocity and pressure change as water passes through the runner and draft tube
The buckets are in action only when they are in front of the nozzle	Blades are in action all the time.
Runner is partially filled with water	Runner is fully submerged in water
Casing has no hydraulic function to perform as it only prevents splashing and guides water to the tail race	Pressure at inlet to the turbine is much higher than pressure at outlet. The unit has to be sealed from surroundings and therefore, casing is a must
Turbine runner is installed above the tail race	Turbine runner is submerged in water below the tail race elevation
When water glides over the moving buckets, its relative velocity either remains constant or reduces slightly due to friction	There is continuous drop in pressure while water flows through the blades.
No cavitation due to free flow of water from jets to runner and runner to tail race	Cavitation due to the flow of water in closed system

III CRITERION FOR SELECTION OF TURBINES

The hydraulic parameters, power grid requirement geological conditions etc. are to be taken care of in the development of a hydroelectric power project. Hence, the hydro power projects are tailor made i.e. specifications, design, layout, construction etc. of no

two projects are identical. The selection of hydro turbine is project specific and their selection criterions are discussed next.

- (a) **Preliminary selection** - A preliminary idea of a turbine output for different heads and discharge can be obtained from Figure 3.

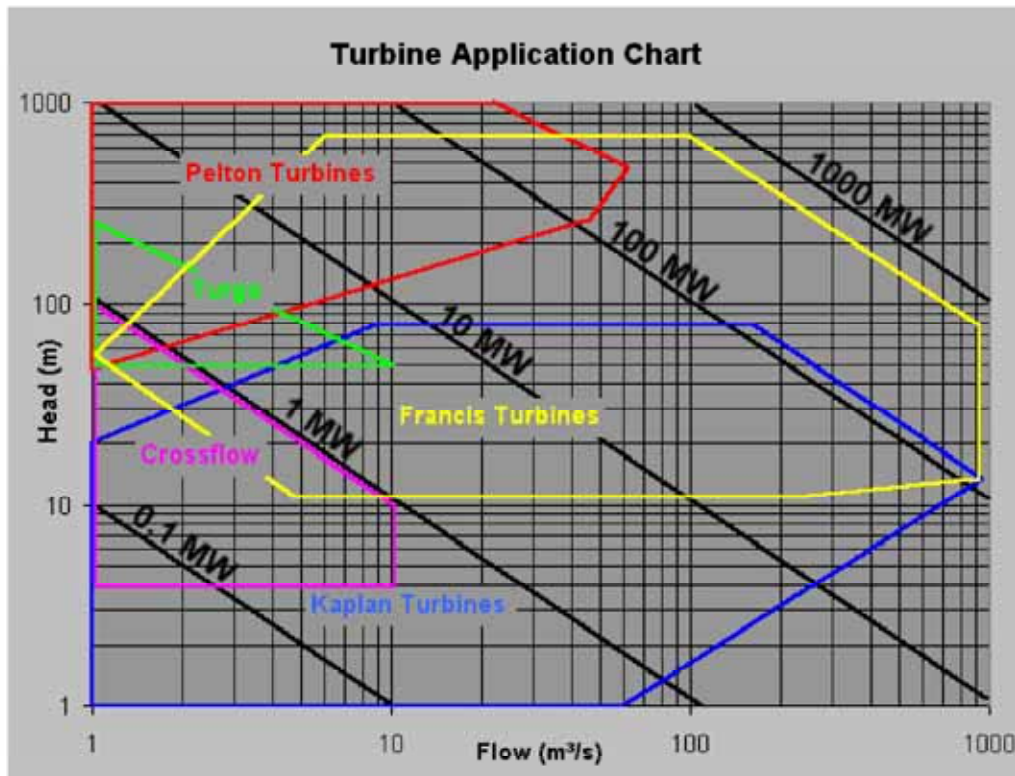


Fig No. 3: Relationship of turbine output with head and discharge [3]

In Figure 3, it is observed that there are some overlapping areas. For example, a discharge of 20 m³/s and head of 300 m fall in the range of Pelton as well as Francis turbine. Such cases need detailed analysis for optimum selection of appropriate turbine.

(b) Specific speed

Hydraulic turbines are the highest efficiency prime movers used for power generation. They convert hydraulic energy contained in flowing water to the mechanical energy. A turbine is coupled to the generator which converts mechanical energy into electrical energy. The hydro turbines are basically categorised as impulse and reaction.

The selection of an appropriate turbine is important for ensuring its optimum performance. The characteristics of a turbine runner are embodied in 'specific speed'. It is defined as the speed at which the turbine would run at its designed efficiency when reduced to scale, so as to produce unit power at unit head. It forms a uniform basis for comparison of different types of turbines. A model developed for a specified specific speed is used for wide range of output with same geometrical shape i.e. homologous reproduction, differing only in size. All such turbines would have the same specific speed. The specific speed (rpm) is given by the following equation:

$$\text{Specific speed } n_s = \frac{n\sqrt{P}}{H_n^{5/4}} \quad (1)$$

where,

n = Speed, rpm
P = Turbine output, kW
H_n = Net head, m

The concepts of specific speed and hydraulic similarity are applicable to all the types of turbines. The mechanical design considerations, tendency of cavitation, vibration, drop in peak efficiency and increased ratio of runaway speed to normal speed impose limitations on the specific speed of hydro turbines. These limiting factors are being progressively overcome with the technological advancements such as better understanding of the hydraulic profiles with the help of computational fluid dynamics (CFD) software in respect of pressure & velocity distribution; reasonably accurate prediction through model testing by adopting precision measurement techniques etc. The modern trend aims to attain higher specific speed which makes the turbine economical.

For example, the initial three Francis turbines for Grand Coulee Dam-III, USA were 600 MW, 86.9 m head and 72 rpm with a specific speed of 213 rpm. Later, three more Francis turbines installed were 700 MW and 85.7 rpm had a specific speed of 274 rpm.

- (i) **Specific speed and heads** - The specific speed and head are interlinked with each other. Higher specific speed of a turbine results in smaller size of generating equipment and smaller dimensions of a power house. The maximum net head acting on a turbine is one of the criteria for selection of a turbine for a specific site. The normal ranges of specific speed and head for various turbines are given in Table 2. **Specific speed and head range of turbines [4]**

Table No. 2

Type of Turbine	Specific Speed (rpm)	Head Range (m)	Remarks
Pelton	15-60	> 200	High heads
Francis	70-400	30-600	Medium heads
Deriaz	200-400	50-150	Medium heads
Pumped storage-reversible	70-400	30-600	Wide head range
Kaplan	300-800	10-80	Low heads
Bulb/Tubular	600-1200	3-25	Very low heads

In the overlapping head ranges, an elaborate techno-economic analysis becomes necessary. The variation in turbine model efficiency with specific speed is shown in Figure 4.

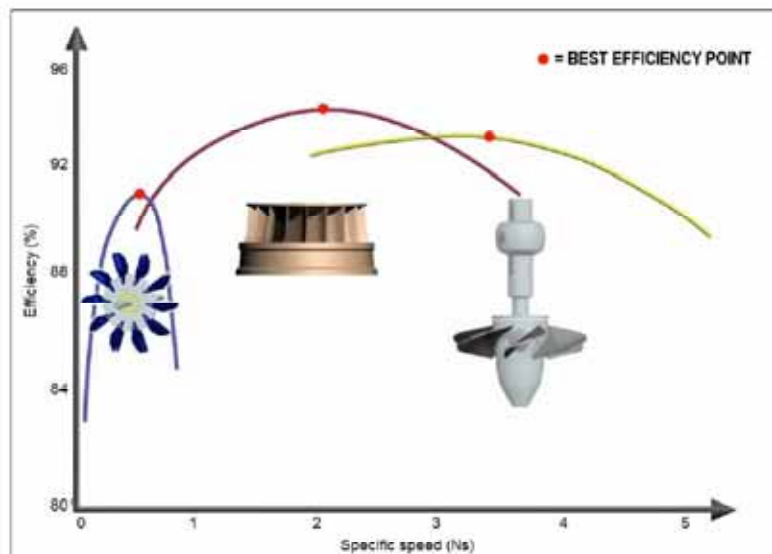


Fig No. 4 Variation in turbine model efficiency with specific speed [2]

- (ii) **Specific speed and setting** - The setting of centre line of runner depends on specific speed. The operating speed of a turbine is proportional to specific speed. Selection of higher specific speed turbine results in high speed generator which reduces generator cost and also the size of power house.

In case of an underground power house, the selection of high specific speed turbine results in compact generator which reduces the size of power house and excavation. On the other hand, high specific speed necessitates deep setting of centerline of turbine which increases excavation. However, there is overall economy as the quantum of excavation for the power house reduces due the reduction of power house dimensions. Further, as compared to gross excavation of complete project, the power house excavation is

around 25%. Thus, even deep setting does not matter. In fact, it marginally reduces the excavation which leads to overall economy. The 2 x 80 MW Pench hydro electric projects, near Nagpur, is an example of underground project.

(c) Turbine efficiency - Amongst various sources of energy, the hydropower generating units are the most efficient. The efficiency depends mainly on the type of turbine. The efficiencies of a higher rating turbine are also higher. The general range of efficiency of large and small capacity turbines are given in Table 3. Efficiencies of large and small capacity turbines

Table No. 3

Type of turbine	Efficiency (%)		Remarks
	Large capacity	Small capacity	
Pelton	93	92	
Turgo	---	90	
Cross flow	---	60	
Francis	96	94	
Deriaz	94	93	
Pumped storage-Reversible	94	92	Turbine mode
	Reversible unit operates at its peak efficiency point		Pumping mode
Kaplan	95	94	
Bulb/tubular	95	94	

(d) Part load operation - Allowable minimum part load operation in view of the cavitation and vibrations depends on type of turbine. Normally, the turbine manufacturers do not recommend operation of turbine below the minimum output limit. However, they

specify minimum time allowed for operation below minimum load for which cavitation guarantee has been given. The general limits of minimum turbine loading are given in Table 4. **Part load operation of turbines [4]**

Table No. 4

Type of turbine	Minimum output (% of full load)	Remarks
Pelton	50	with alternate half the jets on, i.e. 2/3
	25	with total 4/6 jets
Francis	40-50	
Deriaz	40	
Pumped storage-reversible	up to 50	Turbine mode
	-----	Pump is operated at the maximum efficiency point.
Kaplan	25-40	
Bulb/Tubular	25-40	

(e) Cavitation and centreline setting of turbine - Recovery of head in the draft tube results in lowering of pressure immediately under the runner of reaction turbines. The absolute pressure at runner discharge is a function of draft tube suction, the relative levels of runner, tailrace and barometric pressure. The only factor which may readily be adjusted at design stage is the difference between the levels of runner centreline and tail race, called suction head. The suction head is decided from the consideration of cavitation. The Pelton runner is installed above the maximum tail water level and hence the excavation requirement from the cavitation point of view is not applicable.

(f) Transient parameters - The fast changes in pressure and speed are of transient nature which happens due to sudden change in the loading of a generating unit. In high head units, the higher pressure rise in penstock increases the cost of penstock and associated civil works. The higher speed rise increases the vibrations and pressure fluctuations in draft tube. A very long water conductor system results in high pressure rise in penstock in case of Francis and Kaplan turbines. The pressure rise in pen stock is restricted to a reasonable level (generally as specified in the contract) by providing pressure relief valve or surge tank to relieve water pressure. Pelton turbine does not require pressure relief valve or surge tank due to the provision of jet deflectors. Pressure rise and speed rise are low in Pelton turbines. The general range of pressure rise and speed rise for various turbines are given in Table 5. **Transient parameters of different turbines [4]**

Table No. 5

Type of turbine	Pressure rise (%)	Speed rise (%)
Pelton	15 - 30	20 - 45
Turgo	15 - 30	20 - 45
Francis	30 - 40	35 - 60
Deriaz	30 - 40	35 - 60
Pumped storage-reversible	10-25 (turbine)	20-35 (turbine)
	Not applicable for pump	
Kaplan	30 - 50	35 - 65
Bulb/Tubular	30 - 50	35 - 90

(g) Transportation Limitations - The transport limitations define the constraints in the design of major components of a generating unit. Normally, runner is the most important component which is desired in one piece from cost, reliability, maintenance, vibrations and cavitation point of view, considerations. Further assembly, welding, fine finishing is very difficult to done at site, if runner is to be sent in two or more segments. The problem of transport in large Kaplan runner is much less due to an option to assemble the blades at site. It is preferred to design the runner of a Francis turbine within transportation limits of weight and dimensions. The large runners may have to be manufactured in two parts or cast fabricated for welding at site which may increase the cost of turbine. The runners of Pelton turbines are small and made in one piece only.

The manufacturers make best efforts to dispatch various assemblies/sub-assemblies factory assembled to the extent possible. Generally, the stator frame and core assembly with partial stator is shipped in segments to site. However, it may not be possible to do so in case of very large and/or heavy assemblies. Indira Sagar Hydroelectric Project is equipped with 8 x 125 MW, 115.4 rpm Francis turbines and 11 kV, 0.9 power factor, 50 Hz hydrogenerators. The lower specific speed of turbine has resulted in the slow speed, large size and heavy generator. The wound stator assembly weighs 230 t. In view of the permissible transport limits, the stator frame was shipped in 6 segments. The core building and winding was done in erection bay of power house. During the installation, the wound stator assemblies were lifted by tandem operation of 2 x 200 t overhead cranes and lowered in the generator pit.

In small hydro power projects, the probability of constraints in transportation is quite low. However, in the hilly terrain, sometimes the transport limitations may pose problem due to old, small and low capacity of bridges, culverts, steep slopes/bends etc. In some areas, the road traffic is blocked for several months due to heavy rainfall. Zojila pass in J&K is one such example which remains closed for several months during winter. In Leh-Ladakh, two projects of NHPC Ltd. were installed, namely 3 x 15 MW Nimmo Bajgo and 4 x 11 MW Chutak in Kargil in which several consignments had to be air lifted to avoid erection hold-ups.

(h) Maintenance of equipment - The maintenance of turbine, generator, auxiliaries, control/protection systems, cranes etc. as per the schedule provided by their manufactures plays key role in the performance of the generating unit. The guide vanes, guide bearing, runner in reaction turbine, nozzles/buckets in Pelton turbine etc are the critical components which are susceptible to damage by cavitation and silt erosion and they necessitate regular maintenance. In a hydropower project, even a 10 to 20 MW generating unit may have quite a large size components in case of low speed reaction turbines. In large Kaplan or Francis vertical axis turbines, provision may be made for bottom removal of runners and other under water parts without dismantling of a generator. Large Kaplan turbines may be designed to enable replacement of the runner blades without dismantling the generator and turbine top cover. The damages due to cavitation and silt erosion are relatively difficult to maintain and repair. They need more time for maintenance in reaction turbines as compared to Pelton turbines in which major and vital parts are easily accessible being in open. Replacement of spears and nozzles of Pelton turbines are much quicker and easier than replacement of guide vanes of reaction turbines.

In generator, windings and thrust/guide bearings need special care and attention in monitoring and maintenance.

IV CONCLUSION

The turbine is selected from techno-economic considerations which include the cost of civil works and associated benefits. It is really a difficult decision to select appropriate turbine as far as reaction turbine is concerned. Sometimes, depending on proven model testing and operation of prototype turbine, selection of turbine of lower specific speed may also be preferred.

Depending upon unit capacity, number of units, total energy generation, exhaustive studies, model test etc. are required to be done before final selection, as it relates to the cost of generator, its size, weight etc. which in turn relates to the sizing of the power house, crane capacity etc.

It is always intended to enhance the specific speed of turbines as can be noted from various papers published in leading national and international journals. On the basis of data of number of turbines manufactured during last several decades, analysis is carried out that shows the preference for higher and higher specific speeds for high heads. The objective is to economize on overall dimensions of power house which depend mainly on runner diameter. Several researches and experiments aim to improve metallurgy, profile of turbine blades etc. to minimize cavitation, erosion due to hard particles, silt etc. Though initially it increases cost of a turbine but over the useful life of a turbine, the additional cost incurred is paid back due to the reduced maintenance and increased availability of unit for operation. Thus, the optimum selection of hydro turbines to suit site parameters is very important.

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A Review on Fused Deposition Modeling of Additive Manufacturing Processes

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ABSTRACT

Fused Deposition modelling (FDM) is the most promising field of additive manufacturing technology. In fused deposition modelling method polymer filament is melted inside the extruder and extruded material were deposited one above another to manufacture product. In FDM process filament feed rate, heat sink fins, extrusion rate, nozzle diameter, pressure drop inside the extruder and temperature distribution are the parameters on which performance were depends. Here in this paper, it review the FDM process evolution and development in FDM process use as commercial 3D printing technique and also investigate the different process parameters on which the performance of 3D printer depends. This paper also reviews the dynamic analysis that is considered for the liquefier during working of FDM process.

Keywords-Fused deposition modeling, 3D printing, process parameters, Development, Dynamic analysis

1 INTRODUCTION

Fused deposition modeling is the most prominent field of additive manufacturing. Thirty years into its research and development, additive manufacturing has become a mainstream manufacturing process. Through Fused deposition modeling additive manufacturing process different 3D components can be manufactured adding materials one over another layers with the help of computerized 3D solid model. It does not require any kind of predefined setup for manufacturing the product like jigs and fixtures or any other means. 3D printing as Fused Deposition Modelling (FDM) is one of commonly used additive manufacturing technology for various engineering and well as day to day life manufacturing product applications. Stratasys Inc was the first to introduce FDM process commercially in early 1990s in USA, during that time additive manufacturing is in its evolution period. In fused deposition modeling, a polymer filament where it is poly-lactic acid (PLA), Acrylonitrile butadiene styrene (ABS) or Nylon is feed into an extruder barrel through feed mechanism. Polymer gets melted into the heated block of liquefier where heat cartridge is used as a heat source above heat block, in liquefier heat sink is there to maintain temperature of polymer below melting point so that at the entrance of polymer filament in heat block it remain in the solid form so that it act as a plunger to extrude the melted polymer through nozzle. This enables to build complex 3D objects as the melted bead leaving the nozzle solidifies. The most common materials used in this type of process are amorphous thermoplastics, with acrylonitrile butadiene styrene (ABS), with poly lactic acid (PLA) being the most common. This paper provides more detailed information about the typical components of Fused Deposition Modeling and importantly, gives a review of the state of the art in process modeling and science for these processes.

position and value of fused deposition modeling in today time is near about \$1.325 billion industry (2010 estimate) and it will reach to over \$5 billion by 2020 (Wohlers, 2011[42]). Additive manufacturing products are used worldwide such as in industrial plants, homes/offices, service providers and academic institutions and government/military settings. Research and development in FDM from both government agencies and the private sector have grown rapidly in last decade for the improvement of product quality and ability to produce end product which do not required any kind of other processing (Scott *et al.*, 2012[27]), including the recent establishment of the National Additive Manufacturing Innovation Institute (NAMII, 2012[26]). Based on the report presented by Wohler in 2010[42], Stratasys' market share in the field of AM FDM systems is 3.5 times that of any other FDM system manufacturer near about 41.5 percent of all systems sold in 2010 (Wohlers, 2011[42]). Through report it is found that till the end of 2010, there were 15,000 Stratasys FDM machines installed worldwide (Wohlers, 2011[42]). The current market of personal fabrication (Lipson and Kurman, 2010[21]) is also dominated by fused filament fabrication-type 3D printing systems, many of which are based on the open-source RepRap project (Jones *et al.*, 2011[14]). The growth and popularity of these systems have been increased remarkably due to the expiration of the initial Stratasys patents on the FDM process, as well as the low cost and easy of construction and handling of the systems. Regardless of the manufacturer, these small-scale machines sell for \$1,500-5,000 and print parts from ABS and/or polylactic acid (PLA) polymers.

- (a) **Development and uses of FDM process** An FDM technology was first introduced in the 1990s, a growing number of applications are for end-use parts that must meet stringent functional design requirements for mechanical properties, thermal properties and dimensional tolerances. The market

II DESIGN OF FDM SYSTEM AND SCIENCE

Fused deposition modeling process includes different components which are extruder liquefier and print

bed, gantry, filament feed mechanism, build surface, nozzle angle, nozzle diameter build environment, printed object, and heat source. Fig.1 shows the different components of FDM 3D printer.

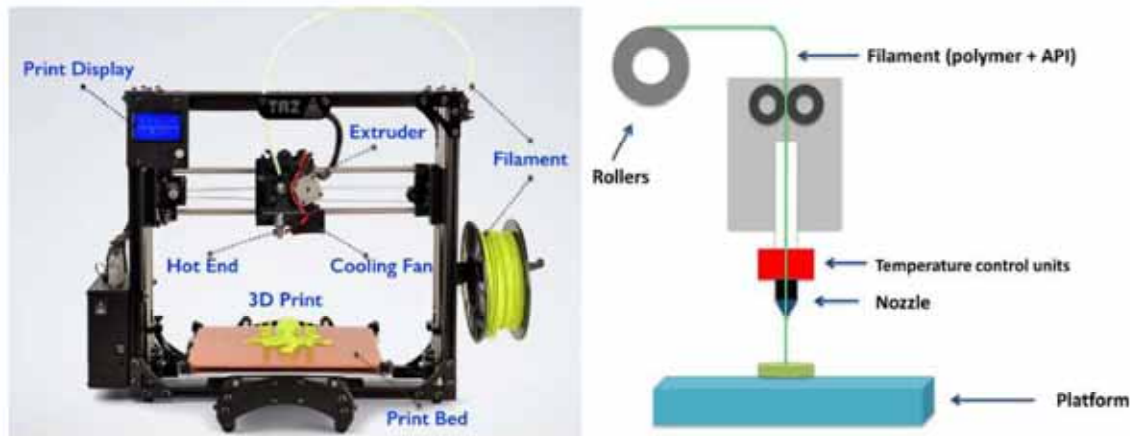


Fig No.1(a)FDM 3D printer (b) configuration diagram of fused deposition modeling

(a) **Material feed mechanism** - In FDM process filament feed materials are commonly thermoplastic polymer (PLA, ABS and Nylon) having diameter of near about 1.5-3 mm. In some small 3D printers systems filament feed material is provided as a loose coil where as in large systems it is provided in the form of reel to provide the filament to the system. In FDM process, feed filament is responsible to push the melted material through the extruder with the help of feed roller mechanism as shown in fig. 1(b). with the help of stepper motor which is connected to one of the rollers gives driving force in order to feed the filament in to the liquefier assembly. One of the rollers has a grooved or toothed surface like a gear to create sufficient friction for the roller to grab the feed filament and feed it to the liquefier inlet without

slippage (Agarwala *et al.*, 1996[16]). Sufficient pressure were applied by the roller on the feed filament to smoothly feed inside the liquefier, extra feed force causes the bending of polymer filament.

(b) **Force required by feed mechanism** - During feeding filament is in tension above the feed rollers mechanism, which pull the filament from its reel (Bellini *et al.*, 2004[5]), whereas below the feed rollers it is in compression. The filament feed rate is controlled by the feed stepper motor so as to maintain a constant and consistent volumetric flow rate (Q) of melted polymer material from the nozzle exit. For a desired road width (W) and slice thickness (H), the linear filament feed velocity (v) can be approximated as (Agarwala *et al.*, 1996[16]; Bellini *et al.*, 2004[5]):

$$= \quad (1)$$

While assuming no slipping in between the filament and rollers during feeding. The filament feed velocity can be simply related to feed roller velocity can be expressed as

$$= \quad (2)$$

Where ω is the angular velocity and r is the radius of the rollers, respectively (Bellini *et al.*, 2004[5]; Agarwala *et al.*, 1996[16]). The necessary force required to push the polymer melt through the liquefier can be determined if the pressure drop (ΔP) inside the liquefier is known,

$$F = \Delta P \cdot A \quad (3)$$

Where A is the cross-sectional area of the filament, which is assumed to be equal to the cross-sectional area of the liquefier (Bellini *et al.*, 2004[5]). This enables to calculate the torque (T) required by the stepper motor

$$= \frac{\eta}{2} \quad (4)$$

And also calculate the power required by the motor () (Bellini *et al.*, 2004[5]):

$$= \quad (5)$$

- (c) **Liquefier dynamics** - In FDM, liquefier is the most important component of 3D printer, where the solid polymer feed material get melted and pushed through a nozzle and extrude melted polymers. The dynamics of the FDM liquefier are critical and challenging in terms of modeling, the thermal properties of polymer melt inside the liquefier is a nonlinear function of temperature and shear rate. The behavior of different polymers during melting inside the liquefier is critical in describing the viscosity and variation of specific heat with respect to temperature. Polymers used during FDM process are generally shear thinning material and they are assumed as to follow a power-law viscosity model (Bellini *et al.*, 2004[5]; Mostafaet *al.*[25], 2009; Ramanathet *al.*, 2008[32]; Yardimci *et al.*, 1997[43]),

$$= (2\dot{\epsilon})^n \quad (6)$$

Where η is the viscosity, $\dot{\epsilon}$ the shear rate and K and n are consistency and flow behavior index parameters. The change in viscosity with respect to temperature must also be considered because the material will be nonisothermal as it flows through the liquefier chamber. The change in viscosity with respect to temperature and shear rate-dependent terms, respectively (Bellini *et al.*, 2004[5]):

$$= \left(\frac{\eta}{\eta_0} \right) (2\dot{\epsilon})^n \quad (7)$$

The viscosity depends on shear rate is simply the power-law expression with fit parameters evaluated at some reference temperature, η_0 . An Arrhenius model has been used for the variation of viscosity with respect to temperature,

$$\left(\frac{\eta}{\eta_0} \right) = \left(\frac{1}{1 - \frac{1}{H(T)}} \right)^{\frac{E_a}{R(T - T_0)}} \quad (8)$$

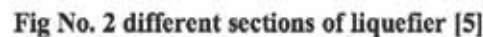
Where E_a is the activation energy (Bellini *et al.*, 2004[5]; Kariset *al.*, 1996[17]). Whereas $H(T)$ is 1 at the reference temperature. Till now, only power-law viscosity models have been used in order to analyze the flow behavior of polymer melt inside the FDM liquefiers.

Some researchers have assumed that the heat capacity () of melt is constant and it is not varying with the temperature (Bellini *et al.*, 2004[5]; Bellini, 2002[3]). However, is changing with respect to the glass transition temperature () for amorphous polymers. The specific heat of melt varies with respect to temperature. If the temperature is below 300 K it follows the following relation

$$= 4.4 + 58 \quad (9)$$

$$= 1.05 + 1668 \quad (10)$$

al., 2008[32]; Mostafaet *al.*, 2009[25]). For easy analytical analysis and observation the liquefier is typically divided into sections, as shown in Figure3. Different design parameters include the liquefier length (L_1), liquefier/filament diameter (d_1), nozzle angle (θ), nozzle diameter (d_2) and nozzle length (L_2). Whereas the nozzle diameters are in the range of 0.2-0.5 mm with nozzle angles 120° (Yardimci et *al.*, 1997[43]).



2008[32]) used analytical solutions to the momentum balance equations developed for extruder liquefier (Michaeli, 2003[23]) for cylindrical barrels, conical and cylindrical shapes corresponding to section I, II and III, respectively, as shown in Figure 2 in conjunction with a power-law viscosity model with Arrhenius temperature dependence (equations 7 to 9) to model the liquefier. The assumptions that are considered during the dynamic analysis of melt is incompressible, a no-slip boundary condition applies at the walls of the liquefier and that the flow is fully developed, steady state and laminar (Michaeli, 2003[23]). The pressure drops inside the liquefier in each section are given respectively by:

$$\Delta_2 = \left(\frac{2}{3} \right) \left(\frac{1}{3} - \frac{1}{3} \right) \times \left(\frac{1}{2} \right) \quad (+ 3) 2^{+3} \times \left[\left(\frac{1}{2} - \frac{1}{2} \right) \right] (12)$$

$$\frac{1}{2152} \left(\frac{1}{2} + 2 \right) \left(\frac{1}{2} \right) \frac{1}{2} \frac{1}{2} \quad (13)$$

$$\Delta_3 = 2 \left(\frac{r_3}{f} \right) \left(\frac{r_3}{2} \right)^{+3} \left[\left(\frac{r_3}{2} - \frac{r_1}{2} \right) \right]$$

Where the dimensions r_1 length of first section, r_3 length of third section, r_1 and r_2 correspond to the diameter of first and third section is the nozzle angle of the conical section of the liquefier, and m and f are power-law fit parameters (Ramanath *et al.*, 2008[32]; Bellini *et al.*, 2004[5]; Bellini, 2002[3]; Michaeli, 2003[23]). The total pressure drop inside the liquefier is the sum of the pressure drops in different sections

$$\Delta = \Delta P_1 + \Delta_2 + \Delta_3 \quad (14)$$

III EXISTING RESEARCH EFFORT

The researcher have performed so much work in order to optimize the different input and output parameters of 3D printing in order to optimized it. They used different 3D printers, methods, optimization technique. All the work in the area of fused deposition modeling optimization is investigated and mention in the tabular form

Table No. 1
Existing research efforts

Name of Researchers	Year	Contribution	Working Material	Input Parameters	Output Parameters
Sebastian et.al.[50]	2008	Developed a new method for printer calibration and contour accuracy manufacturing with 3D – print technology	Plaster powder ZP130	Direction and position	–
Sun et.al.[51]	2008	Investigated the effect of processing conditions on the bonding quality of FDM polymer filament	ABS-P400	Liquefier temperature, envelope temperature, convective condition	Mesostructure, Bond strength b/w filaments
Saaidah et.al.[52]	2010	Analyzed fused deposition modeling performance	ABS-P400	Layer thickness, road width, air gap, built style or direction	Dimensional accuracy and surface roughness
Mohammad el.al.	2010	Investigated the effect of layer thickness and binder saturation level parameter on 3D printing process	Zp102 powder & Zb56 binder	Layer thickness, binder saturation level	Mechanical strength, integrity, surface quality,
		Experimentally		Layer	

Nancharaiah et.al.[54]	2010	investigated the surface quality and dimensional accuracy of FDM components	ABS	thickness , road width , raster angle, air gap	Surface quality and dimensional accuracy
Masood et.al.[55]	2010	Evaluated the tensile property of processed FDM polycarbonate material	PC	Build styles, raster angle, raster width	Tensile strength
Arivazhagen et.al.[56]	2011	Performed Dynamic mechanical analysis of FDM rapid processed polycarbonate material	PC	Build style, raster angle, raster width	Storage modulus, complex viscosity, loss modulus
Zhang et.al.[57]	2012	Optimized process parameters for fused deposition modeling	ABS	Wire Width compensation, extrusion velocity, filling velocity, layer thickness	Dimensional error, warpage deformation
Nannan et.al.[58]	2013	Presented a study on Additive manufacturing technology, application and research needs	ABS	—	—
Ismail et. al.[59]	2013	Performed experimental investigation of FDM process for improvement of mechanical properties and production cost	ABSplus-P430	Raster angle, part orientation	Surface roughness, manufacturing time, maintenance cost

Sahu et. al.[60]	2013	Performed a study on dimensional accuracy of fused deposition modeling	ABS	-	-
Villalpando et. al. [61]	2014	Proposed an optimization approach for components build by fused deposition modeling with parametric internal structure	ABS	Deposited layer, raster orientation	Mechanical property, build time, material utilized
Galantucci et. al.[62]	2014	Analyzed the dimensional performance for a 3D open source printer based on fused deposition modeling technique	ABS (3 mm dia)	Change in length, width and height	Dimensional accuracy
Baschetto et. al.[63]	2014	Predicted accuracy in fused deposition modeling	ABS	Layer thickness, deposition angle	Dimension deviation
Yangyang et. al.[64]	2015	Executed 3D printing of shape memory polymer for functional part fabrication	Shape memory polymer	Extruder temperature, scanning speed	Part density, dimensional accuracy and Surface roughness
Isalam et. al.[65]	2015	Performed an experimental investigation in to the dimensional error of powder binder three dimensional printing	Z150 (plaster of Paris) & binder Zb63	-	Base flatness
Singamneni et. al. [69]	2015	Performed Modeling and evaluation of curved layer fused deposition	Fabproxy, ABS polymer	Curved laver thickness	Compressive load

IV CONCLUSION

Fused deposition modeling is a prime method of additive manufacturing and also the most cheapest and easy useable method. Here in this paper it focuses on different parameters on which the performance of FDM 3D printer depends. From the study it has been understood that the parameters like orientation, layer thickness, raster width, feed speed, temperature distribution and model build temperature directly affects the quality of the part. There are various approaches for parameter optimization of FDM process and different techniques for improving the quality of the part.

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A Critical Review and Analysis of Construction equipment emission factors

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ABSTRACT

Diesel-powered construction equipment is the primary source of Green House Gas (GHG) and exhaust emissions during the construction stage of a large infrastructure project. The equipment pollutants such as nitrogen oxides, carbon monoxide, and particulate matter (PM 2.5 and PM 10) endanger people's health and surrounding environment. A critical review and analysis of factors affecting the amounts of construction emissions is conducted through literature review and a case study, four categories of factors including equipment and conditions, equipment maintenance, operating conditions, and equipment operations are reviewed. A case study is made on 14 wheel loaders with different makes and capacities with accumulated weekly data with the aim of determining the impact of emission factors on the weekly equipment emissions. It is found that equipment engine power, equipment conditions, and equipment operator skills are significant factors on average fuel consumption and emissions in the case study. Based on the findings from current research literature and the case study, some recommendations are made on how to reduce fuel consumptions as well as pollutant emissions for contractors and other equipment owning organizations.

Keywords: Construction equipment emissions; emission factor analysis; emission reduction

I INTRODUCTION

Construction equipment contributes a significant portion of Greenhouse gas and air pollutions in urban areas during construction works such as site preparation, foundation works, road construction and maintenance. Carbon and pollutant emissions from diesel-burned construction equipment are also of increasing concern for the government and general public. Many countries have made it a legal requirement for construction equipment to be in compliance with a stipulated set of emission criteria. In some countries and metropolitan areas, contractors have to submit annual carbon emission reports, and the developers have to submit environmental impact assessment and mitigation strategies in for large infrastructure projects. Among all the emission reduction strategies, improving equipment maintenance and operations can be feasible, attractive, and cost effective approaches for implementation in emissions reduction.

In Dholera SIR Project Dholera, Ahmedabad, deteriorating air quality and slow progress in meeting greenhouse gas emission reduction targets are a major environmental issue. As one of the significant pollution and emission sources, heavy construction equipment, powered by diesel engines, emit toxic pollutants including CO, NOx, HC, particulate matter, as well as CO₂. Recent regulations on emission compliance for non-road mobile machinery are mainly targeted at equipment newly imported to Dholera SIR Project. Complete replacement of the current stock of 1100 units working on construction sites will take many years due to their long service lives, if no environment regulations are imposed.

According to a government report, there are about 13,500 units of Non-road Mobile Machinery (NRMMS) operating in Ahmedabad - Bhavnagar Highway Near Dholera SIR Project, among which 11,300 units, or 80%, are operating on construction sites [1]. Since most of the NRMMS are powered by diesel engines and emit the toxic pollutants carbon monoxide (CO), nitrogen oxides (NOx), particulate matter, and non-methane hydrocarbons (NMHC), in addition to the greenhouse gas, carbon dioxide (CO₂). The NRMMS on construction sites, the airport and container terminals contribute about 7% (6,800 tonnes) of the local emissions of nitrogen oxides (NOx) and 11% (600 tons) of respirable suspended particulates (RSP) respectively. Since infrastructure projects are usually located within environmentally sensitive areas, operations of heavy construction equipment pose health hazards to construction workers and people nearby.

To reduce air pollutants from non-road diesel equipment and help to meet the government target in carbon reduction, the new Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation was approved by Legislative Council and took effect after public consultation. Under this regulation, all newly imported NRMMS with rated engine power outputs between 19 KW and 560 KW have to meet the EU Stage IIIA, US Tier 3 or India MoE emission standards [1]. Existing NRMMS in use before, however, are exempted due to strong resistance from the stakeholders of NRMMS. The estimated average age and average service life of the in-use NRMMS in Gujarat are about 8 years and 14 years respectively. Although both the stakeholders of the construction equipment and the government have reached a consensus on emission controls of heavy construction equipment, the exempted equipment will operate on construction projects for many years until they are replaced by new low-emission units, if no immediate

regulations are implemented and incentive measures taken.

It is a difficult task to estimate the accurate amount of emissions due to lack of measurement and monitoring information. Currently the emissions can only be measured based on specified emission rates, modified by load factors, operating time, equipment deterioration, etc. However, the emission rates themselves depend on equipment year of manufacture, engine power, engine conditions, etc. another approach is fuel-based estimation, i.e. the emissions are estimated based on the amount of fuel burned by the equipment in a particular period of time.

The aim of this paper is to discuss the factors affecting construction equipment emissions and propose to apply analytical approach to quantify the degree of impact from these emission factors, so that actions can be taken based on their priority in emission reductions and cost effectiveness.

II QUANTIFICATION OF CONSTRUCTION EQUIPMENT EMISSIONS

The NONROAD2008a emission model published by the Environmental Protection Agency of USA [2] is the most comprehensive model for estimating emissions from non-road construction equipment. The emission factor is defined as the quantity of pollutants emitted by that particular type of equipment during a unit of service. The emission factor, after adjustments to account for transient operation and deterioration can be estimated as below:

For HC, CO, NO_x, the exhaust emission factor for a given diesel equipment type in a given model year/age is calculated using eq. 1.

$$EF_{adj} (HC, CO, NO) = EF_{ss} \square TAF \square DF$$

EF_{adj} – Final emission factor for HC, CO, NO_x after adjustment (g/hp-hr) [‘hp’ is horsepower]

(1)

EF_{ss} – Zero-state, steady-state emission factor (g/hp-hr), related to model year and horsepower category (technology type)

TAF – Transient adjustment factors (unitless), varying on equipment types, accounting for the difference between the steady-state and the transient state of the engine.

DF – Deterioration factor (unitless), related to technology type and age of engine

The particulate matter (PM) particles emitted from diesel engines are assumed to be smaller than 10 microns (PM₁₀), among which 97% are smaller than 2.5 microns (PM_{2.5}). PM emissions can be estimated by using eq. 2:

$$EF_{adj} (PM) = EF_{ss} \square TAF \square DF \square SPM_{adj}$$

EF_{adj} – Final emission factor of HC, CO, NO_x after adjustment (g/hp-hr)

SPM_{adj} – adjustment to PM emission factor to account for variations in fuel sulphur content (g/hp-hr) (2)

Emission factors for CO₂, SO₂, and HC are directly related to the brake-specific fuel consumption (BSFC), which is available from the EPA publication “Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling” [2]. Since EPA data sources are obtained from steady-state modal engine dynamometer tests, many researchers have measured the real world emissions data. Relevant research data and findings can be found from many publications such as Lewis et al. [3]; Abolhasani and Frey [4]; Lewis et al. [5]; Barati and Shen [6], etc.

The NONROAD2008a model is an emission model published by the US Environmental Protection Agency (2010), a compressive method for the estimation of construction equipment emissions, including Nitrogen oxides (NO_x), hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO₂), and Particulate matter (PM). California Air Resources Board (CARB) proposed the OFFROAD2007 model for off-road emission inventory estimation for various types of off-road equipment [7]. The California South Coast Air Quality Management District (AQMD) developed the California Emissions Estimator Model® (CalEEMod) to quantify criteria for pollutant and greenhouse gas (GHG) emissions associated with both construction and a variety of land use project operations [8].

Many researchers used portable systems (such as Portable Emission Measurement System) to measure real world emissions of construction equipment. For examples, Lewis and Rasdorf [5] studied the weighted average fuel use and emission rates according to engine types and tiers based on emissions data collected from in-use equipment. Abolhasani and Frey [4] presented emissions measurements for nine selected non-road construction vehicles, analyzed the variability in emissions with respect to engine operations and ambient conditions. Lewis et al. [3] discussed the quantification of emissions data for construction equipment and compared the EPA NONROAD model with emissions data collected in the field. It is concluded there are large discrepancies between measured emissions data and theoretical emission models such as NONROAD2008a. Estimation of fuel-based emissions gives much lower values than the results from emission models at the national level in USA [9].

III FACTORS AFFECTING THE CONSTRUCTION EQUIPMENT EMISSIONS

There are a large number of factors affecting the exhaust emissions of construction equipment, many

are difficult to measure and quantify their degree of impact on the rate of emissions. Overall the factors can be categorized into four groups as shown in Fig. 1.

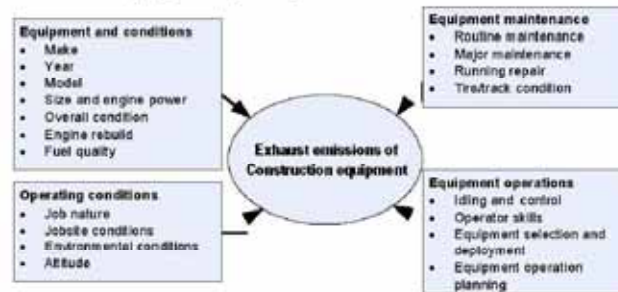


Fig No. 1 Factors of Impact on construction equipment exhaust emissions

(a) Equipment and conditions

The rates of exhaust emissions from construction equipment are mainly determined by engine year of manufacture, engine model, engine size and horsepower. Different equipment manufacturers or makes can also contribute to variations in equipment emission due to their difference in engine design, automatic control system, and configurations. Engines of newer generations (for example, Tier 4 engines) can have significant reductions in emission rates and fuel consumption. However, the equipment replacement to newer generations is slow due to large initial investment and affordability for small to medium size contractors.

Equipment deteriorates when the equipment ages with more units of service accumulated, both equipment age and accumulated units of services (distance travelled or hours worked) are good indicators of equipment conditions. The equipment condition is also dependent on maintenance quality, daily care, and operation history. Equipment of good conditions is more fuel efficient with lower emissions in operations.

Use of low Sulphur or bio diesel can reduce emissions effectively. Use of low emission diesel has been compulsory with government incentives in some counties. Use of high quality diesel can help to extend equipment life and reduce emissions.

(b) Equipment maintenance

Construction equipment maintenance should follow the manufacturer's instruction manuals. Good maintenance strategy of the equipment keeps the equipment in good working conditions with efficient use of fuel in delivering output power. Both routine maintenance (changing of oil, grease, filters, clean-up etc.) and major maintenance works such as engine over hall should be properly scheduled and implemented. There is already a consensus that delayed maintenance or run-to-failure maintenance is a poor maintenance strategy which can lead to higher equipment repair costs, resulting in higher rate of fuel consumption as well as high emissions due to

clogged air flow and insufficient burning of engine fuel.

Any defaults in the engine, if not diagnosed and repaired immediately, can cause underperformance of equipment and increase the amount of exhaustive emissions.

Timely replacement of worn ground-engagements such as tires/tracks is important to reduce emissions from unproductive job activities.

(c) Operating conditions

Off-road construction equipment is deployed for construction activities such as digging, loading, hauling, backfilling, compaction, lifting etc. Different job activities have different work conditions and requirements, which influence the time percentage of equipment working in different load conditions and engine status.

The fuel consumption and emissions of equipment inevitably increase in tough working conditions involving hills and slopes on jobsites, or medium to hard underground or ground soil conditions. The amounts of fuel consumptions or emissions can increase up to 2-4 times for heavy duty works, as compared with light duty applications for the same equipment, according to Caterpillar Performance Handbook.

Equipment operating in high altitude site also consumes more fuel and produces more emissions due to underperformance of engine. Also equipment operating in severe weather such as cold winter consumes more fuel with more emissions due to engine performance issues and longer time in engine startup and warmup to reach efficient working conditions.

(d) Equipment operations

Equipment should be properly selected for a specific job. The equipment also works in fleet of proper configuration for productive use. If the equipment overmatches the site conditions and tasks or overloads, more fuel is burned with more emissions, in addition to higher equipment cost.

Idling time and operational skills are critical for equipment emissions. Reducing idling time and improving operator skills are favored by small to medium size contractors thanks to added benefits of fuel savings and lower

Costs. However, there is a lack of quantitative measurement on the effectiveness of improving operator skills to achieve emission reductions; some literatures give descriptive benefits or a range of cost savings or emission reductions.

The impact of equipment idling time has been studied much in related research, with a focus on minimizing equipment idling time by reasonably allocating equipment resources to reduce waiting and queuing time. In order to further save fuel and reduce emission, engines can also be shut down after a few minutes waiting time (either manually or automatically) with electronic control devices. On the other hand there is a misperception that skilled operators are expensive to hire and less skilled operators can achieve similar results and that preventive maintenance can be delayed or skipped without significant effects on equipment performance. This is especially true for small contractors who always try to achieve savings through any means.

Skilled and experienced operators can reasonably minimize idling time by reducing such interruptions as miscommunications, poor understanding of work tasks, and poor coordination with others. Skilled equipment operators consume less fuel compared with less experienced and average operators per operating hour as skilled operators take good care of equipment, identify equipment problems in a timely manner, reduce idle time, follow correct working procedures, and operate equipment in the smartest and most cost-efficiency way. Some factors affecting the operator skill level include:

- (i) Years of education: the number of years the operator received formal education;
- (ii) Years of experience: the number of years the operator has operated the equipment with a license;
- (iii) Salary pay scale: different pay scales of the operator in the organization,
- (iv) Accumulated hours of training after being licensed: the hours the operator received continuous training in equipment operations.

IV CASE STUDY

Although construction equipment emissions vary with different engine operation modes and level of load, the amount of equipment emissions is highly correlated with the fuel consumption of the diesel-powered equipment on average. The daily fuel records of 14 pieces of wheel loaders with gross horsepower from 50 to 300 are retrieved from an equipment database along with the information on equipment information and operators. The daily diesel fuel records are accumulated to weekly basis to reduce the discrepancy between fuel records and fuel consumption. The aim of the case study is to explore the strength of the relationship between weekly equipment emissions and a set of explanatory variables including equipment age, engine horsepower, makes and operator skills through multiple linear regressions (MRL) analysis.

Target variable: equipment rate of emissions. The amount of different types of equipment emissions is estimated based on the amount of fuel consumption, according to Table 1 extracted from [10]. The weekly fuel consumption is converted to weekly amount of emissions per engine horsepower output. The emission amount of Oxides of nitrogen (NO_x) is chosen as a target variable for study, which is measured in Kgs of NO_x per week per horsepower. Since the wheel loaders are used for similar purposes in highway construction in the case study, we assume the load factors and working efficiency keep consistent over the observation period with no significant variations.

Table No. 1
Emission factors (kg/kWh) for diesel industrial vehicle (wheeled tractor) exhaust emissions

Substance	Emission factor (Kg/Kwh)	Emission factor (Kg/litre)
Carbon monoxide	9.84×10^{-3}	3.25×10^{-2}
Oxides of nitrogen	1.60×10^{-2}	5.28×10^{-2}
Particulate matter 2.5 μN^2	1.56×10^{-3}	5.15×10^{-3}
Particulate matter 10 μN^2	1.70×10^{-3}	5.61×10^{-3}
Sulfur dioxide	7.26×10^{-6}	2.40×10^{-5}
Total volatile organic compounds	2.36×10^{-3}	7.79×10^{-3}

Source: Emission estimation technique manual for Combustion engines

(a) Explanatory variables:

- (i) Equipment age: the years of equipment operations since its date of purchase. The equipment age is a factor reflecting the dominant engine conditions under normal operating conditions and routine maintenance.
- (ii) Equipment makes: the manufacturer of the equipment. The makes are from five major equipment Manufacturers, i.e. Caterpillar, Case, Komatsu, John Deere, and Volvo. The variable is recoded into 4 binary variables to indicate manufacturers of the equipment.
- (iii) Equipment engine horsepower: Gross horsepower of equipment engine is used to measure the rated power Output in operations by the engine; the gross horsepower is commonly used to estimate the engine fuel consumption, and emission rates. Since the load factor is not measured and recorded on the job site, we assume the

average load factor is consistent over the weeks for similar job conditions.

- (iv) Equipment operator skills: equipment operator skills are classified into "low", "average", and "high", coded into "1", "2", and "3" by the equipment manager based on the operator's working experience, education and training, work attitude, personality, etc, to measure the efficiency of operations and skill set processed by the operator. The classification is based on the equipment manager's personal judgment based on the operator's background information.

Least square method is used to derive the multiple linear models with NOx emissions as the target variable and equipment make, gross horsepower of engine, equipment age, and operator skills, as explanatory variables. The following model is derived using SPSS statistical tool:

Table No. 2
Model summary

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	F Change	df 1	df2	Sig. F Change
.524 ^a	.275	.268	.146	.275	41.423	7	765	.000

Since F-test result $F(7, 765) = 41.423$, with probability of 0.000, the null hypothesis of the no linear relationship between predictor variables and target variable is rejected, and the model is valid.

The R-square of the model is 0.275, and adjusted R-square is 0.268 with consideration to the number of variables and cases, indicating that 26.8% variations are explained by the model. The adjusted R-square is not high as there are still many other explanatory variables not included in the model, however, the three included variables already explained nearly 1/3 of the variations in exhaust emissions.

Unstandardized coefficients:

$$\begin{aligned} \text{Emission rate of NOx (Kg/wk*hp)} = & -0.107 + 0.002 * [\text{Gross} \\ & \text{Horsepower}] + 0.001 * [\text{Equipment age}] \\ & - 0.030 * [\text{Operator skill}] \\ & + 0.053 * [\text{Caterpillar}] + 0.220 * [\text{Case}] - \\ & 0.035 * [\text{Komatsu}] + 0.227 * [\text{John Deere}] \end{aligned} \quad (3)$$

Standardized coefficients are obtained by centering the value of each variable by subtracting the mean and then divided by the standard deviation of the variable:

$$\begin{aligned} \text{Emission rate of NOx} = & 0.647*[\text{Gross Horsepower}] + 0.189*[\text{Equipment age}] - \\ & 0.285*[\text{Operator skill}] \\ & + 0.156*[\text{Caterpillar}] + 0.393*[\text{Case}] - \\ & 0.085*[\text{Komatsu}] + 0.386*[\text{John Deere}] \quad (4) \end{aligned}$$

The standardized coefficients reflect the influence of change in predictor variable variation on the variation of target variable, and therefore can be interpreted as the importance in causing fluctuations of equipment emissions.

Among Standardized coefficients, it can be observed that the importance of predictor variables: gross horsepower, equipment operator skills, equipment age. The explanatory variable "Equipment make" cannot be interpreted, but on average, it is comparable to operator skills.

Considering the fact that the relationship between the predictor variable and the set of explanatory variables might not be linear, neural network model is built and tested in SPSS, and model can achieve an accuracy of 55% if 70% selected randomly as training data and remaining 30% as test data. Nevertheless, the multiple linear regression models is preferred to fit the data as the data set is relatively small which makes it difficult to fit a nonlinear model. On the contrary, linear model can describe the general trend of the hidden relationship with less error in interpolation and extrapolation.

The following comments and observations are made based on the MLR model:

- (i) The NOx emissions measured in kg/hp-wk accumulated to weekly total with no consideration to specific working efficiency and load factor assuming they are consistent over the operation period.
- (ii) There are many factors which are difficult to measure or no data are available and therefore they are not Included in the model
- (iii) The equipment maker, horsepower, age, and operator skills can be compared in terms of their contributions to the variations in weekly NOx emissions per hp power output.
- (iv) The equipment weekly fuel consumption and emissions will increase with the increase in engine gross
- (v) Horsepower. This finding is different from the characteristics of the break specific Fuel Consumption (BSFC) which actually decrease in large engines. Such difference is likely caused by different load factors, different working efficiency, different job natures, or difference in operation difficulty.
- (vi) Better equipment operator skills help to reduce the engine emissions.
- (vii) Equipment aging causes increase in engine emission, which is in line with the deterioration factor (DF) recommend in EPA 2008 model.

(viii) Effects from equipment makes cannot be ignored; some manufacturers committed more to research and design

(ix) To manufacture equipment that is fuel efficient with lower emissions. The contractor should compare different equipment makes in economic and environmental performance based on his own records.

V RECOMMENDATIONS

The operation and maintenance of construction equipment is an important factor for achieving fuel economy and reducing exhaust emissions. Since other emission reduction strategies may involve large capital investment or financial spending, improving operations and maintenance practice has proved to be more feasible for equipment owning organizations, especially for small to medium size contractors.

It is cost-effective to take measures in training and education of equipment operators, implementing proactive maintenance strategies, and deploying right equipment for right jobs. Yet the actual equipment emissions are difficult to measure and fluctuate with many factors of impact. Analysis of equipment maintenance and operations data can help to identify the factors that contribute most to the fuel consumptions and emissions and determine the priority of emission reduction measures with consideration of cost effectiveness.

Equipment telematics are products that are built into the equipment or can be purchased separately and connected to the engine for collecting real time data on engine status, power output level, fuel and fluid level, location tracking, engine fault diagnostics, driver management, etc. Nearly all the major equipment manufacturers provide telematics products, including Product Link from Caterpillar [11], KOMTRAX from Komatsu [12], and Modular Telematics Gateway, from John Deere [13]. Telematics are smart devices that can be used to collect data and transfer data to an equipment management information system. An equipment management information system stores equipment operation and maintenance data which can then be used for different statistical or advanced data analysis to evaluate the equipment productivity, engine performance, fuel consumption, etc. Since the emission related data such as fuel consumption, working hours, engine load, engine status (idling, full load, or other load levels) and durations are all captured in real time, the engine emissions can be analyzed and reported with high accuracy on daily, weekly, or monthly basis.

VI CONCLUSION

Large infrastructure projects rely on construction equipment for construction. In the meantime, construction equipment emissions are a major concern to the construction personnel and general public, especially in densely populated areas. Stringent control and regulation of construction equipment emissions has been in legislation or already in effect in many countries and metropolitan areas. This paper discusses the factors that affect the rate of emissions from diesel-powered engines of construction equipment and organizes the factors into four categories: equipment and conditions, equipment maintenance, operating conditions, and equipment operations. Considering the fact that the current construction equipment cannot be replaced by new low-emission models or even engine rebuild.

In the near future, improvement in equipment maintenance and operations is more cost effective in emission reduction. A case study is used to demonstrate that factors on equipment fuel consumption and emissions can be identified and their degree of impact quantified through statistical analysis and modeling, and actions can be taken accordingly to reduce emission through improved maintenance and operations. The factors of impact on equipment emissions can vary with different projects, different equipment types, and different organizations, therefore it is advised to collect and keep emission-related data and conduct analysis for diagnostics of emission fluctuations and corrective actions. Telematics and construction equipment management information system can help to provide more accurate estimation of activity-based and fuel-based emissions and fact-based decisions in emission reduction of construction equipment.

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Analysis of Engine Performance and Emission by Using Dual Bio Fuel

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ABSTRACT

The significance of this present investigation undertakes the feasibility study of a new combination of bio-fuels. For this rationale; the diesel engine operated with blends of Jatropha biodiesel, karanja biodiesel with a view to completely eliminate dependency on fossil fuel. Jatropha biodiesel (methyl ester) and karanja biodiesel is a low and high viscosity fuels combination with comparable heating values to that of diesel; this makes conducive for its use in a diesel engine. Extensive experimental work is carried out on a Kirloskar make the single cylinder, natural aspired diesel engine to examine combustion performance and emission characteristics using Jatropha methyl ester with karanja methyl ester blends (dual fuel blends. Dual fuel blends are found to be the best substitute to conventional diesel fuel in all aspects such as performance and emissions. Further, BT 50 resulted at full load condition, reduction of 2.9%, 4.72%, 4.56%, 42.5% and 29.16% in the brake thermal efficiency, NO_x, HC, CO and smoke respectively while CO₂ emissions increase 10.7%

I INTRODUCTION

India is also rich in renewable energy sources (solar, wind, hydro and bio-energy sources) but it has very less hydrocarbon reserve (0.4% of world's reserve). Given the limited domestic fossil fuel reserves, India depends on fossil fuel imports to meet its energy demands. the import of crude oil alone accounted for 31% of the country's total imports. So, it has ambitious plans to expand its renewable power industries.

Energy is an essential and vital input for economic activity. It is also the lifeline of modern societies. Building a strong base of energy resources is a pre

requisite for sustainable economic and social development of a country. With increasing trend of motorization and industrialization, the world's energy demand is growing at a faster rate.

(a) **Properties of Jatropha oil** - Oil quality and consistency are important for producing biodiesel. The physical and chemical content of jatropha oil can be extremely variable. Oil characteristics appear to be influenced by environment and genetic interaction, as are seed size, weight and oil content. The maturity of the fruits also can affect the fatty acid composition of the oil, and processing and storage further affect oil quality .[1]

Table No. 1.1
Comparative characteristics of fossil diesel to pure jatropha oil [15]

Properties	Diesel	Oil of jatropha cruces seeds	Jatropha biodiesel
Density kg/l (15/40 °C)	0.84-0.85	0.91-0.92	.879
Cold solidifying point (°C)	-14.0	2.0	-3
Flash point (°C)	80	110-240	191
Cetane number	47.8	51.0	51-52
Sulphur (%)	1- 1.2	0.13	<.001

(b) Karanja Oil

Table No. 1.2

Comparison of fuel properties of karanja oil, karanja biodiesel and diesel [2]

Properties	Unit	Karanja oil	Karanja biodiesel	Diesel
Density@15 ^{0C}	gm/cc	0.9358	0.797	0.850
Viscosity@ 40 ^{0C}	cm ² /sec	38.8	7.0	2.6
Flash Point	0 _C	212.0	97.8	70.0
Cetane Number		38.0	42.9	46
Sulphur Content	%	.025	—	—
Cloud point	0 _C	2.0	-7	-16

II LITERATURE REVIEW

This part of the thesis will provide background in context of this research. A substantial amount of work has been done on the use of biodiesel as alternate fuels in compression ignition (CI) engines.

Ma and Hanna (1999)^[3] described the transesterification, micro emulsions, thermal cracking (pyrolysis) and blending as different ways to lower the viscosity of the oil or fat. Although blending of oils with other solvents and micro emulsions of vegetable oils lowers the viscosity, engine performance problems, such as carbon deposit and lubricating oil contamination still exist.

Planning Commission of India (2003)^[4] report of the committee on development of bio fuel, discussed the problems in using petroleum derived high speed diesel and characteristics, rationale, feasibility of producing biodiesel as substitute of petroleum diesel as well as target of bio-diesel production, specifications and quality standards for bio-fuels. While discussing the characteristics planning commission of India stated that bio-diesel had properties similar to petroleum diesel fuels.

Y.C. Sharma et al. (2007)^[5] Development of biodiesel from karanja tree, mainly found in rural India has been investigated. The biodiesel was developed from oil expelled from the seeds of the tree. Molecular weight of the oil was determined and found to be 892.7. Both the acid as well as alkaline etherification was subsequently performed to get the final product. NaOH was found to be a better catalyst than KOH in terms of yield.

Plants absorb more carbon dioxide from the atmosphere during the process of photosynthesis than what they add to the atmosphere when used as fuel in compression ignition engine. Also use of biodiesel reduces wear of engine parts in comparison of diesel this happen by the property of lubricity of bio fuels.

Mathiyazhagan et al. (2011)^[6] investigated on the non-edible oils as feed stocks for biodiesel production to reduce the cost of biodiesel. Normally alkali catalyzed method was followed for biodiesel production process. However the non-edible oils having high FFA content which is not suitable for normal transesterification process.

Pankaj B. Gavali et al. (2015)^[7] Biomass derived vegetable oils are quite promising alternative fuels for agricultural diesel engines. Use of vegetable oils in diesel engines leads to slightly inferior performance and higher smoke emissions due to their high viscosity. The performance of vegetable oils can be improved by modifying them through the transesterification process.

AbsarLakdawala et al.(2016)^[8] Amongst all the experiments done for the alternative fuel, it is observed that biodiesel produced from renewable and domestic source represent a more sustainable source of energy and play a significant role in transport sector the major of research shown that emission of CO₂ and CO reduced due to presence of O₂ in biodiesel, presence of biodiesel enhance the proper combustion in the engine cylinder so exhaust comes out from the engine having low quantity of carbon oxides.

Hasimoglu et al. (2008) ^[9] stated that though esterifies fuels gives lower exhaust gas emissions and are biodegradable and renewable as compared to petroleum based diesel oil, viscosity and volatility problems still exist with these fuels. With the concept of a low heat rejection (LHR) engine (the engine that thermal barrier coating is applied is called low heat rejection (LHR) engine & the thermal barrier coated engine parts are piston, cylinder head, cylinder liners and exhaust valves), the energy of bio-diesel can be released more efficiently thereby improving engine performance.

Zheng et al. (2008) ^[10] used soy, Canola and yellow grease derived neat biodiesel fuels and an ultra-low sulphur diesel fuel in the high load engine operating conditions with application of EGR. A naturally-aspirated four-stroke single-cylinder DI diesel engine was instrumented for the tests.

Sahoo and Das (2009) ^[11] compared the combustion characteristics of biodiesel fuel derived from jatropha, karanja, and polanga in a small engine at different load conditions. The authors reported that the pure polanga biodiesel was the optimum fuel blend as far as the peak cylinder pressure is concerned. However, they also reported that the ignition delay for pure Jatropha biodiesel was shorter than for diesel fuel, all of which are lower than diesel fuel.

Yanowitz and McCormick (2009) ^[12] experiments have been done on biodiesel and its blends to evaluate the combustion emissions like carbon monoxide (CO), carbon dioxide (CO₂), particulate matter, sulphur oxides (SO₂), oxides of nitrogen (NO_x) and smoke are the main pollutants which are formed by biodiesel combustion.

Lin et al. (2009) ^[13] have examined eight different types of vegetable oil methyl ester in a single cylinder, 4-stroke, direct injection water cooled engine. They found higher range of bsfc from 9.45 to 14.65% for biodiesel than that of diesel fuel, which refers the same result obtained in case of LHV range from 12.9 to 16% of these vegetable oil methyl esters.

Haldar et al. (2009) ^[14] studied the performance and emission characteristics of Putranjivaroxburghii. In the Tropic of Cancer, these plants are abundantly available. The investigators observed that million tons of seeds of Putranjiva oil go a waste annually which villagers in remote areas can use in pure form or blended with diesel oil to operate engines for running irrigation pumps, grinding mills or straw choppers for cattle feed for shorter duration at the time of fuel crisis or emergency period.

Armas et al. (2010) ^[15] performed experiments on turbocharged diesel engine operated at 2400 rpm and 64 N m torque. The engine was tested with single and split (pilot and main) injections and without exhaust gas recirculation (EGR). Three fuels were used: an

ultra low sulfur diesel fuel, a pure soybean methyl-ester and a Fisher-Tropsch fuel.

Panwar et al. (2010) ^[16] conducted a study for Performance evaluation of a diesel engine fuelled with methyl ester of castor seed oil. In this investigation, castor methyl ester (CME) was prepared by transesterification using potassium hydroxide (KOH) as catalyst and was used in four strokes, single cylinder variable compression ratio type diesel engine. Tests were carried out at a rated speed of 1500 rpm at different loads. Straight vegetable oils pose operational and durability problems when subjected to long term usages in diesel engines. These problems were attributed to high viscosity, low volatility and polyunsaturated character of vegetable oils.

Subbaiah et al. (2010) ^[17] investigated the performance and emission characteristics on a single cylinder diesel engine of conventional diesel, rice bran oil biodiesel, diesel and biodiesel blend and diesel-biodiesel-ethanol blends. He observed the bsfc of the biodiesel and all the other fuel blends was higher than that of the diesel fuel. The CO and hydrocarbon emissions (HC) of the biodiesel and all the other fuel blends were lower than that of the diesel fuel. The NO_x emissions of the biodiesel and all the other fuel blends were low at lower loads and high at higher loads compared with the diesel fuel.

Yao et al. (2011) ^[18] analyzed reducing CO₂ emissions from vehicles in China is crucial and will significantly alleviate the environmental burden of the Earth. Some promising technologies that make possible low-carbon vehicles are reviewed in this work, including electric vehicles, fuel cell vehicles, hybrid vehicles; bio fuels vehicles, other alternative fuel vehicles and conventional internal combustion engine vehicles with improvement.

Ghodasara and Rathore (2012) ^[19] conducted experiments on single cylinder, air cooled, constant speed direct injection diesel engine and developed and fitted EGR in engine. They concluded NO_x emission decreases with increasing EGR rates but Smoke opacity, HC emissions increases with increase in EGR rates.

Roy (2013) ^[20] examined the emission of carbon monoxide (CO), hydrocarbon (HC), nitric oxide (NO), nitrogen dioxide (NO₂), nitrogen oxides (NO_x) and carbon dioxide (CO₂) with pure and used canola biodiesel blends. CO and HC emissions from biodiesel-diesel blends were obtained significantly less than neat diesel fuel. The higher the biodiesel percentage in biodiesel-diesel blends, the lower the CO and HC emissions.

B. Tesfa et al. (2013) ^[21] Biodiesel is one of the alternative fuels which is renewable and environmentally friendly and can be used in diesel engines with little or no modifications. In the present study, experimental investigations were carried out on the effects of biodiesel types, biodiesel fraction

and physical properties on the combustion and performance characteristics of a (compression ignition) CI engine.

R. Prakash et al. (2014)^[22] Preliminary investigations on characterisation and utilisation of emulsions obtained from Wood pyrolysis oil (WPO) and Jatropa methyl ester (JME) revealed that up to 15% of WPO can be emulsified with the JME and used as a fuel in a DI diesel engine. From the experimental results in terms of emulsion stability, combustion, performance and emission parameters, the emulsion prepared from 81% by volume of JME, 15% by volume of WPO with the help of a mixed surfactant 4% by volume was found to be a better emulsion for further investigation. However, it was found that the emulsion was acidic in nature, due to the addition of WPO.

R. Senthil et al. (2014)^[23] The brake thermal efficiency of various biodiesel blends and diesel is perceived. It is observed that BTE of engine and its blends are slightly lower than that of diesel fuel.

Pankaj dubey et al. (2016)^[24] The significance of this present investigation undertakes the feasibility study of a new combination of bio-fuels. For this rationale; the diesel engine operated with blends of Jatropa biodiesel and turpentine oil with a view to completely eliminate dependency on fossil fuel. Jatropa biodiesel (methyl ester) and turpentine oil is a high and low viscosity fuels combination with comparable heating values to that of diesel; this makes conducive for its use in a diesel engine. Extensive experimental work is carried out on a Kirloskar make the single cylinder, natural aspired diesel engine to examine combustion performance and emission characteristics using Jatropa methyl ester with turpentine oil blends (dual fuel blends) and conventional diesel. Dual fuel blends are found to be the best substitute to conventional diesel fuel in all aspects such as performance and emissions. Further, BT 50 resulted at full load condition, reduction of 2.9%, 4.72%, 4.56%, 42.5% and 29.16% in the brake thermal efficiency.

- (a) Research Gap** - This comprehensive study on biodiesel; its sources, production, emission, engine performance characteristics and technological issues reported in literature were analysed to formulate the research work pattern and for better understanding of the work undertaken looking in to following parameters:
- (i) Production and sources of biodiesel
 - (ii) Performance parameters with biodiesel
 - (iii) Emissions with biodiesel

A lot of work has been done on the study of performance and emission characteristics of alternate fuels in IC engines. Limited amount of work has been done related with using of dual blended fuel and testing of engine parameters and engine emission at different load condition. To obtain optimal

performance condition of tribological parameters for different blend ratio.

III METHODOLOGY

Engine performance characteristics can be determined either experimentally or analytically based on the experimental data. The term "performance" usually means how well an engine is doing its required task in relation to the input energy or how effectively it provides useful energy in relation to some other comparable engines. It has been tried to investigate the optimum operating temperature of engine that will deliver the best performance level. The blends of biodiesel (jatropa and karanja) in varying proportions were prepared and investigated in single cylinder, four stroke CI engine computerized test rig.

- (a) Biodiesel Preparation Method** - Here starting from the raw material used for biodiesel production along with its method each step for biodiesel production is explained. Various properties of the prepared biodiesel are discussed later.

- The following resources are required
- Thermometer
- Magnetic plate stirrer
- 50ml flask
- Weighing scale (accurate to 0.01 grams)
- Funnel
- Methanol 99% purity
- Potassium Hydroxide (KOH) 85 % purity
- Sodium Hydroxide (NaOH)
- Separating flask
- Jatropa oil
- Karanja oil

(i) Procedure

Step one: Purification - Jatropa oil and karanja oil was heated to about 600C for about thirty minutes while stirring to reduce water content in the oil. The oil was then passed through a sieve while still hot to filter off solid particles and debris.

- **Step two: Pre-treatment process** - Both jatropa and karanja oil reacts with methanol in the presence of the catalyst (H₂SO₄) to produce glycerol and fatty acid ester. Specified amount 500 ml of Jatropa oil 100 ml methanol and 4 ml catalyst (H₂SO₄) by volume ratio were taken in a round bottom flask. The mixture was heated to 500C and stirred (2 h) till ester formation began and then cool about 18 h at a separating flask without stirring. In the separating flask, two layers were formed. The top layer was the ester and bottom layer consisted of glycerol. Same process also followed for karanja oil.
- **Step three: transesterification** - In third post treatment process pre-treated Jatropa oil react with methanol in the presence of

the catalyst (NaOH/KOH) to produce glycerol and fatty acid ester. Specified amount 500 ml of pre-treated Jatrophaoil 100 ml methanol and 4 g catalyst (NaOH) by a volume weight ratio were taken in a round bottom flask and apply the same above process till two layers were formed. The top layer was the ester and bottom layer consisted of glycerol.

- **Step four: Separation** - Since glycerol has a higher density than biodiesel, it settled at the bottom of the container. After 24-hours of separation, the tap beneath the container was opened and glycerol was drained off.
- **Step five: Washing and Drying** - Crude biodiesel was washed three times by agitation with clean water to remove traces of methanol and KOH from the oil. After each wash, the oil was transferred to the settling container for about four hours where it was allowed to separate. The amount of water used in each wash was equal to the amount of oil being cleaned. Water was then drained off after separation. It was noted that using warm water hastened the separation processes.

Finally the oil (biodiesel) was heated to about 110°C for about thirty minutes while stirring to evaporate off residual water from the washing process.

- (b) **Preparation of Engine Performance Test Samples** - First be sure that biodiesel blending components all meet BS15607:2005 specification. Biodiesel blending procedures depend on a variety of factors, including the volume of B100 required to make the blend, the finished blend level, the volume of blended products being sold, tank and space availability, and equipment and operational costs. The temperature of the biodiesel should be a minimum of 60°F or 10°F above the cloud point when being blended.[12]

IV EXPERIMENTAL WORK

A computerized CI engine test rig was used for this experimental investigation. This experimental test rig consists of a single cylinder, four strokes, constant speed, water cooled, direct injection diesel engine, having a rated power output of 5.22 kW at a constant speed of 1500 rpm. The test rig has eddy current dynamometer as loading system, water cooling system, lubrication system and various sensors and instrumentation integrated with computerized data acquisition system for online measurement of load, air & fuel flow rate, instantaneous cylinder pressure, position of crank angle, exhaust emissions and smoke



Fig. No. 4.1 Photograph of experimental set up in IC Engine Laboratory

The experiments are carried out on a single cylinder, direct injection, Kirloskar TV1, water cooled, naturally aspirated engine. It was chosen for the existing investigation. This engine is mostly used for domestic electricity generations and agricultural activities. A layout of the experimental setup along with all instruments is shown in fig 4.1. The Kistler makes pressure sensor and TDC sensor was fitted at the cylinder head near the flywheel to measure the

pressure of the combustion chamber and the crank angle at different engine loadings. The fuel injection system was the conventional, cam-driven, in-line (Pump-Line-Nozzle) fuel injection system which injects the fuel at 200–220 bars. Technical specifications of the engine are given in table. A fuel tank of 5 L capacity was mounted at the back of the panel on the wall with manual fuel consumption measuring burette which is nearer to the engine at the

highest position. AVL CDS 250 exhaust gas analyzer attached to the computer was used for the measurements of various exhaust gas parameters like CO, HC, CO₂ and NO_x. The accuracy and reproducibility of the instrument were 1% of full-scale reading. AVL 437 smoke meter attached to the exhaust manifold to measure the smoke emission, which work on light extinction principle. A personal computer connected the software 'DAQ factory software' was provided by Legion Brothers. The Legion data acquisition system has been used to record major parameters such as ignition delay, combustion duration, mass fraction burns angle, engine speed (rpm), in-cylinder gas pressure, crank

angle measurement, heat release rate and the indicated power. To apply different engine loads an eddy current dynamometer (manual) maximum rated power 7.5 kW at 1500– 3000 rpm controlled by a switch providing in control panel coupled to the engine. At the steady state condition, the data collected and stored in the computer for post processing. The test was repeated to take the peak value so as to minimize the effect of fluctuations. The fresh lubricating oil 20W40 is filled in oil sump before starting the experiments. The engine is provided with necessary instruments for combustion pressure and crank-angle measurements.

(a) Table No. 4.1
Specification of the engine

model	TV1, Kirloskar oil Engine Ltd. India
type	Single cylinder, four stroke, water cooled, constant speed, direct injection, compression ignition engine
bore	87.5mm
stroke	110mm
Max power	5.22KW
speed	1500rpm
Compression ratio	17.5:1
Injection pressure	210- 220 bar
governor	Mechanical(centrifugal) type
Dynamometer	Eddy current
Pressure sensor	Kistler
Crank angle measurement	Magnetic TDC pick up sensor
TDC at	360° crank angle
Start of injection at	23 deg before TDC
Sensor response	Piezo electric
Resolution crank	1 deg crank angle

(i) Required

- **Engine exhaust:** Engine exhaust connection is taken out of the lab by shortest straight route and bends are voids.
- **Electric supply:** The setups need single phase electric supply with proper earthing. The typical supply voltages should be Phase-Neutral: 220V-240 V; Phase-Earth: 220V-240V; Neutral-Earth: 0- 5V Max. This should not exceed 5V.
- **Computer:** Provide computer of standard configuration with DVD drive (for computerized engine test setup). The computer has 3GB RAM and USB port for communication. The computer may need to be formatted before installing 'DAQ factory software'.
- **Water supply:** Continuous, clean and soft water supply @ 2000 LPH, at 10 m. head. Provided tap with 1" BSP size connection. Water recirculation is avoided as the inlet water will continuously heat up and steady state shall not be achieved. Engine set up is supplied with water pump.
- **Software:** DAQ factory software was provided by Legion brothers. The Legion data acquisition system has been used to record major parameters such as ignition delay, combustion duration, mass fraction burns angle, engine speed (rpm), in-cylinder gas pressure, crank angle measurement, heat release rate and the indicated power.

(b) Measurement Systems - Various measurement systems used to capture the experimental data used in the test rig are load measurement system, fuel injection pressure measurement system, cylinder pressure measurement system, emission measurement system and data acquisition system.

- (i) Load measurement system:** The experimental study is conducted at various loads and hence an accurate and reliable load measuring system is a must. The load measuring system of this experimental test rig consists of a dynamometer of eddy current type, a load cell of strain gauge type and a loading unit. The load is applied by supplying current to the dynamometer using a loading unit. The load applied to the engine is measured by a load cell. The dynamometer, load cell and loading unit.
- (ii) Load cell:** A load cell is a transducer that is used to convert a mechanical signal (force) into an analogous electrical signal.
- (iii) Loading unit:** The loading unit consists of a dimmer stat to control the magnitude of the direct current flowing into the dynamometer and a switch to ON/OFF the loading unit. The current is supplied into the loading unit through the main power supply.

(iv) Cylinder Pressure Measurement System:

The cylinder pressure is measured using a Piezo sensor of Make kistler group. The piezo sensor consists of a quartz crystal. One end of the sensor is exposed to the cylinder pressure through the diaphragm. As the pressure inside the cylinder increases the crystal is compressed. Since the piezoelectric crystals have a tendency to generate electric charge when deformed, the sensor generates electric charge proportional to the pressure.

(v) Commercial Software - DAQ factory software:

'DAQ factory software' was provided by Legion Brothers. The Legion data acquisition system has been used to record major parameters such as ignition delay, combustion duration, mass fraction burns angle, engine speed (rpm), in-cylinder gas pressure, crank angle measurement, heat release rate and the indicated power.

(vi) Emission Measurement System -

The emission measurement system is used to measure the constituents of exhaust gas and its opacity (smoke number). This system consists of an exhaust gas analyzer and a smoke meter. The exhaust gas analyzer measures the exhaust gas constituents of Carbon dioxide (CO₂), Carbon monoxide (CO), Oxides of nitrogen (NO_x), Unburnt Hydrocarbons (HC) and Oxygen (O₂). The smoke meter is used to measure the intensity of exhaust smoke and it is measured.

(vii) Exhaust Gas Analyzer:

An instrument used to analyze the chemical composition of the exhaust gas released by a reciprocating engine is called exhaust gas analyzer. The instrument measures the concentrations of Carbon monoxide (CO in % & ppm), Carbon Dioxide (CO₂) and Oxygen (O₂) in percentage, Hydrocarbons (HC) and Nitric Oxide (NO_x) in ppm in the engine exhaust gas.

V CONCLUSION

The present work has tried to use dual fuel, Jatropha biodiesel and karanja oil in a compression ignition diesel engine, eliminate the use of standard diesel completely and without any modification. Under this, the properties of both fuels are acceptable and favorable for use in the diesel engine. The dual fuel blends were investigated and compared to pure diesel on combustion, performance and emission characteristics of the engine. The salient points are as follows.

- (a) In the use of dual fuel blends, the engine operated successfully & smoothly and performed better; the BTE is lower as compared to being conventional diesel fuel.

- (b) Regardless of the load conditions dual fuel blend, BT50 gives lower NO_x, CO, HC emission as compared to mineral diesel fuel. Moreover, at full load condition,
- (c) Jatropha methyl ester has lower volatility and higher viscosity compared to karanja oil, which might have karanja oil caused proper mixing and complete combustion; therefore, dual fuel blends shows lower emissions.
- (d) It has found that the significant physical and chemical properties of bio fuel for CI engine use are mostly within the corresponding values for pure diesel fuel. The main exception is viscosity, calorific value and oxygen content.
- (e) Although literature on short run test suggest that bio fuels can replace convention diesel fuel along run analysis is essential for assessment of engine life.
- (f) Regarding the performance and emissions of engines running on bio fuels, a review of sources has shown that, compared to Chemical modification of vegetable oil improves the quality of oil that makes the applicability in a wide area. Continue research in these areas promises to lead to a more detailed understanding of tribological characteristic of various non-edible vegetable oils.

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Vermicomposting in College Campus of S.G.J.Quaderia College, Burhanpur, M.P., India

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ABSTRACT

When the green revolution was done in 1960, then there were a lot of increase in agricultural products, but use of chemical fertilizers and pesticides also gets increase. Due to which soil acidity is increase day by day, cause infertility of soil, that's why today's need to stop this problem is vermicomposting. Earthworm plays an important role in the recycling of waste of college. College waste consist of weed, grass, twigs obtained by pruning, tree droppings (leaves), food waste generated by home science lab and other degradable waste by all labs. It is eco friendly technique to manage college waste. vermicomposts are defined as organic matter of plant and/or animal origin consisting mainly of finely-divided earthworm castings, produced non-thermophilically with bio-oxidation and stabilization of the organic material, due to interactions between aerobic microorganism and earthworms, as the materials pass through the earthworm gut. We observe many benefits of this technique. It increases nitrogen, phosphorus, potash, Ca, Mg in soil. It increases soil fertility. Earthworm mix and spread humus and soil in all layers. Due to activities of earthworm, soil become porous, which do aeration properly and it increase water holding capacity of soil. Increase useful bacteria in soil. Weed less grow in soil which rich in vermicompost.

Keyword:-vermicompost, earthworm, green waste, chemical fertilizer

I INTRODUCTION

Vermicompost is a great bio fertilizer rich in nutrition's. Vermicompost is an organic matter, made by weed, grass, twigs obtained by pruning, tree droppings (leaves), food waste generated by home science lab and other degradable waste by all labs. Earthworm's casting released by eating all of this called as vermicompost. This is good for secure to environment.

Tree droppings (leaves) are major waste generated in the campus. About 15kg tree dropping waste generated per week in the campus, which is managed by vermicomposting.

II MATERIAL AND METHOD

There is a 350 species of earthworm found on the earth. But only few are used in vermicomposting which live on the surface of soil like *Eiseniafoetida*, *Eudriluseugeniae* etc.

Vermicomposting is practiced in 3X8 area. It is located near the green house in botanical garden. First collect the organic waste and separate non bio-degradable waste in this. green waste (, grass, twigs

obtained by pruning, tree droppings (leaves) etc.) are spread in a layer for 1-2 days in the sun light, than deep into the water filled pot for pre decomposing process.

In a bed at the bottom lay the plastic sheets. On it lay 3-4" thick layer of Green waste and neem leaves. Sprinkle water 2-3 times in a day. Make 3-4" thick layer of cow dung and soil in proportion to 1:3. Now add earthworm. Again make 3-4" thick layer of cow dung and soil in proportion to 1:3. Sprinkle water one times in a day. On it lay 3-4" thick layer of Green waste and neem leaves.

Here is a point to be noted, bed is not heighted more than 1-1.5 feet. Now covered by stack that keeps moisture in it. Temperature should be controlled at 25-30° C.

Now leave this unit for 20-25 days. To maintain temperature, regularly sprinkle water on it.

In 20-25 days numbers of earthworm increase rapidly. Vermicompost is ready after 3months. Vermicomposting should be practiced in shadow. Earthworm can be live in 0-40 °C. so, it is required to plan for it. Only surface dwelling earthworm should be selected.



Fig No. 1 (a) Fresh Organic Waste



Fig No. 1 (b) Spreading in Layers



Fig No. (c) Arranged in a bed



Fig. 2 (d) Vermicomposting



Fig No. 2 Key steps in vermicomposting process

III OBSERVATION & VERMICOMPOST RESULT

The result of proposed vermicomposting is summarised below.

(a) Harvested in – 1-1.5 month

(b) Nutrients present

(i) Nitrogen	-	2-3 %
(ii) Phosphorus	-	1-2 %
(iii) Potash	-	1.5- 2 %
(iv) M.O. and others	-	comparatively less than other manure.

IV CONCLUSION

The proposed vermicompost system is being used in college garden and college waste recycled. It is eco-friendly method to manage college waste. It increases nitrogen, phosphorus, potash, Ca, Mg in soil. It increases soil fertility. Earthworm mix and spread humus and soil in all layers. Due to activities of earthworm, soil become porous, which do aeration properly and it increase water holding capacity of

soil. Increase useful bacteria in soil. Weed less growth of soil enriches vermicompost.

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Cooling Techniques Used for Photovoltaic Panels: A Review

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ABSTRACT

A brief review of various techniques used for cooling of solar Photovoltaic panels is presented. The operating temperature of PV module is an important parameter which influences the performance of PV panel. A small portion of solar energy is converted into electrical energy whereas major part of solar energy gets converted into heat which raises the temperature of panels and consequentially reduces efficiency. The reverse saturation current of a solar cell increases rapidly with temperature which decreases the cell voltage.

Key words: cooling techniques, photovoltaic, solar PV efficiency, renewable energy, solar cooling chimney.

I INTRODUCTION

In the last few decades, renewable energy sources are becoming more and more popular as they are pollution free, environment friendly and have become cost effective also. Solar energy is the most important source of energy. In a solar PV panel, in the process of converting solar light energy into the electrical energy, lot of heat is generated and raises the temperature of solar panel. The overall efficiency of solar PV cells generally ranges from 5% to 20%. The remaining solar energy which may be up to 87% gets converted into heat, resulting in rise in temperature of a PV cell. Thus, the cell works above the ambient temperature. Many researchers observed that overall efficiency of Photo Voltaic (PV) cells drop considerably with the rise in temperature. The rate of decrease in efficiency ranges from 0.25% to 0.5% per °C depending on the cell material [1-6]. The current-voltage (I-V) characteristic of a solar PV device depends on temperature variation under illumination. Open circuit voltage (V_{oc}) and the maximum generated power (P_{max}) reduce rapidly with the rise in temperature due to fast increase in reverse saturation current. If constant insolation level is maintained, the temperature rises and there is a marginal rise in the PV cell current but a remarkable fall in PV cell voltage. The power up to 5% can be conserved by cooling of panel [7]. Recent developments have also made use of the waste heat for applications. Normally, hybrid elements are called photovoltaic-thermal units (PV/T unit) which make use of both electrical and thermal solar energy. These units usually have a higher overall efficiency as compared to stand-alone photovoltaic and solar collectors [8,9]. They save considerably on cost and require less space for installation. The aim of this paper is to present an overview of various techniques used for cooling of solar PV panels.

II COOLING OF SOLAR PHOTOVOLTAIC PANELS

Cooling of photovoltaic cells improves the efficiency of solar panel and reduces cost of solar energy in following ways.

- (a) Cooling of PV panels increase the efficiency.
- (b) Cooling helps to limit the temperature of the PV cells from irreparable damage.
- (c) Heat taken away from cooling PV system can be used for some applications.

III METHODS FOR COOLING OF PHOTOVOLTAIC CELLS

The photovoltaic cells can be cooled by passive system or active system. For heat removal, passive cooling uses natural convection/conduction whereas active cooling system consumes energy to operate cooling pump, fan, etc.

- (a) **Passive cooling methods:** Air cooling, water cooling and conductive cooling are the three main types of passive cooling. Cuce et al. [10] worked on two PV cells, one with heat sink and other without heat sink. The aluminum fins with thermal grease duly applied act as heat sink. The illumination was varied from 200 to 800 W/m² in which increase in 9% efficiency was observed by passive cooling using a heat sink. Hernandez et al. [11] observed that the depth of flow channel below PV cells affect the passive cooling for larger PV surface (1.95 m²). The authors noted that for a length-to-depth ratio of 0.085, the PV module temperature increased by 5-6° C.
- (b) **Active cooling methods:** These methods are mainly based on air or water cooling. Fan/pump is needed for circulation of fluid (i.e. water, air etc.). Hence, it continuously consumes power for cooling the PV module. The active cooling methods are mainly used in large power plant and are more suitable for concentrated PV cells.
- (c) **Hybrid cooling systems:** There are various combinations of passive and active systems as shown in Fig. 1. Proper combinations improve the results in terms of costs, output and energy etc.

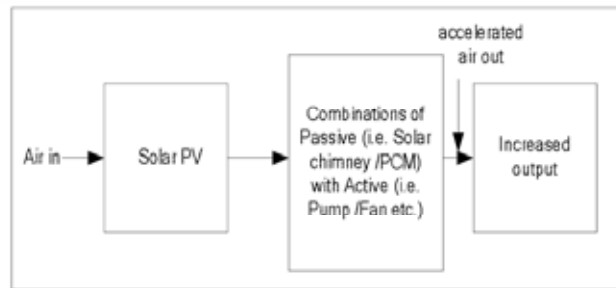


Fig No. 1 Hybrid solar PV systems

The combination of cooling systems in solar PV system increases air flow behind the panels improving the cooling of panels and in-turn the output. Some important technologies are discussed in this paper, namely phase change material (PCM), cooling in submerged water, hybrid PV/T system, micro-channel, thermo-electric cooling system, solar chimney cooling system.

IV PHASE CHANGE MATERIAL (PCM)

Phase change material (PCM) is excellent for special type of conductive cooling (shown as Fig. 2) [12]. Hassan [13] observed that decrease in temperature by 15° C relative to reference PV cell could be achieved in 5 hours by using right type PCM material, at an insolation of 1000 W/m². The author used 65 W solar PV panels with 50 mm thick PCM material on the back and vertical aluminum fins to improve conduction.

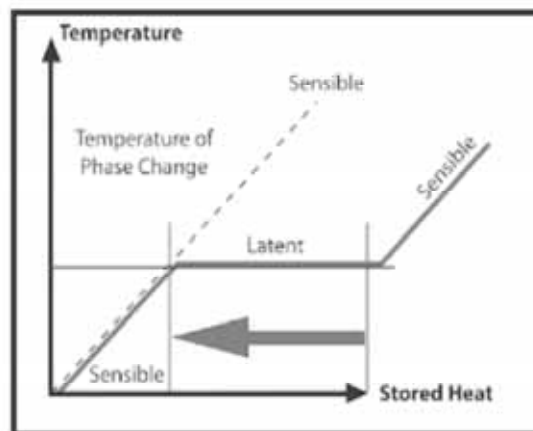


Fig No. 2 PCM cooling technology

Maiti et al. [14] used a V-through reflective panel. A PV panel of 0.133 m² surface areas was used by applying 5.5 kg of PCM material which resulted in decrease of the maximum temperature from 85° C to 65° C and increase in the efficiency by about 55% [15].

(a) **Cooling in water submerged panels-** Water cooling is efficient due to higher thermal capacity of water. A number of researchers worked with front and back cooling. Rosa-Clot et al. [16] experimented on submerged water technique to cool the mono-crystalline PV module. It was observed that when temperature was maintained at 30° C, an increase in efficiency in the range of 9 to 22% was noted. This wide variation in efficiency was due to the

change in insolation intensity with the depth of water [16]. It was found that at a depth of 4 cm, efficiency increased by 11%.

(b) **Hybrid PV/Thermal (PV/T) system -** The solar heat energy is used for various purposes such as space heating, water preheating ventilation, food drying etc.[17]. Hybrid (PV/T) solar cooling improved the efficiency of solar PV panel by enhanced circulation of ambient air for heat removal as shown in Fig 3. By placing a solar thermal collector behind a solar photovoltaic (PV) array, the PV cell can be cooled. At the same time, the solar collector can gather most of the energy that passes through the array. PV/T systems are also categorized according to the process of heat removal.

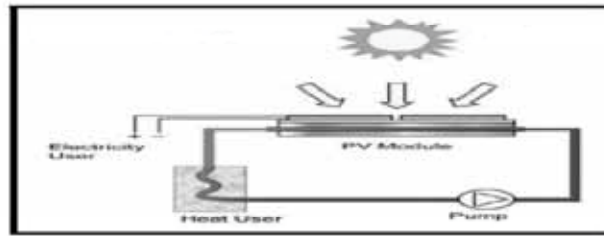


Fig No. 3 Hybrid PV/T solar cooling system

(c) **Micro channel cooling system** - The concept of micro channel/canal cooling was presented by Tuckerman and Pease in 1981[18]. Micro channel cooling system makes use of the

concept of heat transfer in which fluid/liquid flows in cross confinement with typical dimensions below of silicon layer of panel, as shown in Fig. 4[19].

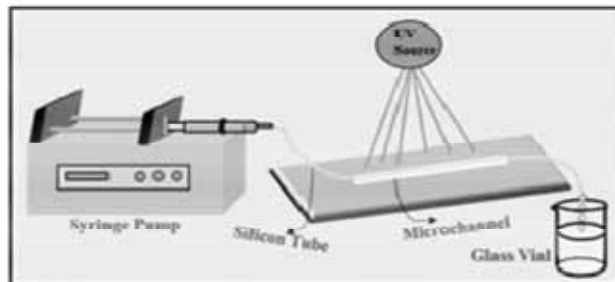


Fig No. 4 Micro channel cooling system

For cooling of electronic components in integrated circuits manifold micro channels/canals are fixed on the back. In electronic components, heat is dissipated by coolant through forced convection.

(d) **Thermoelectric cooling system**- The thermoelectric cooling system works on the principle of Peltier effect. In an electrical junction, one side is hotter than the other side and that is called Peltier effect. Thermoelectric device is made-up of two types of semiconductor

materials viz. n-type and p-type. These two are connected electrically in series and thermally in parallel as shown in Fig. 5. In this cooling system, the majority carriers move in the direction from hot to the cold. Afterwards, an applied voltage forces a current through the materials causing an effective heat pump that cools one side and heats up the other. A heat sink must be connected to hot side to dissipate the heat [20].

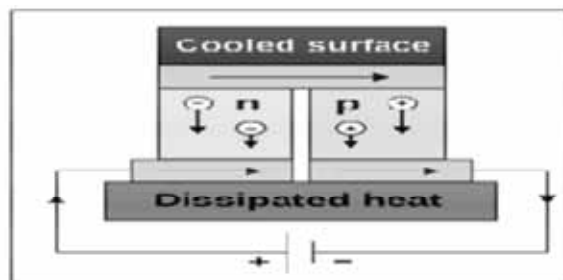


Fig No. 5 Thermoelectric cooling systems

V SOLAR COOLING CHIMNEY (SCC)

A solar chimney is a device that uses solar radiation to move air upwards to create air circulation. At constant pressure, air density decreases with increase in temperature. Air above ambient temperature is driven upwards by the buoyancy force. This physical phenomena is used in solar chimney.

A solar chimney contains a solar absorber, which allows solar heat to be transferred to air. Solar chimneys utilize the 'greenhouse' effect by providing

a transparent material (glass) on one side and a solar absorber on the other side while maintaining a gap for air in between the two. Tall chimney provides a pressure difference between the bottom and the top due to which air is drawn from the bottom tap [21, 22].

Tonai [23] suggested a design which consists of an absorber section such that it helps to increase the natural draft of air to improve cooling of PV panels. The velocity of air rising up in the chimney is directly proportional to the energy absorbed by air.

Solar Cooling Chimney (SCC) has two main parts: top part, and the middle part as shown in Fig. 6.

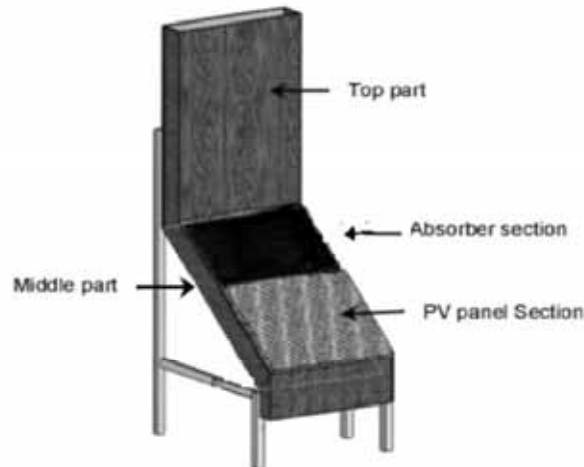


Fig No. 6 Solar chimney cooling system

Top part of the SCC acts as chimney whereas vertical extension to the middle part enhances the natural draft created by rising of the warm air.

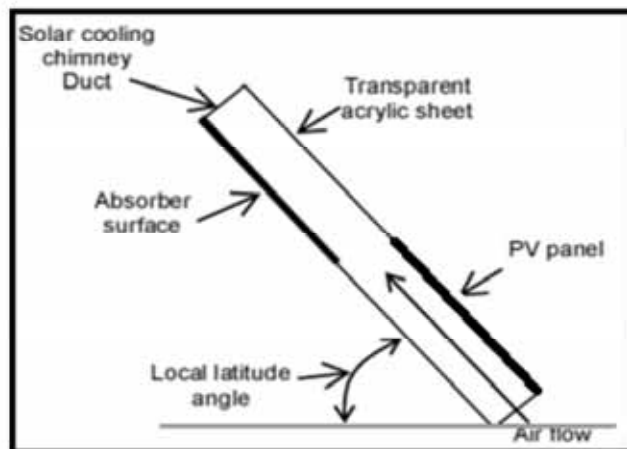


Fig No. 7 Middle part of SCC

The middle part of SCC can be divided in two sections, viz., PV panel section and absorber section and planned such that its length is twice that of PV panel. As shown in Fig. 7, PV panel is placed on the lower half and transparent acrylic sheet is placed on the top half of the SCC duct. To receive maximum solar radiation throughout the year, middle part of solar cooling chimney is installed inclined at an angle equal to local latitude. Black paint is applied on absorber surface to maximize the energy absorption. Most of the incident solar radiations pass through the transparent acrylic sheet and fall on absorbing surface. Thus, the temperature of absorbing surface will rise. High temperature surface transfers the heat to the air entering from the PV panel.

Warm air from absorbing surface has lower density which rises upwards to the top section. If height of chimney is increased, the air velocity increases. From the bottom of SCC, ambient cool air flows through the heated PV panel surface and decrease its temperature.

VI CONCLUSION

It is noted that cooling of solar PV panels increases overall efficiency by 3 to 5% whereas other factors i.e. size of the panels, topographical position, and season of the year also make influence, Passive cooling systems also result in significant improvement in efficiency. The solution lies in solar chimney based air cooling system which provides passive cooling. The combination of both the systems i.e. taller chimney (passive) with fan (active) increases the velocity of air which further reduces the working temperature of PV panel and makes it more efficient. The height of solar chimney needs to be optimized for the cost and effect of shading.

It is found that active cooling techniques yield higher efficiency than passive ones. Active water cooling gives excellent performance by increasing the efficiency. It requires space for water storage and provision for pumping.

Hybrid (PV/T) solar cooling improves the efficiency of solar PV module by enhanced circulation of ambient air for heat removal; the hybrid cooling system can replace active cooling keeping in view the efficiency, cost, system requirements, etc.

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Phytoremediation, a Green, Clean Technology and Effect of Heavy Metals on Morphology of Hyperaccumulator Plants

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ABSTRACT

Phytoremediation is the use of green plants to remediate the contaminants present in soil, water, air, land etc. Heavy metals are hazardous to plants, animals and human beings etc. Heavy metals like Cadmium (Cd), Lead(Pb), Chromium(Cr), Arsenic (As), Uranium(Ur), radionuclides are harmful and damages anatomical features of plants animals and human beings. Processes and mechanism of Phytoremediation are Phytoextraction, Phytostabilization, Rhizofiltration, Phytodegradation, Phytostimulation etc. Heavy metals at very low concentration effect very less but at slight higher concentration effect the Phytoremediator plants, shows the morphological effect like decrease in leaf number, leaf area, chlorosis, reduction's in root and shoot lengths, slight increase and then decrease of dry weight of plant and its aerial parts. Hyperaccumulator plants tolerate a wide range of heavy metals .Brassica juncea(Mustard), Solanum Lycopersicon esculentum (Tomato), Sunflower (Helianthus annus), Eicchornea crassipes (Water hyacinth) studied as hyperaccumulator plants.

Keywords-Phytoremediation,Heavy metals,dry weight, Rhizofiltration.

I INTRODUCTION

Phytoremediation is the use of green plants to remediate the contaminants present in the soil,water,air etc.Phytoremediation Greek word means "Phyto" means "plant"and "remediation""recovery" or" removal". Phytoremediation consists of the various processes ie mechanisms ie Phytoextraction, Phytostabilization, Phytodegradation, Rhizofiltration, Phytostimulation(1-8) etc.Increase, Decrease of Biomass bor dry weight of plant or its aerial parts shows the remediation of heavy metals and other

contaminants. Hyperaccumulator plants have a tendency to tolerate wide range of heavy metal concentration in their aerial parts. Different plants shows different types of Phytoremediation technique.

Hyperaccumulator plants-Lycopersicon esculentum (Tomato), Brassica juncea (Mustard) Helianthus annus (Sunflower),Eicchornea crassipes(Water hyacinth).

Plants-Lycopersicon esculentum (Tomato), Brassica juncea (Mustard) Helianthus annus (Sunflower),Eicchornea crassipes(Water hyacinth).

II OBJECTIVES AND METHODOLOGY

(a) Objective

- (i) To study the Phytoremediation technology, heavy metals, hyperaccumulator plants and to study the effect of heavy metals on morphological features of plants,leaf no. of plants.To study the formula of translocation factor and tolerance level of plants.It is Shoot/Root ratio and Shoot/Soil ratio of plants.
- (ii) To study root, shoot lengths, tolerance level

- (iii) To remediate the heavy metals by Phytoremediation technology and to clean the environment by Phytoremediator plants

- (b) **Experiment & Objectives** -Plants are grown in pots and treated with heavy metals (Pb,Cr,Cd),leaf area,leaf number and dry weight,fresh weight,biomass is observed after keeping plants for few days.(p less than 0.05). TF greater than 1 suggests higher remediation of heavy metals suggests higher remediation of heavy metals. Fresh and Dry weights after treatments on different plants after treatment with heavy metals are shown on tables 1 to 4 and graphically represented at figure 1 to 4.

Tables No. 1
Fresh, dry weight of root, shoot of Cadmium treated Brassica juncea.

Control	Shoot fresh weight	Shoot dry weight
0	45	11
100Cd,mg/l	37	9
200Cd,mg/l	30	7
	Root fresh weight	Root dry weight
100Cd,200Cd,(mg/l).	14,11	4.5,3.2

Table No. 2
Fresh weight, Dry weight in g/seedling of lead treated *Eichhornea crassipes*

mg/l lead	Fresh weight	Dry weight
Control	10.03	0.72
100	9.95	0.71
200	9.63	0.64
400	8.83	0.56

Table No. 3
Tomato plant Fresh and dry weight of root ,shoot of lead treated plant.

Lead mg/l	Root	Shoot
	Fresh, Dry weight	Fresh, Dry weight
Control		
150	1.95, 0.66	6.1, 1.87
300	1.49, 0.58	4.1, 1.4

Table No. 4
Fresh and Dry weight of Chromium treated root, shoot of Sunflower (*Helianthus annus*).

Cr mg treated sunflower	Root fresh ,dry weight	Shoot fresh, dry weight
50	1.16, 0.48	9.69, 1.38
100	2.23, 0.19	11.49, 1.78

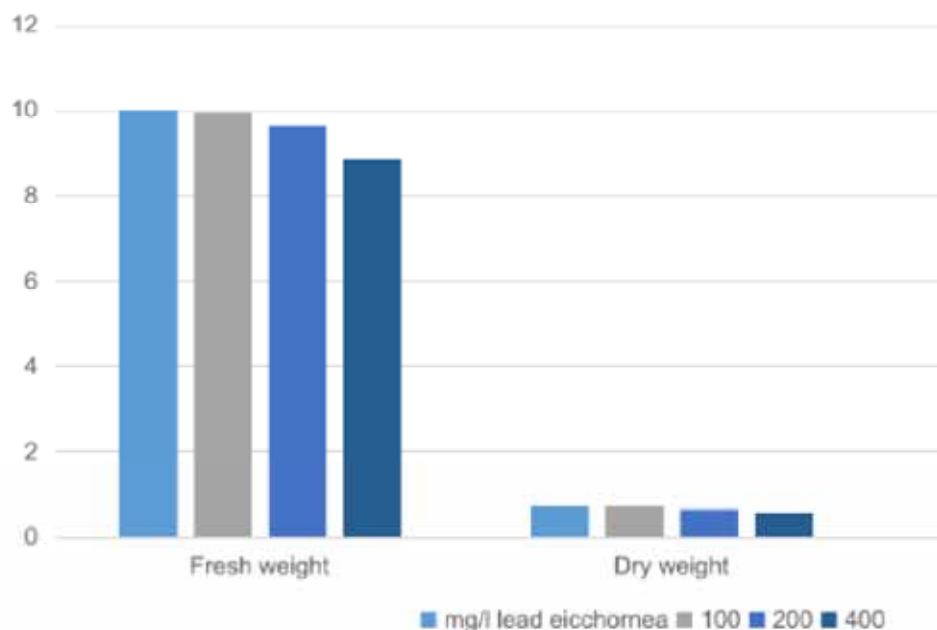


Fig No.1 Fresh and Dry weight of root, shoot of *Eichhornea crassipes* (Water Hyacinth).

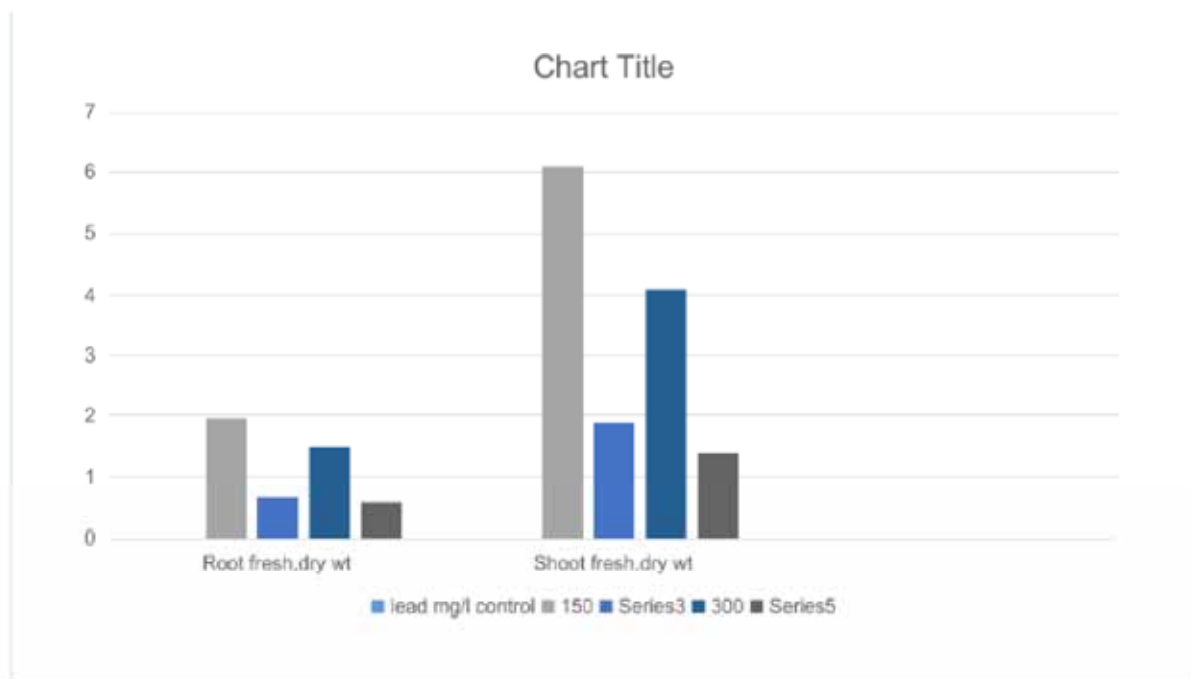


Fig No. 2 Fresh and Dry Weight of root, shoot of *Lycopersicon esculentum* (Tomato plant) of lead treated Plant.

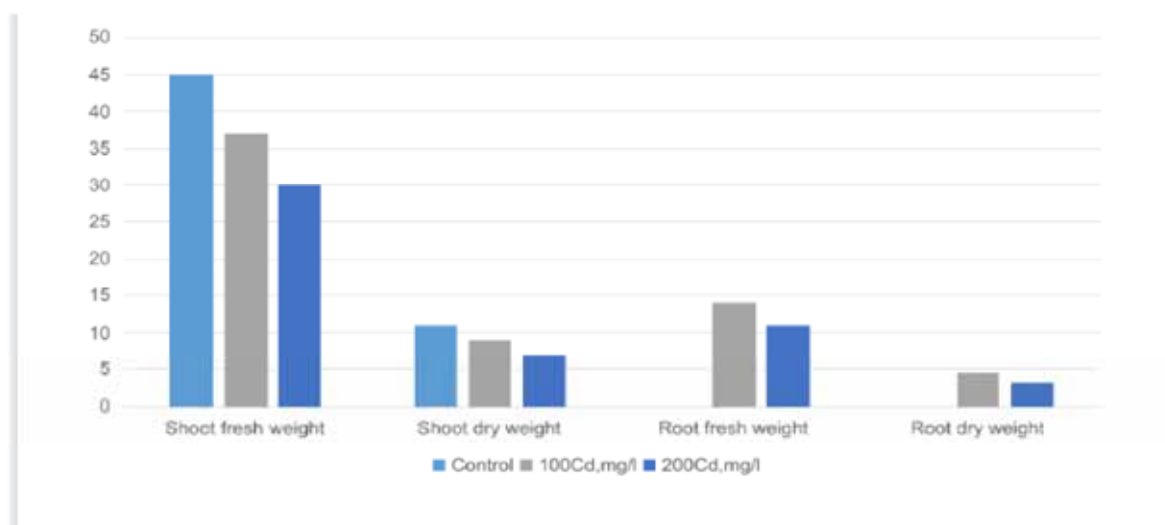


Fig No. 3 Fresh and Dry weight of root, shoot of *Brassica juncea* (Mustard) Plant.

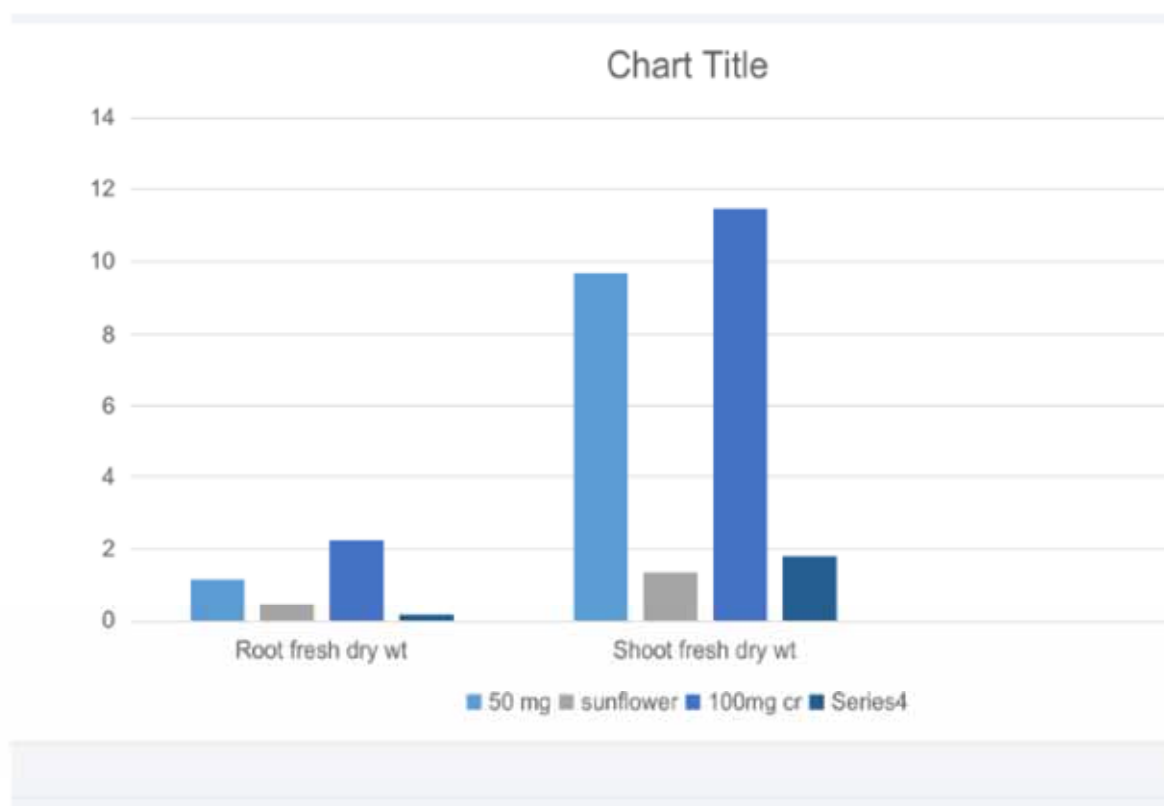


Fig No. 4 Fresh and Dry weight of root, shoot of *Helianthus annuus* (Sunflower) of Chromium treated Plant.

III RESULT & DISCUSSIONS

Slight increase and then decrease of dry weight of the plant and aerial parts of the plants taken suggests that the transfer of heavy metals from root to shoot, on increasing concentration of heavy metals. Leaf area and number also decreases at slight higher concentration of heavy metals. In this way contamination of soil, water is damaging the environment. Photosynthetic rates decreases by the effect of heavy metals.

Future prospects-Phytoremediation is a cost effective technology and has wide applications. The process is helpful in cleaning of environment. Transgenic plants are helpful in technology and helpful in near future.

IV CONCLUSION & APPLICATION

A decrease in yield, dry matter, dry weight, and lengths of plant and its root and shoot. Leaf area and leaf number decreases, chlorosis is also observed in plant leaves and its parts. As the concentration of heavy metals increases, dry weight or biomass at very

low concentration slightly increases and then decreases. The process is helpful in cleaning soil, water, air, land and also remediation of heavy metals and other contaminants.

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Evaluation of Wind Energy Potential and Estimation of Wind Turbine Characteristics

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ABSTRACT

In this study a novel distribution function is discussed to study the wind speed characteristics and wind turbine characteristics. This paper focuses on the study of estimation of wind resource potential and wind turbine characteristics at higher hub height. A detailed wind resource assessment analysis and selection of wind turbine are discussed for estimating capacity factor and harnessing maximum wind power at Mamatkhedha. The selection procedures of the efficient wind turbine (WT) of (class II) for the site, according to IEC 61400, are fully investigated. This study also reveals that the Mamatkhedha has a high wind potential which result in significant increase in AEP.

Keywords: Probability distribution functions, wind power density, Weibull parameters, statistical analysis, wind frequency distribution.

I INTRODUCTION

Wind energy is an interminable and renewable source of electricity generation and has proved its potential in combating climate change. For the successful and economic development, it is necessary to install a wind turbine in a windy area along with suitable selection of wind turbine. However wind is highly intermittent so it is important to understand the different meteorological parameters with time and region. Estimation of wind speed characteristics is therefore an essential factor in assessing wind power potential and performance of wind energy conversion system [1]. The wind direction is less important because modern turbines have yaw control mechanism but the wind power is cubically proportional to the wind speed therefore it is essential to characterize the probability distribution of wind speed. The statistical explanation is simple when a measured histogram can be correctly fitted by an analytical probability density function (PDF) consisting few parameters [2]. Abbreviation symbols used are tabulated at end of this paper as legend.

II LITERATURE SURVEY

There are various methods of modeling the wind speed PDF which are available in literature. The most common method is based on Rayleigh and the more steadfast Weibull distribution [3-7]. However, over land the Weibull fit of empirical data have low quality which encouraged the researchers to suggest various alternative analytical distributions, such as inverse Gaussian [8], lognormal [9], extended exponential functions [10], square root normal [11], inverse Weibull [12], maximum entropy principal [13], generalized gamma [2]. In the recent past years several studies has been conducted to assess wind power potential using single and mix distribution [8-13].

Kiss and Imre [2] tested the performance of Rayleigh, binormal, Weibull, lognormal and gamma distributions for the modeling of wind speed over land and sea both. They found that Weibull functions does not perform well at many location over land whereas generalized gamma distribution provides an adequate and unified distribution everywhere. A. Garcia et al. [14] used lognormal and Weibull distribution function to fit wind speed distributions. Carta et al. [15] used WW-PDF to estimate wind speed distribution in which there was an indication of unimodality, bimodality or bitangentiality. Subarto Kumar Ghosh et al. [16] used Weibull distribution function to assess the wind energy potential of five different coastal areas in Bangladesh. Vaishali Sohoni et al. [17] carried a detailed analysis of three functions Raleigh, Weibull and gamma for the description of wind regimes and identified that the Weibull distribution was best for the sites with moderate wind speed whereas gamma distribution performed best for low and high wind speed sites. Stewart and Essenwanger [18] and Tuller and Brett [19] used a 3- parameter Weibull (W3) model with an added location parameter and founded a better fit compared to normal W2. Nkongho Ayuketang Arreyndip et al. [20] employed generalized extreme distribution to study the wind energy variation and wind energy potential of Debuncha, South-West Cameroon.

To account for parametric model, numbers of non-parametric models were also suggested by the authors. This model has the advantage of considering null wind speed. The most accepted distributions are derived from maximum entropy principle [21, 22]. Zhang et al. [23] adopted non-parametric model using the kernel density concept approach in a numerous distribution model. In the recent past various mixture distributions were found accurate in describing wind energy characteristics as well as in assessing the wind energy potential. Akdag et al. [24] found better fit with two-component mixture Weibull distribution (W3) against ordinary two-parameter Weibull distribution (W2). Akpinar et al. [25] employed the

mixture of truncated normal distribution and traditional Weibull distribution to model wind speed. In the Indian Peninsula limited numbers of studies have been performed to model the distribution of wind speed [26-28]. In all these studies the 2 parameter Weibull distribution function and Rayleigh distribution is employed for modeling wind speed. The Weibull distribution is most common, traditional accepted and has a number of advantages but it cannot represent every wind regimes found in nature, in particular for bimodal distribution and wind speed distribution with high fraction of null wind speed. Subsequently various model have been suggested in the literature which includes hybrid distributions, standard distributions, mixed distributions. As far as wind energy literature is concerned Weibull distribution occupied a prominent position in the recent literature for site assessment.

III NOVEL APPROACH TO ANALYSE WIND SPEED CHARACTERISTICS

In this study a novel approach is discussed to analyse the wind speed characteristics and wind turbine characteristics. The hourly wind speed is modelled using Weibull distribution. Furthermore, this paper focuses on the study of estimation of wind resource potential and wind turbine characteristics at higher hub height. A detailed wind resource assessment analysis is performed for the site at higher hub-heights. The wind speed, wind power density, Weibull parameter is extrapolated at higher height and different wind characteristics are calculated. In addition the selection of wind turbine is discussed for

estimating capacity factor and harnessing maximum wind power at Mamatkhedha. The outcome of this research investigation will provide significant information of wind resources potential at higher elevation and selection of wind turbine model for selected terrain.

The rest of this paper is organized as: Section IV shows the site details. Section V presents the selection of wind turbine model. Section VI shows method for estimating wind energy potential and capacity factor and also discusses the goodness of fit. The results are discussed in Section VII and finally conclusions in Section VIII

IV SITE DETAILS AND WIND SPEED DATA

Madhya Pradesh has good reserves of wind power, as per C-WET (presently National Institute of Wind Energy) data there are various sites of potential in Madhya Pradesh at 80 m and 50 m respectively. The 60 % of the total power generated from renewable resources in the state is the wind power [28]. Because of its geographical location it is called as 'Heartland of India'. It extends to an area about 3, 08,252 sq. km stands second place in India in terms of area. The Mamatkhedha is located in Ratlam district of Madhya Pradesh at 23° 41' N Latitude and 75° 03' E Longitude at a mean sea level of 560 m (Fig 1). The time series Wind speed data was collected at height of 10 m and 25 m for a year. The statistical description of wind speed data is shown at Table 1.



Fig No. 1 Geographical location of sites

Table No. 1
Descriptive statistics of wind speed data

Height (m)	Station	Maximum (m/s)	Mean (m/s)	Standard deviation (m/s)	Skewness	Kurtosis
10 m	Mamatkheda	19.03	6.21	4.231	0.142	-0.275
25 m	Mamatkheda	33	7.12	5.694	0.264	-0.397

V SELECTION OF THE WIND TURBINE

The IEC 61400 describes the minimum design criteria for wind turbines (WTs), the external environmental conditions to be considered during

design are dependent on the type of site for the installation of Wind Turbines. The basic parameter for wind turbine machines classes are discussed in Table 2 [26].

Table No. 2
Parameters for Wind Turbines classes

WTs Class	I	II	III	IV
V _{ref} (m/s)	50	42.5	37.5	30
V _{avg} (m/s)	10	8.5	7.5	6
A I ₁₅ (-)	0.18	0.18	0.18	0.18
a (-)	2	2	2	2
B I ₁₅ (-)	0.16	0.16	0.16	0.16
a (-)	3	3	3	3

VI METHOD FOR ESTIMATING WIND ENERGY POTENTIAL AND CAPACITY FACTOR

(a) **Wind speed distribution modelling** - The modeling of wind speed distribution requires a time series wind data. The most important tools for assessing the wind speed characteristic is

$$f(v, k, c_0) = \frac{k}{c_0} \left(\frac{v}{c_0} \right)^{k-1} \exp \left[- \left(\frac{v}{c_0} \right)^k \right] \quad (1)$$

where k and c_0 represent shape and scale parameter (m/s) respectively. The Weibull shape and scale parameter is computed using the maximum likelihood method which is determined by equation [3]:

$$k = \frac{\sum_{i=1}^n \ln \left(\frac{v_i}{c_0} \right)}{\sum_{i=1}^n \left(\frac{v_i}{c_0} \right)^k} \quad (2)$$

$$c_0 = \left(\frac{\sum_{i=1}^n \ln \left(\frac{v_i}{c_0} \right)}{\sum_{i=1}^n \left(\frac{v_i}{c_0} \right)^k} \right)^{\frac{1}{k}} \quad (3)$$

where n is the number of data points and v_i is the wind speed measured at time step i . An iterative technique is used to evaluate Equation 3. Since, the Weibull distribution does not describe a good description of wind speeds universally [2] therefore this paper focuses on the application of other distribution.

probability density function. In the present study Generalised Gamma distribution and two parameters Weibull distribution is used to describe wind speed characteristics.

(i) **Weibull distribution** - The most commonly accepted and used model for wind speed probabilities is a two parameter Weibull probability distribution [29, 36]:

(b) **Estimation of Wind Energy Potential** - Once the probability distribution of wind speed is obtained, the wind energy potential can be determined accordingly.

(i) **Wind Speed at Higher Hub Height** - The wind speed data was recorded at 10 m and 25 m height above ground level at both sites. The power law method is generally used to extrapolate the wind speed from one level to another level. The power law can be mathematically written as [30]

$$\frac{v}{v_c} = \left(\frac{z}{z_c} \right)^{\frac{1}{\alpha}} \quad (4)$$

where V_1 and V_2 represents the wind speeds (m/s) at heights H_1 and H_2 (m) and \bar{u} is a power law coefficient. The values of \bar{u} varies from 0.1 to 0.32

$$k_z = \frac{z_{ppp}^{\frac{1}{n}}}{z n x (z k x)^{\frac{1}{n}} \left(\frac{z_{ppp}^{\frac{1}{n}}}{z k x} \right)} \quad (5)$$

$$c_z = c_{zzz} \left(\frac{z_{ppp}}{z} \right)^{\frac{1}{n}} \quad (6)$$

$$n = 0.37 + 0.088 \ln(c_{zzz})$$

where k_b , c_b and k_{ref} and c_{ref} are Weibull shape and scale parameters at desired height and required height respectively.

$$CF = \left(\frac{P_{xxx}}{P_z} \times 100 \% \right) \quad (7)$$

$$CF = \frac{z_{zzz} \left[x \left(\frac{P_z}{P_{xxx}} \right)^{\frac{1}{n}} \right] x \left[z_{zzz} \left(\frac{P_z}{P_{xxx}} \right)^{\frac{1}{n}} \right]}{\left(\frac{P_z}{P_{xxx}} \right)^{\frac{1}{n}} x \left(\frac{P_z}{P_{xxx}} \right)^{\frac{1}{n}}} \exp[0 \left(\frac{z}{z_{zzz}} \right)^{\frac{1}{n}}] \quad (8)$$

where, P_{xxx} is a average output power of the wind turbine in kW, P_z is a rated power output of a wind turbine in kW, V_z is a wind velocity (cut-in) in m/s, V_x wind velocity (rated) in m/s and V_z is a wind velocity (cut-out) in m/s respectively.

(iii) **Annual Energy Production** - The AEP is determined using the turbine output from turbine power curve and the observed wind speed distribution, generally assumed a

$$AEP = P_{tot} \times 8760 \text{ kWhrs/ year}$$

$$AEP = 0.5 \times \int x A x V^3 \times CF \times 8760 \text{ kWhrs/ year}$$

(iv) **Wind Characteristics**-The most probable wind speed (V_{mp}) and maximum energy carrying wind speed (V_{mc}) signifies the wind characteristics. The wind speed probability peak is represented by the most probable wind speed, whereas the

$$V_{mp} = c \left(1 - \frac{z}{z_{zzz}} \right)^{\frac{1}{n}} \quad (10)$$

$$V_{mc} = c \left(1 + \frac{z}{z_{zzz}} \right)^{\frac{1}{n}} \quad (11)$$

(v) **Wind power density estimation** - Power (P) in the wind can be calculated using the following relation, where A is the area

$$P = \frac{\rho n}{2\pi} A V^3 \quad (12)$$

As Betz already proved that all the available power in the wind cannot be extracted, only $16/27^{\text{th}}$ portion can be extracted. In practice the wind power captured by the wind turbines is far less from that the Betz criterion.

$$P = C_z \frac{\rho n}{2\pi} A V^3 \quad (13)$$

Where C_z is the performance coefficient, Wind Power Density is defined as power available per unit area swept by the turbine blades.

$$WPD = C_z \frac{\rho n}{2\pi} V^3$$

$$WPD = \frac{\rho n}{2\pi} \int_{z_k}^{\infty} (k v^{\frac{1}{n}})^{\frac{1}{n}} dv \quad (14)$$

Wind power density in terms of Weibull parameters can be expressed as,

representing the degree of roughness. In this study, \bar{u} is considered $1/7$.

Similarly, the Weibull parameter is also extrapolated at higher heights using the following equation [31]

(ii) **Capacity Factor**- The study of usefulness of using a suitable wind turbine at a site is represented by capacity factor and it can be defined as percentage of average output power to the rated power output and mathematically it can be written as [27]

Weibull distribution. The energy produced at each single wind speed is turbine output power multiplied by the time that occurs in a year. By considering the energy production at all wind speeds, the AEP is evaluated. The accuracy depends upon the measured time-series wind data. Mathematically it can be written as [31]

The AEP can also be estimated by simple approximate method by using swept area of the turbine, which is shown below

wind power probability distribution peak is represented by maximum energy carrying wind speed. Mathematically it can be evaluated from the below equations [24, 25]

swept by turbine blades, ρ is the air density, V is the velocity of wind [36]

$$WPD = \frac{z^n}{z^n - z_k} \left(k z^{zV} \frac{z}{z_{\rho V} z_{\rho V}} \right) \left[\times e^{\left(\frac{z}{z_{\rho V}} \right)} \right] dv \quad (15)$$

$$WPD = \frac{z^n}{z^n - z_k} \left(k z^{zV} H - 1 \right) + \frac{zV}{z} \quad (16)$$

- (c) **Goodness of fit test** - To measure the deviation between observed data and the predicted data using probability distribution function goodness of fit test is performed. In this study two statistical error analyses are used to evaluate the fitness of probability density function.

$$RMSE = \sqrt{\frac{\sum_{i=1}^n (y_i - x_i)^2}{N - n}} \quad (17)$$

- (ii) **R² test**: It measure the correlation between predicted cumulative probability and observed cumulative probability of a wind speed distribution. The higher value of R²

$$R^2 = \frac{\sum_{i=1}^n (y_i - z_i)^2 - \sum_{i=1}^n (y_i - x_i)^2}{\sum_{i=1}^n (y_i - z_i)^2} \quad (18)$$

where N is the number of observations, $|_z$ is the frequency of observation, $|_x$ is the frequency of Weibull/Generalized Gamma, $|_z$ is the mean wind speed, n is number of constants used.

- (i) **Root mean square error**: RMSE provides a comparison of actual difference between observed probability and predicted probability. A lower value of RMSE shows a best fit distribution model. It is expressed as [3]:

signifies a better fit of a predicted cumulative distribution. R² can be calculated using [3]:

VII RESULTS AND DISCUSSION

- (a) **Wind Speed Modelling and Analysis** - Several comparisons have been made based on measured data to illustrate the suitability of presented probability distribution function at both the regions. Table 3 lists the values of relevant parameter computed for distribution functions for the stations.

Table No. 3
Computed parameter of Weibull distribution functions at 25 m

Month	Mamatkheda (25m)	
	k	c ₀ (m/s)
July	3.93	9.43
August	4.48	8.00
September	2.34	11.48
October	2.08	8.26
November	2.53	8.51
December	3.40	9.79
January	2.66	7.27
February	2.94	7.77
March	2.67	8.18
April	3.47	8.55
May	4.32	9.57
June	4.33	9.69

The Table 3 shows the monthly estimated Weibull parameters for Mamatkheda. The least value of Weibull shape parameter is found to be 2.08 in October and reached up to 4.48 in August whereas the Weibull scale parameter is minimum in January with 7.27 m/s and reached maximum in December with a value of 9.79 m/s. In Weibull distribution the slope of the curve is dependent on the shape parameter. On generalizing Weibull distribution the constraint on the both tails of the Weibull peak are

eliminated. In Figure 2 the Weibull distribution are compared with the measured data for locations. The improvement is particularly observed at the right tail (high wind speed) side which is correctly fitted at the locations this is due to shape flexibility which allows to fit any number of wind speed with reasonable accuracy. Similarly Figure 3 shows the plot of cumulative distribution function fit of Weibull distribution function with the measured values.

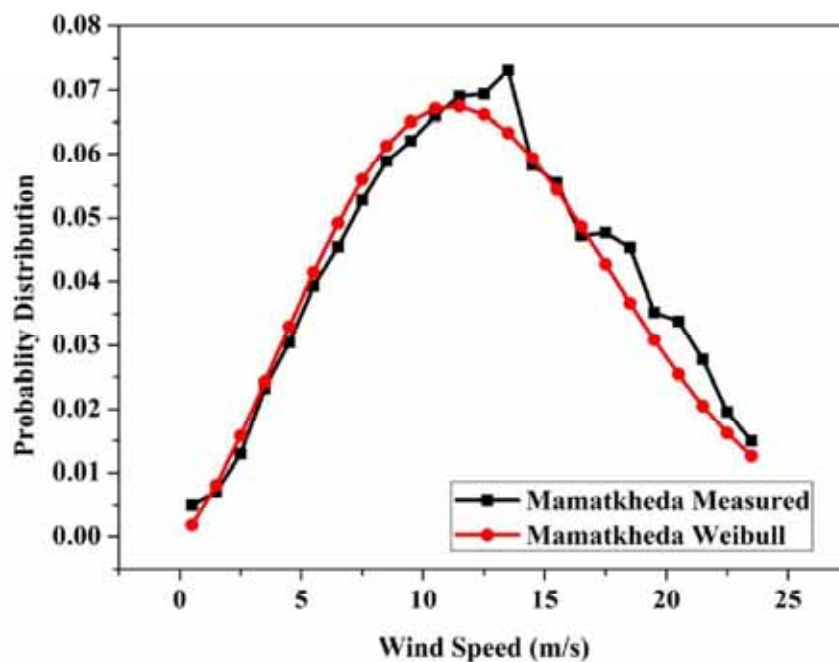


Fig No. 2 Comparison of Probability Distribution Function at 25 m

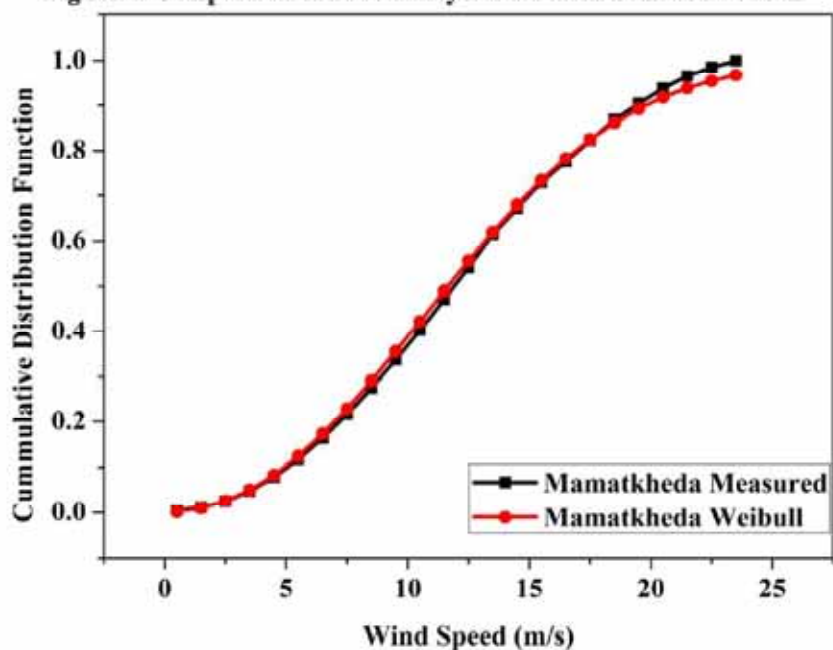


Fig No. 3 Comparison of Cumulative Distribution Function at 25 m

The calculated parameters for the statistical analysis for the measured wind speed data at both locations are presented in Table 4.

Table No. 4
Statistical analysis for wind speed data

Months	Mamatkheda	
	Weibull	
	RMSE	R ²
July	0.0083	0.9338
August	0.0087	0.9583
September	0.0147	0.4516
October	0.0095	0.9379
November	0.0110	0.9335
December	0.0099	0.9564
January	0.0100	0.9087
February	0.0160	0.8298
March	0.0086	0.9088
April	0.0127	0.7951
May	0.0141	0.8671
June	0.1201	0.8761

The higher value of R² and lower value of RMSE (highlighted bold) indicate that the distributions function is better in describing this set of wind speed data. The Table 4 above shows a comparison of

monthly computed R² and RMSE values for the wind speed, which indicates that the values shows the more appropriate and better fit result to estimate wind energy potential at this location.

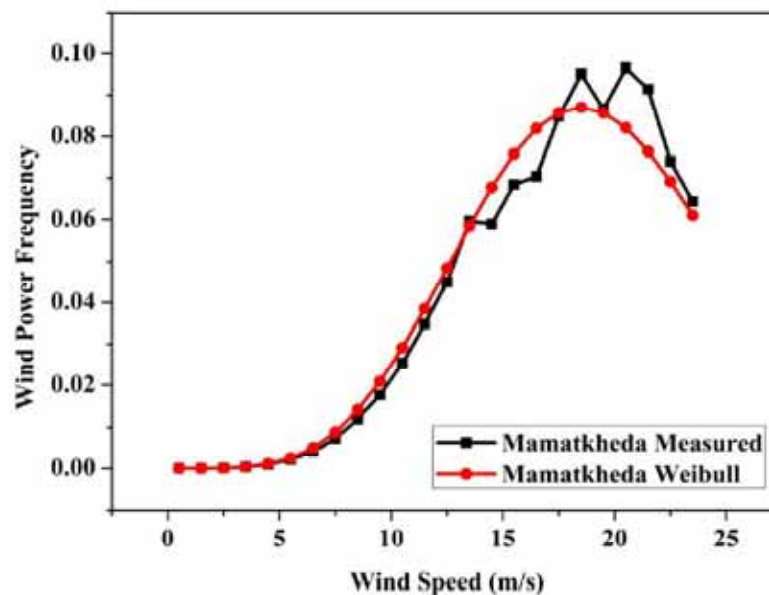


Fig No. 4 Comparison of Wind Power Density frequency at 25 m

The Figure 4 above shows the distribution of wind power at location from figure it is observed that

Weibull distribution fits well to the measured distribution.

Table No. 5
Statistical analysis of wind power density (W/m^2) at 25 m

Months	Mamatkheda	
	Weibull	
	RPE	RMSE
July	0.0304	1.2610
August	0.0589	1.0952
September	3.3897	70.2959
October	5.4113	22.6379
November	1.4747	5.9807
December	0.0104	0.0574
January	1.8218	16.6883
February	0.2974	2.9794
March	0.8642	15.9516
April	4.2229	93.2787
May	5.6673	9.0346
June	39.3864	18.2749

The Table 5 shows the result of statistical analysis of computed wind power density for the distributions. The lower value of RMSE and RPE (highlighted bold) indicate that the two parameter Weibull distribution fits approximately well in estimating wind power density.

(b) Estimated Wind Energy Resource at Higher Height - This section shows the extrapolated wind resource at higher heights to extract the maximum wind energy from the site. The

Mamatkheda has a highest wind potential and it is seen from the table that the annual mean wind speed increases with the increased height. The wind speed data were extrapolated using power law discussed above. The Table 6 below shows the statistics of extrapolated wind speed data. The average wind speed increases to 10.49 % at 50 m height and 6.94 % at 80 m height respectively.

Table No. 6
Descriptive statistics of wind speed at higher heights

Height (m)	Station	Annual mean wind speed (m/s)	Standard deviation (m/s)
50 m	Mamatkheda	7.867	4.336
80 m	Mamatkheda	8.413	6.653

The extrapolated Weibull parameters determined at required higher heights of 50 m and 80 m has been presented in Table 7 below.

Table No. 7
Descriptive statistics of Weibull parameter at higher heights

Height (m)	Station	Shape factor (k)	Scale factor (c_0) (m/s)
25 m	Mamatkheda	2.90	9.57
50 m	Mamatkheda	3.08	10.77
80 m	Mamatkheda	3.21	11.61

From the above Table 7, it is seen that both k and c_0 increases with height, which reveals the availability of greater wind resource at higher height. The magnitude of scale factor increases due to decrease in

turbulence at higher height which results in increase in wind speed. Similarly, the shape of wind increases at higher heights which increases the value of shape factor.

Table No. 8
Estimated characteristics of wind speeds

Height	Characteristics of wind speeds (m/s)	
	Mamatkheda	
	V_{mp}	V_{me}
25 m	8.271	11.462
50 m	9.481	12.671
80 m	10.335	13.500

The Table 8 above shows the value of V_{mp} and V_{me} , technically, in order to extract higher energy the rated speed of wind turbine should be close to the maximum energy carrying wind speed and the most probable wind speed provides useful information for the structural design of wind turbines. The values of most probable wind speed for ranges from 8.271 m/s at 25 m to 10.335 m/s at 80 m, while maximum energy carrying wind speed ranges (V_{me}) between 11.462 m/s at 25 m to 13.500 m/s at 80 m respectively.

(c) **Wind Turbine Characteristics** - The overall cost benefit wind power project depends on the selection of wind turbines in accordance with the condition of wind at a site. The wrong selection of wind turbine results in a financial loss. An efficient wind turbine means that more energy can be converted per cross-section area of the prevailing wind. This can help to mitigate the

challenges related to the cost. On the basis of achieved results:

- The average wind speed at height of 80 m and 50 m is 8.413 m/s and 7.86 m/s which match the specification of class II wind turbine.
- Weibull fit to the wind speed distribution shows a 'k' value 3.36 that is high compared with the standard value in IEC 61400-1 Edition 2.

The most appropriate wind turbine for Mamatkheda it is classified under class II. The selected wind turbine for Mamatkheda has a power rating of 2 MW (VESTAS V90), a diameter of 90 m, and a hub-height of 80 m. Its corresponding power curve is depicted in Figure 6 below and the Table 9 shows the technical specification of selected wind turbine [34].

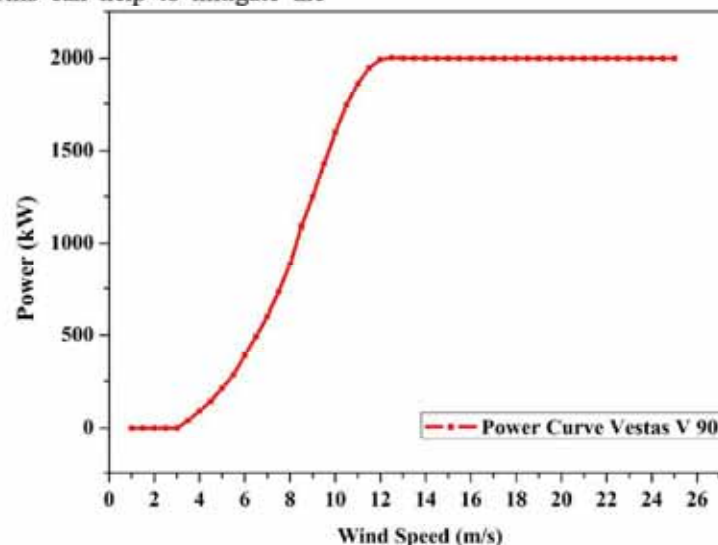


Fig No. 6 Power curve (Vestas V90)

Table No. 9
Technical specification Vestas V90

Parameter	Value/Dimension
Rated power	2000 kW
Rotor diameter	90 m
Hub-height	80 m
Swept area	6362 m ²
Blade length	44 m
Cut-in wind speed	3.5 m/s
Cut-out wind speed	25 m/s
Rated wind speed	12.5 m/s
Wind class	IEC IIA

After selecting the wind turbine for a site, capacity factor at 50 m and 80 m for Mamatkhedha is calculated considering Equation 10. At 50 m the capacity factor is found to be 0.49 while at 80 m capacity factor increases by 12.2 % attaining a value of 0.55. The capacity factor increases due to the increase in average distribution of wind speed. The maximum capacity factor results in the higher efficiency of wind turbine at the site. The annual energy production is directly proportional to the capacity factor. On the basis of capacity factor annual energy production is determined using Equation 11 at both heights for the site. The AEP at 50 m and 80 m are 8143.8 GWhrs/year and 11179.4 GWhrs/year. The AEP increases by 37.3 % at 80 m as compared to 50 m due to wind turbine capacity to operate efficiently at the site. A larger wind turbine and increased average wind speed at higher hub-height result in significant increase in AEP. The increased AEP can fulfil the electricity demand by generating considerable amount of unit of electricity through wind energy.

VIII CONCLUSION

The investigation of wind resource potential is a primary step for developing a wind farm. Moreover, empirical equations are used to evaluate wind speed at higher height by measuring at different lower heights which arises uncertainty in measurement. The appropriate selection of wind turbines for the regions was also examined, providing a theoretical foundation for local wind energy resources. The following major conclusion are drawn from the study

- The annual average wind speed at Mamatkhedha was found to be 6.21 m/s at 10 m and 8.41 m/s at 80 m height which shows a 35.47 % increase in wind speed.
- The most appropriate wind turbine for Mamatkhedha is classified under class II. Therefore, it is recommended that site is feasible for the extraction of wind energy at higher height.
- The capacity factor is found to be 0.49 at 50 m height while at 80 m capacity factor increases by 12.2 % attaining a value of 0.55, due to the increase in average distribution of wind speed.
- The AEP at Mamatkhedha increases by 37.3 % at 80 m as compared to 50 m which may result in fulfilling considerable amount of unit of electricity through wind energy.

Legend

Nomenclature	
Root mean square error	RMSE
Coefficient of determination	R^2
Shape parameter of Weibull distribution	k
Scale parameter of Weibull distribution (m/s)	c_0
Generalized Gamma distribution	GG
Probability distribution function	pdf
Wind power density (W/m^2)	WPD
Wind speed (m/s)	V
Number of observations	n
Wind speed measured at the interval i.	v_i
Frequency for wind speed ranging within bin i	$f(v_i)$
Cumulative distribution function	$F(v)$
Weibull, probability density function	$f(v)$
Mean wind speed (m/s)	\bar{v}
Power in the wind (Watt)	P
Swept Area (m^2)	A
Coefficient of performance	C_p
Capacity Factor	CF
Annual Energy Production	AEP
Cut-in wind speed	V_c
Rated wind speed	V_r
Cut-out wind speed	V_f
Greek letters	
Density of surrounding air (kg/m^3)	ρ
Gamma function	Γ
Standard deviation	σ
Shape flexibility	β
Order of Moment	i

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Analysis and Modification in Cooling System Using Solar Photovoltaic Module

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ABSTRACT

Under the project, the effects of fins cooling (passive cooling) and water cooling on performance parameters of solar photovoltaic (PV) module have been done. In the system of fin cooling, an aluminium sink containing fins have been attached to the backside of PV module in order to dissipate efficiently the waste heat from it. In the second method, a water film is created by continuously circulating the water over the surface of solar panel using a pipe distribution system to the top of the panel. After completion the test, it have been concluded that the power and the electrical efficiency of the cooling PV system are higher than the traditional one. It have also been found that the module temperature of the fins cooling method has maintained it 3°C to 5°C below the conventional reference module and the percentage increase in electrical efficiency is 2.1% to 5.85%. Whereas the module temperature of water cooling method has maintained at 15°C to 28°C below the conventional and the percentage increase in electrical efficiency is 6.9% to 16.9%.

Keywords: solar panel, cooling, efficiency, thermal analysis, smart cleaning and cooling, dust effect, temperature effect, photovoltaic etc.

I INTRODUCTION

(a) **Background** - At current condition, most of the world's energy (80%) is produced from fossil fuels. Massive exploitation is leading to the exhaustion of these resources and imposes a real threat to the environment, apparent mainly through global warming and acidification of the water cycle. Keeping the above in mind as well as the lack of fossil fuel present in earth indicates to choose some alternatives to fulfill our requirement of power hence, Renewable energy is one of the most promising alternatives to the above problems. Renewable energy resources have enormous potential and can meet the present world energy demand. The renewable sources of energy derived from the sun are one of the promising options. Solar energy is one of the most important renewable energy technologies, since it provides an unlimited, clean and environmentally friendly energy. PV cell is one of the most popular renewable energy sources. It can directly convert the solar energy into electricity through the photovoltaic effect. Conversion of sunlight directly into electricity by photovoltaic (PV) cells is a significant and rapidly developing solar energy application. Intensive efforts are made to reduce the cost per peak power obtained from PV cells. These efforts aim at narrowing the gap between PV and conventional power sources. Besides the importance of developing new manufacturing processes related to PV cells, it is quite significant to provide the most appropriate operating conditions for a PV system.

(b) **About Photovoltaic** - The photovoltaic effect was first discovered by the physicist Edmund Becquerel in 1839. Despite that, this technology is considered to be a very recent one. The first cell which could be considered as PV was constructed in 1941 with an efficiency of 1%. Sunlight is composed of photons, or packets of energy. These photons contain various amount of energy corresponding to the different wavelengths of light. When photons strike a solar cell, a semiconductor P-N junction device, they absorbed the photons. Absorption of a photon in a solar cell results in the generation of electron-hole pair. This EHP, when separated from each other across the P-N junction, results in the generation of a voltage across the junction, who can drive the current in an external circuit and, therefore, power can be extracted from the solar cell, also referred to as photovoltaic device. Present photovoltaic technology has been well developed since 1941. PV panels are used as the primary electricity source in space missions and satellites. The cost of producing electricity for house applications has dropped dramatically and PV panels are becoming more and more economic viable. New materials have been developed and new technology has created PV panels at efficiencies of 20% in many cases. One relative new type of PV panel is the hybrid PV panel. This type of panel converts the sun's radiation to electricity while providing heat to the system for other purposes. This can be done by either air or a fluid coolant. The cooling medium apart from conducting heat is cooling the panel making it more efficient. The most widely used fluid is water.

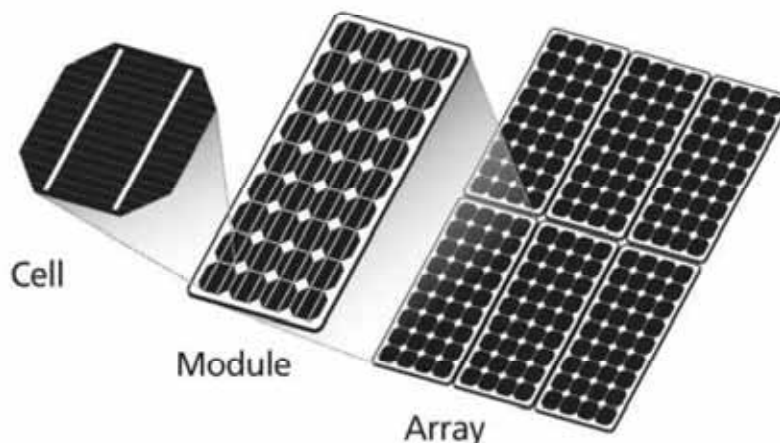


Fig No. 1.1 Photovoltaic module

A solar PV module can be considered as a big solar cell (array of solar cells connected in series and parallel) with larger voltage and current output than a single solar cell (hence large output). The solar PV module is obtained by interconnecting smaller solar cells. In order to protect the module from environmental damage, the PV modules are packaged using glass at the front side and polymer resin for

encapsulation and back side protection which provide electrical isolation and protection. Protection from environment is achieved by using two sheets of encapsulant at either side of the electrically connected cells. At the rear side of the module a hard polymer material is used. Normally, it is polyvinyl fluoride (PVF), which is white in color.

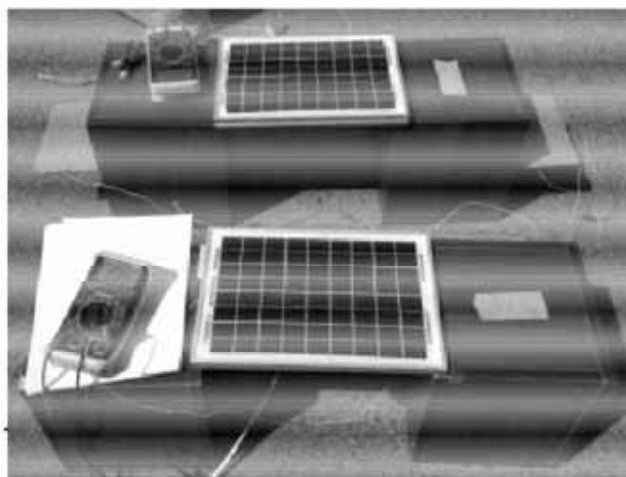


Fig No. 1.2 Component of PV module

II OBJECTIVES OF THE PROJECT

This project is based on the experimental analysis of cooling methods and thermal analysis of photovoltaic module. The objectives of the project are

- Apply a passive cooling method by fin cooling method.
- Cooling by utilizing a flowing film of water on the module front face (water cooling method). Then, a comparison between these two systems for the most efficient.
- Present a thermal mathematical model of photovoltaic module for calculating the PV module temperature.

Passive cooling method means there is no need of energy and in active cooling method energy input is required. In first method, the cooling system is used in which the aluminium fins are attached to the rear side of the PV module. In the Second method a continuously flowing film of water is utilize on the module front.

III LITERATURE

Many studies have been focused on the temperature response of PV performance since operating temperature is one of the biggest factors that affect the conversion efficiency. In order to reduce the impact of temperature on PV cell performance, a cooling system can be implemented to take heat out of them. There are some cooling methods of photovoltaic module.

(a) **Previous Work** - The problems of the temperature influence on the current-voltage characteristics of silicon photovoltaic system. Physical aspects of deterioration of the output power and the conversion efficiency of solar cell and PV module with increasing temperature are explained by many researchers. Radziemska [1] revealed that the output power declines at $-0.65\%/^{\circ}\text{C}$ for crystalline PV cells, which is actually much higher than the theoretical value of $-0.4\%/^{\circ}\text{C}$. Skoplaki and Palyvos [2] presented regarding the operating temperature of commercial grade silicon-based solar cells/modules and its effect upon the electrical performance of photovoltaic installations. The operating temperature plays a central role in the photovoltaic conversion process. Both the electrical efficiency and hence the power output of a PV module depend linearly on the operating temperature. Tonui and Tripanagnostopoulos [3] investigated the performance of two low cost heat extraction improvement modifications in the channel of a PV/T air system to achieve higher thermal output and PV cooling so as to keep the electrical efficiency at acceptable level. PV/T technology allows to produce electrical and thermal energy at the same time, through the direct conversion of solar radiation. They present a theoretical model and validated against experimental data and used to study the usual and modified configurations applied to the PV/T test models. The use of thin (flat) metal sheet suspended at the middle or a finned back wall of an air channel in a PV/T air.3. Shahsavari and Ameri [4] has designed and tested a model of direct-coupled PV/T air collector at a geographic location of Kerman, Iran. In this system, a thin aluminum sheet suspended at the middle of air channel is used to increase the heat exchange surface and consequently improve heat extraction from PV panels. This PV/T system has tested in natural convection and forced

convection (with two, four and eight fans operating) and its unsteady results are presented in with and without glass cover cases. Setting glass cover on photovoltaic panels leads to an increase in thermal efficiency and decrease in electrical efficiency of the system.

(b) **Outcomes of Literature Review** - It is evident from the literatures that the influence on the efficiency of PV module of its operating temperature is significant. There are a lot of work has been done in various cooling method. Some of cooling techniques are natural or forced convection by air, use of heat pipe, heat sink at the back side of panel, water cooling etc.

IV METHODOLOGY

(a) Experimental Set-Up

(i) Equipment Used For Experimentation

- **Solar PV Module** - Two small solar panel is used for this purpose. One module is left without cooling and the other was cooled by two different cooling method. Two 10 watt rated power photovoltaic module of same specification and manufacturer is used. The second PV module is always used for comparison purpose. The module has 36 cells. The electrical parameters of the module at STC condition are-
- **Infrared Thermometer** - Infrared thermometer is a non-contact type thermometer. The basic design consists of a lens to focus the infrared thermal radiation on to a detector, which converts the radiant power to an electrical signal that can be displayed in units of temperature after being compensated for ambient temperature. The temperature range of the thermometer is -50°C to 550°C with an accuracy of $\pm 2\%$.



Fig No. 4.1 Infrared thermometer

(c) **Complete Experimental View** - The output of the photovoltaic module which is kept in the sunlight is connected to the ecosense main

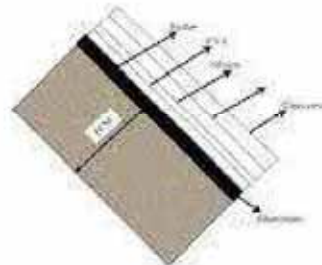
controller. The load is changed by rheostat. Other measurements are done by pyranometer, infrared thermometer and anemometer.



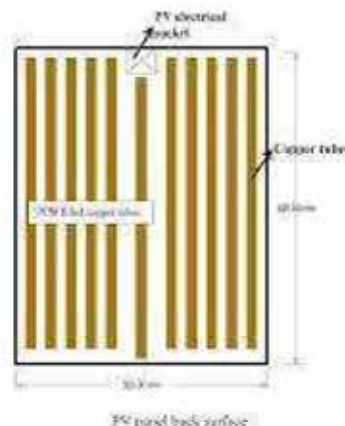
Fig No. 4.2 Complete setup view

- (d) **Fin Cooling Arrangement** - In fin cooling a heat sink of fins are attached on the rear side of one photovoltaic module with the help of adhesive. The materials of fins are aluminum because of higher thermal conductivity

(207w/mk) and light in weight. Fins are made of aluminium block with extended surface as shown in figure 4.8. Total number of fins are 21 with 1.5 cm spacing. Thickness of fin material are 2 mm.



PCM incorporated with PV panel in previous studies [13,15,17,22]



V METHODOLOGY

Objective of the project is to compare the performance of the cooled PV module with a conventional module. Two different cooling methods are applied. One is fins cooling method and second is water cooling method. Methodology followed for both cooling methods is same.

- (a) **Fins Cooling Method** - The goal of this study is to investigate passive cooling effects on the performance of PV module and enhancement in the efficiency and power output. In order to evaluate the performance of PV module with fins, experiment has been conducted. Two identical module have analyzed in the experimental study. One of the PV module is equipped with an aluminum heat sink while the other is not. The heat sink is attached at the back of the PV module using adhesive. Experiment has conducted in the month of April 2015 for 4 hour duration.

- (i) Before starting the experiments, both PV module maintained at same temperature.

Both module are placed at same time in same inclination angle and same weather condition.

- (ii) All measurements (module electrical characteristics, module temperature and ambient condition) are taken in the intervals of 1 hour.
- (iii) In the intervals of 1 hour, radiation intensity is also measured with the help of pyranometer by keeping it parallel to module surface. The ambient condition like ambient temperature and local wind velocity are measured by Anemometer for every 1 hour.

- (b) **Water Cooling Method** - In the current experiment used two solar PV panel, one is cooled by a continuous film of water on the working surface of the panel while other is not. Besides the cooling of the panel, the other advantages of this system are loss reduction caused by radiation reflectivity (refractive index of water is 1.3, i.e. an intermediate value

between 1.5 for glass and air with 1.0) and the possibility of cleaning deposits such as dust or dry leaves on the surface of the panels. Due to the rapid flow of the water there is only a slight increase in water temperature.

VI RESULT AND DISCUSSION

- (a) **Thermal Analysis** - The thermal model which is shown in the work is implemented with the energy balanced equation and heat transfer

analysis. Operation of the model is validated simultaneously with experimental measurement. Calculation of a series of module temperature values using the dynamic model requires an initial value of module temperature. So far, all calculations have used the measured value of temperature as the initial estimation.

- (b) **Fins Cooling Method Result** - It is observed that the module temperature decreases using fins cooling system. This causes the panel efficiency to increase.

Table No. 6.1
Result

Time	Conventional PV module Temperature (°C)	Fins Cooled PV Module temperature (°C)	Conventional PV module efficiency (%)	Fins cooled PV module efficiency (%)	Increase efficiency (%)	Percentage increase in efficiency (%)
10:00	49.1	47.1	7.1	7.43	0.33	4.64
11:00	58	55.8	6.59	6.92	0.33	5
12:00	64.4	60.5	6.2	6.39	0.19	3.06
13:00	62.7	58.9	6.5	6.65	0.15	2.3
14:00	54.5	51.6	6.9	7.12	0.22	3.18

- (i) **Change in Power with Time**-In the morning the radiation level is low, so initially the power output is low. Changes in temperature primarily follow changes in irradiance. At around 12 pm due to fluctuation in radiation and there is a period of low wind speed causing the heating of the

modules so ultimately power output reduces, but again with increase in radiation power output increases.

Fins cooled module temperature is 2-3°C cooler than conventional reference PV module.

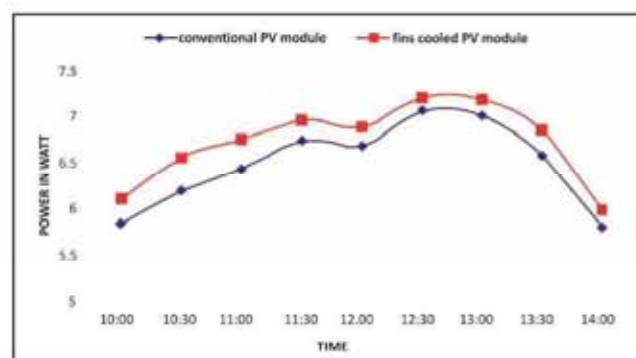


Fig No. 6.1: Graph

(ii) **Change In Efficiency with Time** - High module temperature decrease the module efficiency, which is shown in the graph below. The increases in efficiency of both

modules are 0.13% to 0.41% and percentage increase in efficiency by using the fins cooled module is 2.1% to 5.8%.

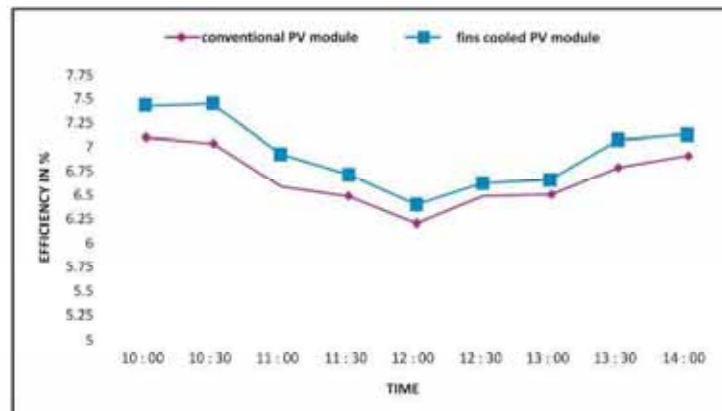


Fig No. 6.2 : Graph of efficiency vs. time

(iii) **Change in PV Module Temperature** - PV module temperature mainly depend on the sun radiation intensity. It also depends on various climatic variables. In this experiment by using the fins at back of

panel, heat transfer is increases due to natural air cooling. This is the reason fins cooled module temperature curve is always below the conventional module.

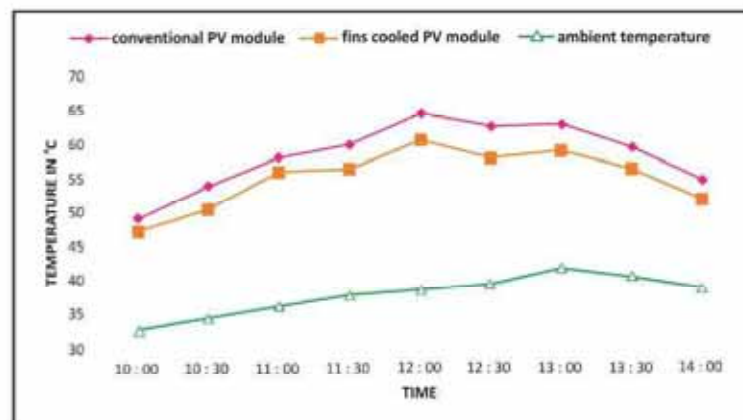


Fig No. 6.3: Graph for module temperature vs. time

(c) **Water Cooling Result** - Experimental measurements of the power and the module temperature of the PV panel is done during April 2015. Operating temperatures is reducing

significantly in comparison to a conventional reference module which is measures simultaneously with water cooled module.

Table No. 6.2 Result								
Time	Conventional module temperature (°C)	PV Fins cooled module temperature (°C)	Conventional PV Module efficiency (%)	Fins cooled PV module efficiency (%)	Increase in efficiency (%)	Percentage increase in efficiency (%)		
10:00	46.6	31.6	7.18	7.68	0.5	6.96		
11:00	56.9	34	7.02	7.86	0.84	11.96		
12:00	60.7	36	6.99	7.77	0.78	11.15		
13:00	65.7	37.3	6.68	7.81	1.13	16.91		
14:00	58	36.8	6.84	7.94	1.1	16.08		

For this system, the basic requirements are simply a submersible pump that is able to pump a continuous layer of water over panel, water distribution lines, and a tank to collect and recirculate the water. The experiment is carried out using a small, low-cost pump with poor pump efficiency. Using such a pump did not justify the use of the flowing water film in terms of energy gains within an energy balance. The cooling water flowed from 15 holes lined up over the width of modules (354 mm). This configuration utilized very less amount of the pumped water for cooling and the rest directly go into the tank.

After using the water cooling method it gives extra 6.9-16.9% of a normal module power output. In this experiment, pump is submerged in the tank and height from tank to upper edge of panel is 42 cm. So static head required to pump the water is 42 cm. With the help of pump discharge and pipe dimension, calculated frictional head loss is 0.083 m. So total head becomes 0.5 meter. For a 40% overall efficient pump and 0.5 m total head, energy input require 4-5 watt. In above experiment by using 10 watt small panel, gain in power is 0.4 to 1.243 watt which is not justify the use of the flowing water film in terms of energy gains within an energy balance. But if the higher power module (large scale) will use then with the same percentage increase in efficiency, net gain in power will be more and use of pump can be justify. One more way to justify the use of pump is to arrange PV module in arrays.

VII CONCLUSION AND FUTURE SCOPE

(a) **Conclusion** - The photovoltaic panel efficiency is sensitive to the panel temperature and decreases when the temperature of the panel increases. Results of present work shows that temperature of the panel can be control at a desired temperature level. Temperature of the PV module is also dependent on the ambient temperature. The module surface temperature has a significant effect on the open circuit voltage while it has less effect on short circuit current.

(i) **Fins Cooling** - By using this method, fins cooled module is compared to the usual system as shown in power-voltage curve in chapter 6 results. Efficiency and power output of PV module with and without fins are determined from this curve.

- The temperature difference between the finned module and conventional reference module is only 3°C to 5°C.
- Experimental result shows that increase in efficiency is 0.13% to 0.41%.
- Percentage increase in efficiency is 2.1% to 5.8%. This cooling method is more appropriate when wind velocity is high.

- (ii) **Water Cooling** - A film of water for cooling photovoltaic panel results in decreasing the temperature and reflection loss of the PV panel which increased electrical efficiency. Therefore, total energy output of the system increased significantly compared to the energy output of the conventional photovoltaic panel.
- Temperature difference between the water cooled module and conventional module is 15°C to 28°C. Increase in efficiency in case of water cooling method is 0.5% to 1.13%.
 - Percentage increase in efficiency is 6.9% in the morning (low radiation) and it is 16.9% when radiation is maximum. Thus water cooling method is more effective when radiation level is at its peak value.
 - The power required by the pump is generally substantially less than the power improvement created by the cooling effect for higher power module.

The water cooling method is significantly higher than the fins cooling method. Due to the quick flow of the water there are only minimal increases in water temperature.

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Constraints and Challenges in Deployment of Micro- Grids – A Review

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I INTRODUCTION

According to the 2011 census, an estimate of only around 56% of the rural households has excess to electricity [1]. One of India's major advantages today and going forward is that its RE potential is extensively vast and at the same time it is yet to be tapped. Recent estimates indicate that India's solar potential is greater than 10,000 GW and its wind potential is higher than 2,000 GW [2]. To fully take advantage of India's RE potential over the next few years, however, will require new initiatives from central and state governments — beyond policy and programs currently in place — to support the engagement, participation, and new behaviour of power sector stakeholders including RE industry and developers, grid operators, public and private finance, consumers, and others. In the current debate on the reform of electricity markets, in addition to "stand-alone" generators of renewable energy, the evolution of smart grids, with particular focus on micro grids, gains increasing relevancy. Smart grids enable local platforms (micro-grids) integrating locally and real-time based generation and consumption of renewable energy. The roles of consumers and producers of electricity are no longer clearly distinguished, merging into "prosumers [3]." Nevertheless, micro-grids cannot be considered as isolated commons, but still need to be interconnected with the traditional electricity networks. The potentials of smart grids are not only limited to local micro-grids, but challenge the whole infrastructure of traditional power sector. There has to be no doubt that the evolutionary path toward distributed energy and smart grids is irreversible. In order to survive, future electricity utilities should be enabled to exploit the new business opportunities not stopped by regulatory policies. With the increased adoption of electric vehicles and advanced demand-side technologies such as smart thermostats, load control switches, and home energy management systems, this capability is emerging as a major factor that can enhance the economics of residential micro-grids. Aggregated electric vehicles deployment offers large capacity energy storage in the power system. Plug-in electric vehicles further offer great potential as facilitator of demand response, especially for load shifting, via charging at off-peak hours and discharging at peak hours. The second place is Asia regions; following North America with the Revenue market share over 27.83% in 2016. Europe is another important consumption market of Micro-grid Technology. Micro-grid Technology used in industry including Campus/Institutional Micro-grid, Community/Utility Micro-grid, Commercial/Industrial Micro-grid, Military Micro-grid and Remote Micro-grid. Report data showed that 41.79% of the Micro-grid Technology market demand in Campus/Institutional Micro-grid,

24.24% in Commercial/Industrial Micro-grid, and 21.28% in Community/Utility Micro-grid in 2016. [4].

Micro-grids are now knocking the door of commercial markets, and are simultaneously undergoing. Improvements in techniques, as result of reduction in costs, growing needs and requirements owing to the benefits which might be derived by deployment. The micro-grid with its fast advancement taking place are being preferred as it gives improved reliability and resilience of main electrical grids, by integration of distributed clean energy resources like wind and solar(PV) generation to reduce conventional fuel emissions, and to provide electricity in last mile habitat areas presently not being served by centralized electrical networks. This article elaborates

- (a) Micro grid and its advancements
- (b) Today's micro-grid challenges and future prospects.
- (c) Impact on revenue and expected change in working of Electrical utilities due to future deployment of advanced micro-grids.

It is observed that as of now the world's electricity networks are Likely to undergo a transitional changes, which are Lowering the electricity costs, replacement of decaying infra-structure, improving the resilience and reliability, reduction in carbon emissions to mitigate climate change, and provide reliable power to areas lacking in strong electrical network. However the other factors responsible for fast deployment of micro-grids and the particular solution may differ from place to place. Micro-grids are the answer to complexity of transmission and pit head generations located at very far distances, for enabling the deployment of distributed energy resources which can meet the wide ranging needs of various communities from metropolitan Cities to rural and remote parts of developing countries like India.

In industrialized countries, micro-grids have to face the realities of existing features of gig watt capacity generating units, very long high voltage transmission lines, minimal energy storage, and carbon emitting fossil fuels as a primary energy source, and the deployment of Micro-grids even becomes a bigger challenge in spite of the more potential and high demand of RE integration and distributed generation there.

II RENEWABLE ENERGY/DISTRIBUTED GENERATION SCENARIO

Stakeholders involved in the road map process were very clear in identifying the key problems constraining the fast development of RE in India. Main among these roadblocks is the absence of a comprehensive and coherent national framework for RE both in the form of regulations or policy. The absence of a long-term vision as well as policy-certainty is holding back much-needed investment in infrastructure and RE integration.

Most importantly, it provides a possibility for electrification of last mile villages which are far from reach of the conventional grid. There is need of re look on need of application of DC micro-grids for rural and urban scenarios in India.

Application in rural areas as community-micro-grid is gaining momentum in India also. For urban scenario, application of the DC-micro-grid concept to attain the goal of a Zero Energy Building (ZEB) is scope of study for researchers in context of smart cities being developed in the country by Govt. of India. The deployment of micro-grids is equally important and will better results to give relief to decaying infrastructure of transmission/distribution and pit head polluting Generation for both rural and urban India [5].

The micro-grid normally consists of radial feeders which are connected to various loads, sources and storage devices. Sources can be in the form of solar PV panels, wind turbines, diesel generators and Combined Heat and Power Plant (CHP) [6]. The loads of the system can be either electrical or thermal. A micro-grid system can also have several types of storage options such as battery, flywheel, fuel cell, super capacitor storage, etc. The radial distribution network is connected to the utility grid through a separation device known as the Point of Common Coupling which is usually implemented as a static switch. The distributed energy sources and loads in the micro-grid network are controlled by the action of the Local Controllers (LC) which is mostly power electronic converters. The Micro-grid as a whole is controlled by the Micro-grid Central Controller (MGCC) which gives command signals to each of the LCs. The highlights of control methods for micro-grid invert and the importance of dynamic security has been discussed. Also, the challenges in the micro-grid for future trends have been discussed [7].

A micro-grid can be defined as a collection of distributed sources, loads and energy storage devices which act a single controllable unit and can operate either in grid connected or Is-landing mode. A more precise definition given by the Department of Energy - US describes it as "A group of interconnected loads and distributed energy resources with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid (and can) connect and disconnect from the grid to enable it to operate in both grid connected and is-landing mode". A micro-grid is "a local

energy grid with control capability, which means it can disconnect from the traditional grid and operate autonomously. A micro-grid can be powered by distributed generators, batteries, and/or renewable resources like solar panels. Depending on how it's fuelled and how its requirements are managed, a micro-grid might run indefinitely."

The micro-grid can back-up the grid or operate independently. This makes them very attractive to local communities wishing to actively participate and also take control of their power generation, as well as rural communities looking for economical besides being most robust and independent power supply.

In the continued global shift toward renewable energy generation to counter the effects of climate change, micro-grids enable communities to improve local energy delivery by providing the best of green technologies.

III MICRO GRID CONCEPT AND PRESENT STATUS

A micro-grid has several advantages as compared to a traditional grid. DER penetration on smart micro-grid based energy conservation and optimization solutions could help smart micro-grid planners and operators to adopt effective technologies according to their impacts on micro-grid feeders. Moreover, studying the impact of DER penetration could result in more accurate energy conservation and optimization solutions as, typically, conventional approaches do not take DER impact on energy conservation into account [8]. It opens a gateway for smaller, more efficient distributed generations to be embedded into the distribution network. As the generation is carried nearer to the load centres the losses in bulk power transmission are asthmatically reduced to a huge extent. The concept has drawn much attention worldwide because of the growing concerns in the environmental adverse impacts of sources of generation of conventional power.

A provision for mixed power quality and reliability is presented in a Micro-grid. The concept of micro-grid can also help in load levelling of a certain region. A wide range of energy sources are being integrated, from photo voltaic and wind-power plants to hydro-power and biomass-power plants. Electric vehicle (EV) batteries also are going to be part of the energy supply future. Intelligent control systems coordinate the energy sources, many in conjunction with bio-diesel generators, emergency power units and storage modules, to guarantee the supply of power [9].

(a) Types of Micro grid

Micro-grids can be broadly categorized in three types based on operational frequencies which are as under:

- (i) **AC Micro-grid** - An AC micro-grid system may consist of a medium or a low voltage AC distribution network. Distributed sources, storage devices and loads are connected to this AC network with or without a converter depending on the frequency ratings. Native AC generations such as diesel generators, micro turbines and wind turbines can be directly connected to the AC network without any converters. For native DC sources like PV systems, DC/AC converters are normally used. Similarly, AC loads are connected directly while for the case of DC loads, AC/DC rectifiers are required. Even though a great deal of research work is carried out in AC micro-grids, it does have some disadvantages. A few of the major problems in such network include the complexity in control and synchronization issues.
- (ii) **DC Micro-grid** - A DC system also brings about other significant advantages solving some of the control issues inside a micro-grid. For instance, synchronization of the distributed generations is no longer required and the controls are directly based on DC bus voltage. Moreover the primary control is much simpler due to the absence of reactive power flow control. And finally, most of the modern appliances also run in DC power, which provides an added benefit.
- (iii) **A DC/AC Hybrid Micro-grid** - As the name suggest hybrid micro-grids consist of AC and DC network connected together by multi- bidirectional converters. A hybrid system can reduce the number of AC-DC-AC and DC-AC-DC conversions in individual AC or DC micro-grids. Here, AC sources and loads are connected to the AC network whereas DC sources and loads are tied to the DC network.

(b) Application of Micro grid

- (i) **Rural Applications: Community DC Micro-grid** - As per the census of 2011, 46.5% of the rural households and 32.8 % of the total population in India does not have access to electricity. This amounts to around 800,000 villages in rural India [1]. A majority of the rural households rely on non-conventional inexpensive fuel sources for lighting and cooking. And around half of this population use kerosene for lighting purposes. These fuel sources not only causes environmental pollution, they are also known to have serious health implication on prolong use. With a major chunk of Indian population (around 70%) residing in rural areas where electricity supplies is still a big problem, there can be a serious.

- (ii) **Urban Applications: Zero Energy Buildings** - Even though most of the urban households in India have access to electricity, it still faces a number of problems. This includes problems of power quality, security of supply and reliability. With an ever increasing demand in peak seasons, power cuts are becoming more and more prominent even in metropolitan cities. And with more concerns of environmental pollution over conventional generations, supplying electricity to an ever increasing urban population becomes a much more challenging task. This is where the concept of Zero Energy Building (ZEB) comes in. Environment and Forest, India [10]

(iii) Global Micro-grid Market segments by Application

- Commercial/Industrial Micro-grid
- Community/Utility Micro-grid
- Campus/Institutional Micro-grid
- Military Micro-grid
- Remote Micro-grid

IV CHALLENGES AND CONSTRAINTS OF MICRO-GRID DEVELOPMENT

Challenges and constraints of Micro grid development are closely related to following factors

- (a) **Future Business Models and Economics**
- (b) **Advanced Micro-grid Technologies**
- (c) **Public Policy: Drivers and Implications**
- (d) **Value for Local and Engaged Communities**

Research Priorities for Advancing Micro-grid Deployment As global energy systems shift towards decentralization, consumers are seeking close engagement with providers, and the cost of advanced energy technologies is declining regularly. As these trends become more visible micro-grids have potential to offer benefits to utilities, communities, and industrial customers equally. The micro-grid market is charging up, provoking the regulatory agencies and governments to revise the policies and rules that can enable the cost savings and system-wide benefits of intelligent decentralized systems, while not compromising the risks to utilities and consumers. Communities seek deployment of micro-grid systems due to a variety of factors – such as more reliability in the face of extreme weather events, environmental benefits of local renewable generation, economical way of local cost-management or revenue opportunities, increased autonomy, and few more. However, developing/developed countries the electricity system has been effectively centralized for decades and this has provided us with very reliable electricity, for relatively cheap. Seminar and workshop on the subject are tasked with examining frameworks for advancing technology, business value, and public policy for clean energy micro-grids. The event featured industry and utility leaders, multidisciplinary researchers, and

community representatives coming together to discuss factors affecting deployment of smart micro-grids in any energy system and beyond, and specifically plan for future academic research. Building on the conversation taken place in the seminars at [Micro] grids today sought to build linkages between expert researchers, and the industry and utility leaders planning for deployment of micro-grids in global energy networks. The reports on the workshop discussions held worldwide and findings, and aims to develop a road map for research and deeper collaboration on smart micro-grids deployment. The attendees of such seminars explore the economic, public policy, and technical factors affecting deployment, and the

implications for both communities and utility companies. Potential Benefits & Opportunities of Community Micro-grids Resiliency Mitigating the impact of power outages due to extreme weather event, including micro-grids at community support centres. Reliability Support for overall electrical grid reliability and maximum customer 'up time' can be offered through micro-grids, at a cost. Sustainable Energy Increased ability to connect and manage intermittent local renewable generation resources, such as solar or wind with energy storage. Economic Leveraging on site distributed generation may have potential to reduce customer costs and raise the overall system efficiency.

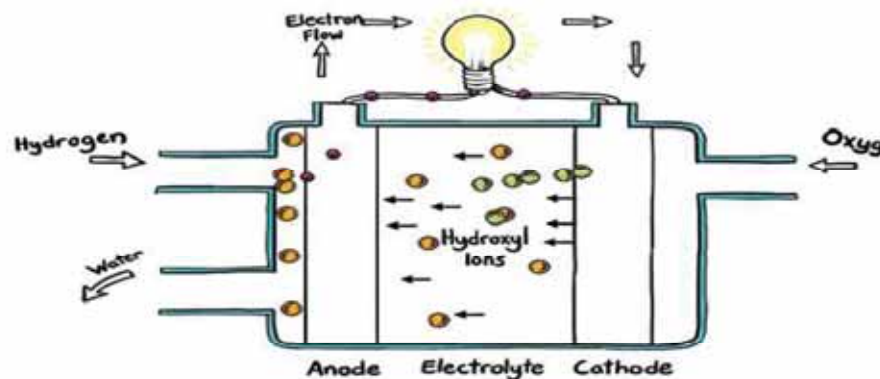


Fig No.1 Conventional Fuel cell

Regulating Renewable and Providing Energy Storage is the need of the hour. One of the inherent benefits of a fuel cell over back up power like DG set or storage batteries is its ability to go beyond just power generation by offering businesses and utilities the capability to also store energy and regulate power flow. This energy storage facility will further support the efficient working of micro-grids of the future. Larger micro-grids have several sources of power generation, normally including renewable solutions in their mix, but due to varying weather conditions, wind and solar cannot provide firm power. In steadying this power supply, fuel cells are ideal [11]. The first steps to develop smart cities are to modernize and optimize the power grid operation. Smart grid allows the integration of sustainable technologies including clean energy sources, reduced air pollution, and accessibility to city services. Energy storage installation among end-users (renewable energy generators, grid operators and distributed generation) is expected to witness larger growth due to smart grid development. The battery energy storage system (BESS) market that had an estimated capacity of 4.9 GW in 2018 and which is expected to reach 22.2 GW by 2023, according to Global Data [11]. The renewable generation integration problem can be investigated under two contexts of large-scale (which attempts to manage the generation of wind and solar farms) [12], and small-scale (which deals with renewable generation at the distribution level). Small-scale coordination approaches mainly focus on various methods of demand side management, such as demand response

and energy storage and aggregated electric vehicles [5].

V CONCLUSION

The ability of electric grids worldwide to move from largely central generation to increasingly distributed generation is arguably the most complex systems integration problem of our time. As the standard of living and economic growth of a country is directly related to availability of quality power supply, much of work is needed to be done in order to meet India's growing demands in a much cleaner and environmentally friendly manner. The economics of operation would involve optimal schedule with the diversified generation technologies used for a particular Micro-grid. The key considerations for success of Micro-Grid are development and utilization of safe and dependable communication infrastructure and control strategies. The enabling technologies used in the Smart-Grid will play deciding role in the fast development and success of Micro-grids [13]. The adoption of electric vehicles has been increasingly growing in the last few years and is set to continue. International Energy Agency (IEA) data show that the global electric vehicle fleet reached over 5.1 million in 2018 and is expected to grow to approximately 130 million by 2030 [9]. The electricity sector is changing rapidly and the grid is changing with it. That will continue no matter what. The question is whether to reinforce and enhance the current grid architecture or to allow the major change and build new one. [14].

And with an ample amount of renewable potential available in the country, the odds are on the favourable side. The article explores the possibility of incorporating these renewable generations in rural and urban India using the concept of micro-grids as distributed generation. And from the discussions it can be concluded that micro-grids have in fact may gain popularity with adopting technological advancement in the field and making major changes in regulatory policies for making the local utilities to support for enabling more and more integration of Renewable power and adoption of concept of distributed generation to achieve improved reliability and resilience of main electrical grids, and reduction in costs besides fulfilling the goals of reduction in carbon emissions. Basically, a grid-scale battery with a modern power inverter/converter is an instant micro-grid all by itself. Coupling micro-grids to meet demand-side flexibility is a problem that must be solved. This will require new technology, new regulations, and new business models, and the smart grid to perform new tasks it was designed to do but has never done before at scale. Micro-grids are inching their way into the mainstream, though most are being deployed by non-utility vendors for third parties. Growing interest in and regulatory support for community micro-grids—as well as micro-grids designed to bolster the overall distribution system—are opening the door for utilities to play a larger, as yet mostly undefined role in the deployment of micro-grids.

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Sentiment Analysis from Customer Reviews – A Survey

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ABSTRACT

Today reviews of the customers on any product or services are highly recommended and appreciated by the online users to come up with a decision. Sentiment and opinions made by a person can influence the perceptions of the other. The extensive use of internet and the growth of web services among the people also created an enormous data in terms of the reviews towards certain services or products. That data can easily be accessed worldwide and assist an individual to create his own viewpoint. The key objective of gathering opinions of the customers is to assess the quality and other parameters of products and services. This paper proposes a methodology for the analysis of sentiments by classifying the feedbacks. The proposed project also reviewed the existing systems, which projects the technique of sentiment analysis.

Keywords-Sentiments, reviews, opinion mining, customers.

I INTRODUCTION

These days, either the services or the products offered by any firm needs an opinion from their customers to enhance the quality of the product or the services provided by them. There are number of vendors available in the market to offer various online services. Reviews of the customers will not only assist those vendors to improve the quality of services provided by them but also help other customers to know about them and come up with a cumulative decision. There are several websites, different forums, blogs and social media application available, which offer the facility of reviewing the product or services provided by them. The feedback given by a particular customer can be randomly read by other customers and accordingly make opinions about that particular product or services. As the reviews about any particular product or the services rendered are higher in number, their opinions will vary too. This may lead a confused and impartial opinion towards that product or service. Opinion mining for sentiment analysis is an effective technique, which extracts the information by text processing and improves the decision making of a customer while using any online services. Customer's reviews are sometime biased, as their ratings and comments are not so coordinated. The proposed research focuses on the analysis of reviews made by the customers and uses the approach to analyze the sentiments. This will create a classification of reviews as positive, negative and neutral, which is known as sentiment polarity [1].

(a) **Classification of Existing Solutions** -Prior work done on sentiment analysis can be distinguished in terms of different factors like; used method, textual view, level of extraction of details from textual analysis, review and rating level etc. Technically, there are three different approaches widely used for sentiment analysis.

(i) **Machine Learning Approach** : Machine learning approach is used to analyze the sentiment by using supervised techniques which needs to get trained in different

preferable domain and the approach uses various algorithms of learning. On the other hand statistical unsupervised learning do not require any prior training and can be dynamically used but at the stake of precision.

(ii) **Lexicon-Based Approach**: This kind of approach computes the polarity level of the sentiments from the reviews of the customers or the users using the semantic notation of words or sentences mentioned in any of the given opinions or reviews. Semantic Opinion is nothing but a calculation of outlook in terms of opinion in the mentioned text and the subject.

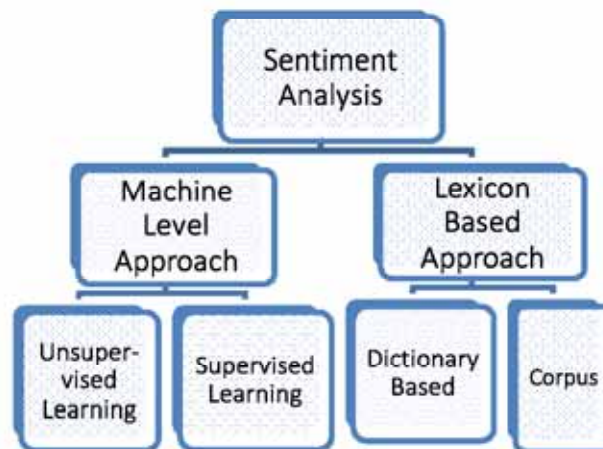
(iii) **Statistical and Rule-Based Approach**: This type of approach analyzes the opinion in terms of words mentioned in a text and distinguishes it depending on the number of positive words and negative words. There are different rules taken into consideration for this approach like dictionary polarity, negation words, booster words, idioms, emoticons, mixed opinions etc.

(b) **Rating Levels**:

(i) **Aspect Rating**

(ii) **Global Rating**

A method can be classified based on two parameters. Computing the strength of the sentiments from various aspects of the services and the products provided by the merchant is considered as the aspect rating, whereas the technique used to rate services and products worldwide at the global level comes under the global rating where throughout the world people can review or read the reviews of certain products or the services. Many services prefer global rating of reviews, which takes mere the polarity of the opinions in terms of positive, or negative and processed on machine learning platform. A technique, which focuses on thorough categorization of ratings (like 4 stars out of 5), needs more linguistic methods, which include different structures. Figure No. 1 shows the categorization of presented methods.

**Fig No. 1: Sentiment Classification**

(c) **Tools for Sentiment Analysis:** There are various tools available for the analysis of sentiments and study the opinions given by users through their ratings and reviews. Commonly used systems consist of different

tools to analyze those reviews from different aspects and parameters and conclude it in the category of positive or negative reactions. The Table No. 1 gives the categories of the tools available and their purpose in the system.

Table No. 1:
Tools for Sentiment Analysis

TOOLS FOR SENTIMENT ANALYSIS	TECHNIQUES USED BY TOOLS
EMOTICONS	Emoticons contained in the Text
LIWC	Dictionary & Sentiment Classified Categories
Senti Strength	LIWC Dictionary with new features to strength & weak sentiments
Senti Word Net	Lexical Dictionary & Scores Obtained by Machine Learning approaches
SenticNet	Natural Language Processing Approach for inferring the polarity of semantic level
Happiness Index	Affective Norms for English Words (ANEW) & Scores for evaluating happiness in the text
AFINN	Affective Norms for English Words (ANEW) but more focussed on the language used in microblogging platforms
PANAS-4	Eleven sentiment psychometric scales
Sentiment140	API that allows tweets classifying tweets t Polarity classes, positive, negative & neutral
NRC	Large sets of human provided words with their emotinal tags
EWGA	Entroy weighted genetic algorithm
FRN	Feature relation network considering syntatic n-gram relations

II LITERATURE SURVEY

(a) Review on existing systems:

Shraddha Mehta et. al. [2]

This paper proposed a method to analyze the rate of success of a movie. For this, an algorithm of ID3 classification was used to create the conclusive rules. The produced conclusions were utilized to calculate the rate of success of a movie. The obtained result was further utilized by the researchers of that field to recognize those movies, which may underperform at

the box office. But while using the ID3 algorithm, at a time, single test was being executed which increased the decision instance. Even small testing resulted in an over classified set of data and the classification of constant data increased the expenses of calculation.

Jingbo Zhu et. al. [3]

Traditionally, to obtain the reviews of the customer about the centered product or services, a series of questions were generated to study the satisfaction rate of the customers who were served. For this, opinion

polling was done. The proposed paper uses the method of aspect based bootstrapping to study the opinions of the customers which neither needs any review in textual form nor any customer to reply the question generated to check the service quality. The proposed algorithm studies aspects to identify and creates segmentation of multi aspect sentences. In the proposed survey, system achieved 75.5% of accuracy during polling. However, the proposed technique does not offer guarantee of the taken samples and fundamentally enhances the load of calculation.

Xiaohui Yu et. al. [4]

The proposed technique in the paper is concerned about the data obtained by developing algorithms and methods, which is useful to gather the information captured from the reviews of the customers. The proposed model has the capability to forecast the upcoming sales of any product, which leads to the steps taken by the stakeholder. A case study is organized for the domain of movies and studies the issues for the prediction of the performance of sales. The analyzed result obtained observes that the sentiments shown in the reviews and their quality have a considerable impact on the upcoming performance of sales of product. While considering sentiment factor, Sentiment PLSA(S-PLSA) is developed and to enhance the accuracy of prediction. Here, the system takes quality factor as a parameter. Though the completely proposed system only uses S-PLSA, it can be implemented in many other scenarios to enhance the performance. For future work, they aspire to discover their role in clustering and differentiation, which is based on the sentiments.

Guoshuai Zhao et. al. [5]

The paper proposed a method, which emphasizes on the user's reviewing manners by taking four parameters related to social network, which are of personal interest of user, interpersonal interest similarity, interpersonal rating behavior similarity and interpersonal rating behavior diffusion [5]. The proposed method of scheduled rating shows the reviewing and rating behavior of the users. The author surveyed the completely social circle of the users and differentiates them into three categories direct, indirect and mutual friends to analyze the rating behavior diffusion [5]. All the resultant factors are taken into consideration to enhance the precision and implementation of the predictions. Taking these factors to explore the rating behavior of the users will also increase the junk information in the database and increased parameter to analyze the behavior may end up with the biased results.

Muhammad Taimoor Khan et. al. [6]

Thorough study and deep analysis of the issues by using ML (machine learning) based technique shows that SA (Sentiment Analysis) and NLP (Natural Language Processing) have some drawbacks, which cannot control the used method. As in the method of NLP, sentiment analysis faces issues like co-reference resolution, negation handling, and word sense disambiguation etc.[6] includes more problems

because of the variations in the considering factors. It has been observed that the method of SA (Sentiment analysis) is nothing but highly constrained NLP problem because the trained system is not efficient enough to identify with the semantics of every word. Complex network analysis is one of the frequently used method for various issues and able to show constructive patterns in subjective text [6]. Machine learning classifies in supervised and unsupervised techniques. Supervised techniques need to be trained in some applicable platform or domain and are more precise. Unsupervised techniques are already trained and are proficient in dynamic environment but at the cost of precision [6].

Silvana Aciar et. al.[7]

Examining the features of a movie by using the technique of machine learning is comparatively unexplored technique to predict the success rate. By taking into consideration, the collected data turns into useful information not only in the interest of the producers and financiers but also the service providers and the viewers. Mostly the existing work emphasizes user specific preference and examines the reviews of the movies [7]. Due to the relevance of huge number of factors and attributes with the success of a movie, various works have been already done in this field. The classification model developed in the proposed paper shows effective results in prediction of the ratings of movies before their release based on movie information database (IMDb). The proposed method also approaches to mine unstructured data from movie [7].

III PROPOSED METHODOLOGY

This study aims at

- (i) Exploring how sentiment analysis and opinion mining strategies can be applied to textual reviews to extract semantic orientations on products, events; and to demonstrate how these opinions can be used for trend detection and knowledge discovery.

The study proposes following objectives:

- (ii) To conduct a literature survey on sentiment analysis strategies and identify suitable domain for analysis domain (like iphone6, laptop).
- (iii) To develop language analysis strategies that are applicable to pre-process text content from social media.
- (iv) To compare the proposed model with existing ones and to evaluate the usefulness of processed knowledge.
- (v) Customers are mainly nontechnical persons. Therefore, the method aims to envision results in legible format like graphs, charts or summary.

IV CONCLUSION

Effective sentiment analysis algorithm/ modules for the Aspect based Sentiment Analysis and visualization of textual feedback will be developed.

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Buying Behavior of the Investors towards Mutual Fund

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ABSTRACT

Indian financial market is constantly getting aggressive. The changes in the financial instrument are required to maintain the equilibrium in the demand aspect of the investor. Investors were need of the instrument which satisfies their objective and motto of the earning maximum return with the low risk. Mutual fund is the solution to the investor which provides the opportunity of investing with low risk. The proposal provides new insight to the investor. The data was collected from the people living in Udaipur. A sample of 201 was considered for applying various tests. The reliability and Validity of the data is checked to apply various test like Factor analysis, Regression, Correlation. The research focuses on various factors like liquidity, alertness, experience and demographic. The study concluded that people are aware about the mutual funds still they are not investing in mutual funds because of their bitter past experience, lack of knowledge, lack of confidence, difficulty in selection of scheme, inefficient investment advisors. Various factors like risk, liquidity, mode of investment, schemes of the investment, safety, profitability, satisfaction and Income will affects the investment decision.

Keywords: Financial Instruments, Investors' Decision, Risk Return

I INTRODUCTION

In year 1822 King William of Netherland came up with the first mutual fund in the world "Societe Generale de Belique". Investment in the mutual fund is not a new concept. The concept emerges in India when UTI was setup in 1964 by an act of Parliament. India have world highest saving rate which is over 23 percent. The highest saving rate will not lead to the economic development of the country. Government has channelized the ideal and unproductive saving in currency or physical assets for economic development. It has lead to establishment of Mutual Fund Industry. The remarkable change was witness during the eighties and nineties. The seeds of change was penetrated by Sri T. Krishnamachari understood the need of catalyze the saving of household. Mutual fund is a lake of money with different investment goals and objective. . Mutual fund helps in channelizing the saving of the small investor. The objective of the individual helps in deciding the scheme and pattern of investment. Every individual across the globe are investing in the securities as it diversify and reduce the risk. Mutual funds are fruits for the investors who are not able to direct the saving towards wealth maximization. It is trusted pools which attract many people to accomplish their goals. In last 10 years Industry has seen six fold increments in AUM. Many Indian people are still away from the mutual fund industry due to inadequate knowledge, fear of losing money etc. Still for retail investors it is the favorite and adopted practice in India. There is around 44 AMCs which are operating in India and the number is rising with the several merger and acquisition. Mergers with the foreign mutual funds have enlarged the houses of mutual fund. A static

growth is seen in the mutual fund industry by the entry of private as well as commercial players. In order to regulate the industry SEBI (Securities and Exchange Board of India) was formed with the objective of protecting the interest of investors, regulate and develop the security market. The trust in the regulatory body has built a strong foundation for the industry. Various factors like risk, return, liquidity, consistency, knowledge which affects the investor decision.

II LITERATURE REVIEW

Warren Buffett said "Risk comes from not knowing what you are doing". Investment is the process of forming the cash in both financial and real assets. Investment is the coin with two faces risk and gain. Higher risk leads to higher the gain. India is having 23 percent of the saving rate which is much greater than other country all over the world. The higher ratio of saving doesn't lead to develop the economic development of the country. The pattern of holding the saving should be changed and diversified which will create a ideal and unproductive funds into productive funds. The government has taken the steps towards the mutual funds to channelize the funds for the economic development of the country. Priyanka Sharma and Payal Agrawal (2015) study reveal that perception of the investor is totally dependent upon the demographic factors. The demographic factors affect the investment decision of the investor. Liquidity and transparency has a higher impact in selecting an investment.

Parihar B B S, Sharma R and Parihar D.S (2009) analyzed the age, gender and income of the respondent with their attitude. Desigan G, Lalaiselvi S and Anusuya L (2006) studied the perception of women investor and concluded that they hesitate to invest in mutual funds as they lack knowledge and have a fear of loss. Another researcher Peggy D Dwyer, James H Gilkenson and John A List (2001) stated that women are less risk taker and have less preference to invest in mutual funds.

Binod Kumar Singh (2012) investigated the impact of demographic factors which affect their investment decision. In 2011 SimranSaini and BimalAnjum studied the types, objective, level of satisfaction and challenge to understand the perception of the consumer. The study of R. Vasudevan & Peermohaideen (2012) stated that investor anticipate the risk as a underperformance of the funds and also states that risk and return of the investment is medium which doesn't provide much satisfaction to the investors. Singh and Jha (2009) studied the awareness & acceptability of mutual funds and concluded that people are more moving towards the mutual fund scheme as they provide better returns as well as liquidity to withdraw the cash as and when required. D. Rajasekar (2013) concluded the study by taking various parameter which are involved in decision making and influence the perception of the investor whereas Vipin Kumar & Preeti Bansal (2014) found that maximum number of investor are dependent upon the agent and brokers to invest in mutual fund. Subramanya PR (2015) found the correlation between demographic factor and saving habit of the investor which stated that age of the people plays an important role in saving habit of the person. Young age people are less concern about saving as compare to the middle and upper age people.

Mukesh. H. V.(2015) had analyzed the perception of the people related to return, SIP, tax benefit and capital appreciation and found that they are not aware about the benefits of investing in mutual funds which will help in taking tax benefit. Preeti Khitoliya(2014) found that people of age group 35-44 who are intended to invest in the mutual funds at moderate risk and a similar flow is seen in mindset of 25-43 age group people but a opposite trend was seen in the mindset of the people who are above the 45 age

group. Their need is to have a guarantee and safety return on the principal amount which balance and grow the funds. K.Lakshman Rao (2011) founde that people of age group less than 20 and greater than 60 are unaware about various plans and scheme of the mutual funds. The unawareness leads to reduction in the number of investor. The investors are comparative less as compare to 31-50 age groups.

Singh and Jha (2009) studied the awareness and acceptability of the mutual funds and level of awareness for the Systematic Investment Plan and found that the preference for the mutual fund is because of the potential return, safety and liquidity of the funds but still people lack the awareness for the SIP scheme and plans. V Rathnamani (2013) investigated the investors and found that investors invest with the motto of having higher gain at low risk, safety and liquidity.

III OBJECTIVE OF THE STUDY

Researcher aims at knowing the perception of the people for the mutual funds. Objectives are framed to know the various factors that affect the mutual fund industry. The research was outlined to find the answer of following:

- (a) To analyze the factors that influences the investors' choice for mutual funds.
- (b) To study the effect of demographic variable on their investment pattern.
- (c) To study the level of awareness for mutual funds.

On the basis of above objective hypothesis are framed:

H01: Risk, Liquidity, mode of payment, scheme, profitability, satisfaction, safety and Income has a direct impact on mutual fund purchase decision.

IV RESEARCH METHODOLOGY

- (a) **Sample Characteristic:** A sample of 201 is drawn to conduct the study that are of different gender, age and occupation. The descriptive analysis was performed with the SPSS V.24 software.

Table No. 1
Demographic Variables

Gender		Frequency	Percent	Cumulative Percent
	Male	132	65.67%	65.67
	Female	69	34.33%	100.0
	Total	201	100.0	
Age		Frequency	Percent	Cumulative Percent
	0-20	12	6%	6.0
	20-40	96	48%	54.0
	40-60	80	40%	94.0
	60 & above	13	6.46%	100.0
	Total	201	100.0	
Area		Frequency	Percent	Cumulative Percent
	Rural	51	25.5%	25.5
	Urban	90	45%	70.5
	Semi urban	60	29.5 %	100
	Total	201	100	
Income		Frequency	Percent	Cumulative Percent
	Below 500000	46	22.9	22.9
	500001-1000000	96	47.8	70.6
	Above 1000000	59	29.4	100.0
	Total	201	100.0	

***Source: Author has calculated value via SPSS on the basis of data collected**

- (b) **Measure:** A structure questionnaire was designed on the basis of Likert five scales to measure the factors which affect the investor decision in investing mutual funds. The seven factors were studied risk, mode of investment, scheme, profitability, satisfaction, safety, Income which affect the investment decision.
- (c) **Procedure:** The study has shown on the basis of the response collected from respondent. The random sampling method was used to collect the data. The respondents are from Udaipur (Rajasthan). Various Statistical tools like Correlation, Regression, and Reliability was applied on the data with the support of SPSS

V.24. The reliability of the data is analyzed which lead to next of factor Analysis where various factor responsible are identified. Multi Regression was applied to check the factor responsible for investment decision.

V RESULT AND DISCUSSION

In order to determine the important factors which have a positive impact on investor mind, a multi regression analysis was applied with the help of SPSS v. 24 software. In order to move to the multi regression step, the first task is to determine over all reliability of the data. Reliability is shown in table 2

Table No. 2
Reliability

Cronbach's Alpha	N of Items
.688	7

***Source: Author has calculated value via SPSS on the basis of data collected**

Reliability of the data is checked by the Cronbach's Alpha. Nunnally 1967 stated that reliability is acceptable when it is greater than equal to 0.6 but less than equal to 0.9. In this case the reliability is 0.688

which is lying in good category. It satisfies the first assumption of reliability. Table no 3 and table 4 displays the factor analysis.

Table No. 3
Rotated Component Matrix

	1	2	3	4	5	6	7
Scheme of Investment	.652						
Risk on Investment		.689					
Mode of Investment						.689	
Satisfaction of Investor					.501		
Profitability on investment				.797			
Safety of investment			.501				
Income							.750
a. 7 components extracted.							

***Source: Author has calculated value via SPSS on the basis of data collected**

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.614
Bartlett's Test of Sphericity	Approx. Chi-Square	55.168
	df	15
	Sig.	.000

***Source: Author has calculated value via SPSS on the basis of data collected**

Table No. 4
Multi- Regression on various factors which affect investment decision:

Descriptive Statistics			
	Mean	Std. Deviation	N
Purchase Intention	1.20	.404	201
Scheme of Investment	3.01	1.398	201
Risk on Investment	1.75	.747	201
Mode of Investment	1.60	.492	201
Satisfaction of Investor	1.33	.471	201
Profitability on investment	2.12	.725	201
Safety of investment	1.96	.871	201
Income	2.62	1.071	201

***Source: Author has calculated value via SPSS on the basis of data collected**

The data is non- multi collinear which satisfy the second assumption of multi regression. The value is higher 1.128 which is below 5.00 reveal that data is not multi collinear and multi regression can be used.

The regression model has given 7 independent factors Purchase Intention, scheme of Investment, Risk on Investment, Mode of Investment, Satisfaction of Investor, Profitability on investment, Safety of investment, Income entered as it explains 55 % of the variance which has an impact on investment decision. The standard error of the estimated is reduced to .393, which means at 95% level.

Table No. 5
Correlation

	Purchase Intention	Scheme of Investment	Risk on Investment	Mode of Investment	Satisfaction of Investor	Profitability on investment	Safety of investment	Income
Purchase Intention	1.000	.083	.186	.038	.172	-.084	.180	.124
Scheme of Investment		1.000	.071	.220	.091	.102	.103	.284
Risk on Investment			1.000	.270	.177	-.028	.115	.143
Mode of Investment				1.000	.099	.108	.021	.133
Satisfaction of Investor					1.000	-.057	.191	.003
Profitability on investment						1.000	.126	.027
Safety of investment							1.000	.246
Income								1.000

Significance (One tail test)

Purchase Intention	.	.120	.004	.295	.007	.119	.005	.040
Scheme of Investment			.160	.001	.099	.075	.073	.000
Risk on Investment			.	.000	.006	.347	.051	.022
Mode of Investment					.080	.064	.385	.030
Satisfaction of Investor					.	.211	.003	.484
Profitability on investment							.037	.352
Safety of investment							.	.000
Income								.

Source: Author has calculated value via SPSS on the basis of data collected*Variable Entered/ Removed**

Model	Variables Entered	Variables Removed	Method
1	Income		Enter
	Satisfaction of the investor		
	Profitability		
	Mode of Investment		
	Risk		
	Scheme of investment		
	Safety of the investor		
a. Dependent Variable: VAR00005			
b. All requested variables entered.			

***Source: Author has calculated value via SPSS on the basis of data collected**

All the values are significant thus it reveal that data is normal and it is followed by normal distribution, Table 6 (a,b).

Table No. 6
a Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			
						F Change	df1	df2	Sig. F Change
1	.297 ^a	.088	.055	.393	.088	2.672	7	193	.012
a. Predictors: (Constant) Scheme of Investment, Risk on Investment, Mode of Investment, Satisfaction of Investor, Profitability on investment, Safety of investment, Income									

Table No. 6
b Annova

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.884	7	.412	2.672	.012 ^b
	Residual	29.753	193	.154		
	Total	32.637	200			
a. Dependent Variable: Purchase Intention						
b. Predictors: (Constant), Scheme of Investment, Risk on Investment, Mode of Investment, Satisfaction of Investor, Profitability on investment, Safety of investment, Income						

*Source: Author has calculated value via SPSS on the basis of data collected

The ANNOVA analyses provide F Ratio which prepare the overall model fit. The sum of Square is 32.637 is the squared error that would accrue if the mean of the factor used to predict the dependent factor (investment decision). The above analysis conclude that Scheme of Investment, Risk on Investment, Mode of Investment, Satisfaction of Investor, Profitability on investment, Safety of investment, Income factors have a impact on investment decision.

A significant change has been seen in the mutual fund industry. The mutual fund has provided ample of offering to the investors to increase the number of investors. Still the numbers of investors are comparative less than other foreign company. Mutual funds are still in the struggle stage to attract and gain more investors. Mutual funds provide the flexible to the investor. Option like Systematic Investment in which investor can save small amount of money and can invest them same as Recurring Account where as in Lump sum a amount is being invested for certain time and period. The study stated that investor are more interested in SIP as it create a big corpus by investing small amount on regular basis. Business comes up with the risk in the same way mutual funds also come up with the risk but the amount of risk is less than the amount of profit earned. People are awareness about the mutual funds and its benefit but still due to bitter past experience, lack of knowledge, lack of confidence, difficulty in selection of scheme, inefficient investment advisors are not investing their money. Various schemes are available open ended, close ended, liquid fund,

Midcap fund and Growth fund to the investor to select as per the objective and motive of investing in Mutual Funds. People are still have the perception that mutual funds are risky if the stock market goes down they will face loss. It is very important to remove the perception and clarify them all the details very properly. Financial instrument are working hard to capture every sector and people of the society which will provide the profits to the investors and industry will be boom up. Organization should try to create more awareness and educate through various modes like advertisement, campaign, publicity, awareness program. Benjamin Disraeli rightly said "The secret of success is constancy of purpose". The industry can grow in the market when they satisfy the need and wants of the investor because a satisfied investor will form a chain of more investor.

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Retail Loan Trends over Last Decade & Study of Factors Affecting Them

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ABSTRACT

Retail Banking remains one of the niche segments of Banking Industry. It basically caters to providing banking services to Micro Small and medium Term Enterprises (MSME's) and Individuals. Interest Based and Non Interest based financial services are provided over to customers as means to generate net income to the bank. Accepting Deposits and granting loans to and from customer provide interest incomes, which are often their main stay of Net income generated. Retail loans and their customer preferences have been subject to changes with changes in social environment, change in demographics, change in family patterns and increase or decrease in people's purchasing power and several other factors over the last two decades since liberalization of Indian economy. The Objective of this chapter is to study the trend analysis of retail loan values outstanding by the Public Sector Bank's over last decade 2007-2017 and highlight what are the factors that are causing the aforesaid trends. The study shall conclude by highlighting the future outlook and necessary recommendations to bank for necessary actions to provide synergy in retail loan facilities, factors affecting them and customer needs.

Key Words: - Retail Loans, NPA, Demonetization, Interest Rate Scenario

I INTRODUCTION

Banking industry, in today's day and age encompasses various business segments in itself, like providing banking services to corporate, wealth management, capital market operations and investment banking.

A noteworthy and interesting segment which has huge revenue potential is the segment of Retail banking. Retail banking segment is characterized by a huge client base and a huge volume of transactions. Banks, its employees, retailers, customers and consumers are highly connected in this banking segment.

Keith Pond Defines Retail banking as "The offering of banking and other financial services to individuals and micro, small or medium-sized enterprises (MSMEs)" Retail banking refers providing banking services to small businesses and individuals, with high volume of low value transactions. Retail Loans are referred to as the loans which are taken from retail lenders and these lenders are those who work with individual as compared to institutionalized lenders who give loans to big organizations and corporations. These retail lenders include organizations such as banks, credit card companies, credit companies and loan financiers.

Retail banks offer various Services. These like account opening, credit card, debit card, ATM, internet banking, phone banking, insurance, investment, stock broking and so on.

Current & saving accounts (CASA) and home loans advances (e.g., personal, housing, auto and educational), are the vital items offered by banks. Related subordinate administrations include credit cards or vault administrations. These are often categorized into Interest based services and Non Interest Based Services. Sheer Quantity of low volume transactions, complimented by multiple products, multiple channels and multiple customer groups characterize Retail banking. This multiplicity

and Diversity is both an advantage as well as challenge, faced by retail bankers.

This is in sharp contrast to whole sale banking segment where multinational companies, governments and government enterprises and the financial institution are the customers and deal in low quantity high value transactions.

The Importance of Retail lending can be understood by the fact that retail loans now constitute a whopping 30 % of all loans given by banks. The percentage of retail loans for NBFC's stood at 35%.

II RESEARCH OBJECTIVE

The intention of this Study is to critically analyze the trend in retail loan values over the last decade, i.e. from 2007 to 2017 and the varied factors which are responsible for the trend values. Thus we can find out the trend of personal finance which indicates the status of economy over this period. Retail Lending done on the basis of Credit worthiness principles of Loan taker, Sound Collateral Guarantee, Profitability on Investment in terms of interest rate difference between lending loans and taking deposits, Risk Diversification and mitigation in terms of varied outreach of loan given in terms sectors allotted. These internal factors are affected and influenced by host of external macroeconomic and other factors.

III REVIEW OF LITERATURE

The data base of Indian economy: the data archives website of reserve bank of India gave the values for the Retail loans for the ten years i.e. from 2007-08 Financial Year to 2017- 2018 financial year. The Work of Lewis R. Barbara., Pond Keith etc provided conceptual clarity about Retail loans [1] and RBI report provided by Shyamala Gopinath provided inputs on the Challenges to retail Banking in India. [3]

The varied macroeconomic and other factors that affect the internal lending policies of banks have been part and parcel of the changes in last thirty years across the world in banking domain. Latest technologies have arrived, transactions are automated and digitalized, and of course customer is the king.

In-fact the demarcation between various segments of banking has become very blurred. Sociological and demographic changing trends have necessitated the need to service customers with technology intensive applications and interface, improvised customer services and banking convenience. Higher technology reach and increased digital literacy levels have increased expectations of Indian customers. Accessibility and pace of innovation in digitalization is increasing and cyber security has become a Prime issue for all digital transactions.

Lewis R B. states that cutting operating cost by adopting secure and scalable technology with effective implementation helps to reduce the response

time to customers. [1] This shall also lead to increase in client base and economies of scale.

The challenge in this sector seems to be an inclusive approach with innovative products and minimum dependence on branches, i.e. to have a multi-channel approach to reach out to customers and keep them informed about various services being offered by bank.

IV RETAIL LOAN TRENDS

According to latest RBI Data, The Indian banking system consists of 21 public sector banks, 21 private sector banks. Apart from this, the banking ecosystem, 45 foreign banks, 56 regional rural banks, 1,562 urban cooperative banks and 94,384 rural cooperative banks, also operate in addition to cooperative credit institutions. In FY07-18, total retail lending was 5217.99 Cr Rs which increased to 19084.69 Cr Rs in FY 2017-18, an increase of 265 %. Thus, it comes as no shock that India's retail credit market is the fourth largest in the emerging countries.



Fig No. 1 Increase in Total Retail Loans & Growth over Last ten Years (Source RBI: DBIE)

The following graph (Fig.1) shows the increase in trend in Retail Loans by Public Sector Banks from FY 07-08 to FY 17-18. The Trend is representative of the contemporary times where by Indian economy has shown a positive trend in spite of Global recession of 2008-10 and Domestic Disturbances caused as a consequences of Demonetization and GST.

Looking at the Deeper Trends These Salient Points Emerge from the value of Retail loans from Database of Indian Economy; RBI data archive

(a) Housing Loan

This remains the biggest segment for retail loans. Countering almost 50 % of the total retail Loans. The percentage of housing loan increases from 50 % of total retail loans in FY07-08 to 51% FY17-18. See Fig 7 & 8. In absolute terms the housing loan increases from 2603.06 Cr Rs in FY07-08 to 9745.63Cr Rs in FY17-18, and steep increase of 274 %. (See Fig. 2)

In absolute terms the housing loan increases from 2603.06 Cr Rs in FY07-08 to 9745.63Cr Rs in FY17-18, and steep increase of 274%. Fig 2 Shows the Growth in Housing Loan Segment.



Fig No. 2 Increase in Total Home Loan segment. Growth over Last ten Years (Source RBI: DBIE)

- (b) **Consumer Durable Segment-** As Compared to Other Segments, The relative share of Consumer Durable loan segment has decreased in proportion of total retail loans from 2 % in FY 07-08 to only 1% FY 17-18. See Fig 7 & 8. In absolute terms, as Fig. 3 Shows their growth has shown only a moderate increase of 100%, i.e. from 97.97 Cr Rs in FY07-08 to 197.03Cr Rs in FY17-18.
- (c) **Education Loan Segment-** This segment has only shown growth in absolute number rising from 205.32 Cr Rs in FY 07-08 to 697.12 Cr Rs in FY 17-18, almost an increase of 200 %. The Fig.4 illustrates the absolute growth in this

segment. The relative proportion of Education loan segment in the total retail loans category remains a measly 4 %, throughout the decade. See Fig 7&8 for comparison.

- (d) **Vehicle Loan segment-** This is a segment which has shown an absolute growth of 223 % rising from 568.22 Cr Rs in FY 07-08 to 1897.86 Cr Rs in FY 17-18. Overall its share in the retail loan proportion as decreased from 11% to 10% of overall retail value. This loan curve growth can be traced in Fig.5 and since this sector is directly affected by consumer and market economy, It shows a bumpy ascendancy rise and choppy behaviour.

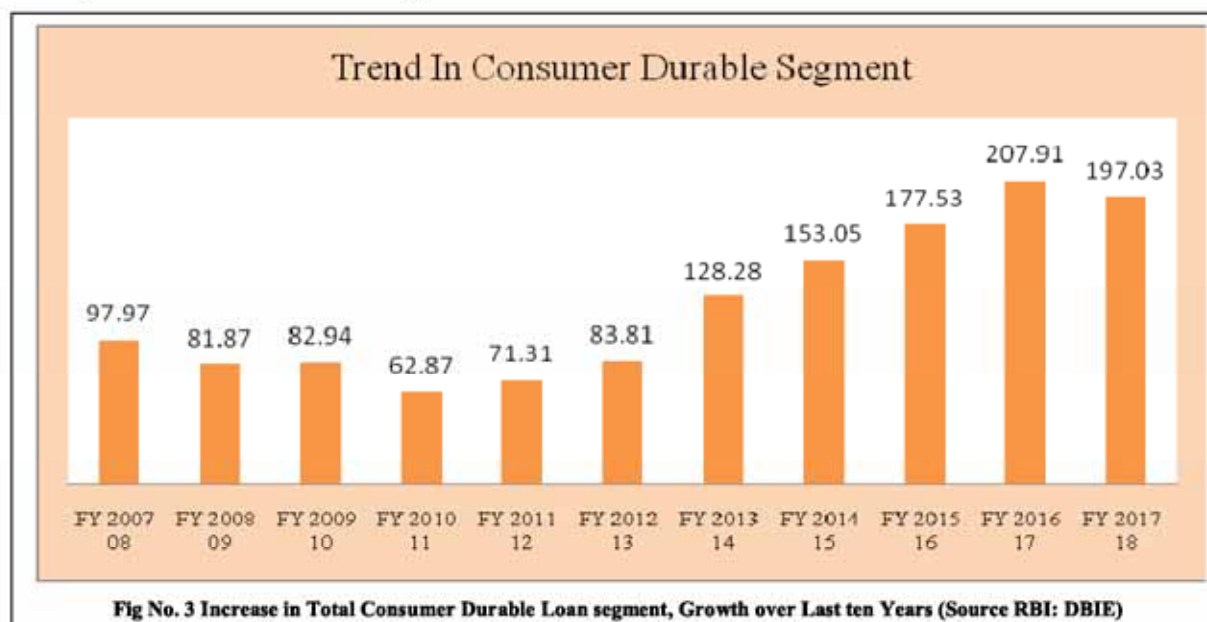
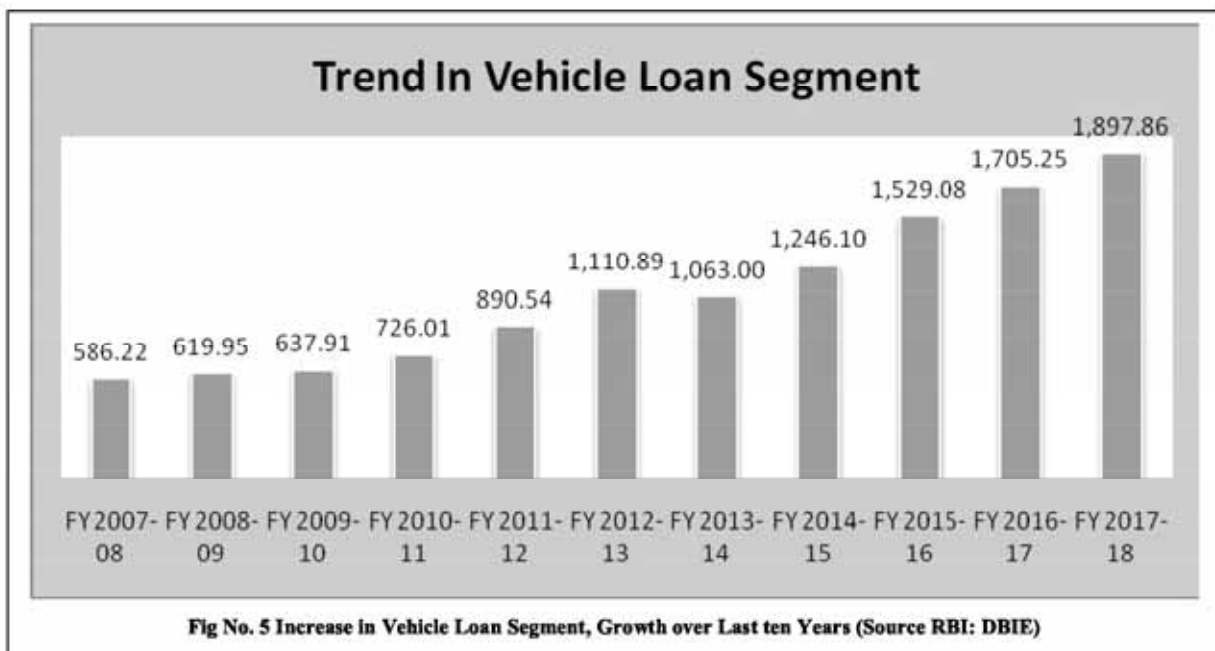
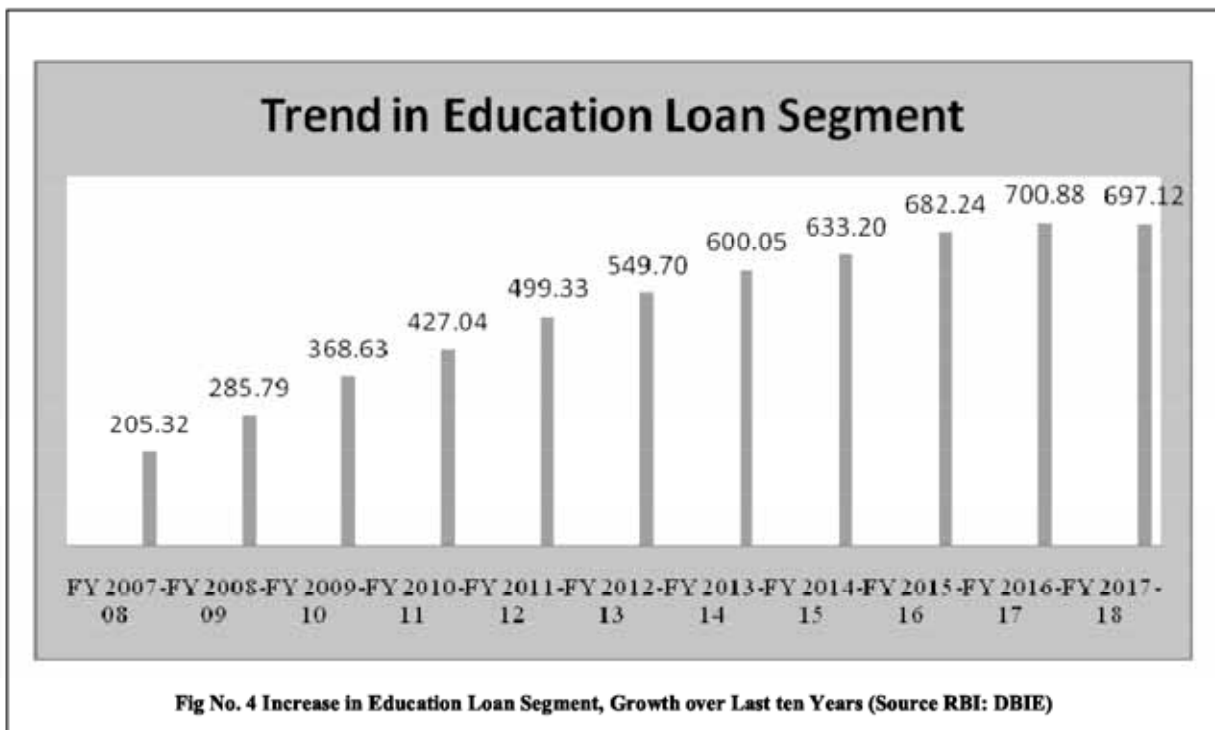


Fig No. 3 Increase in Total Consumer Durable Loan segment, Growth over Last ten Years (Source RBI: DBIE)



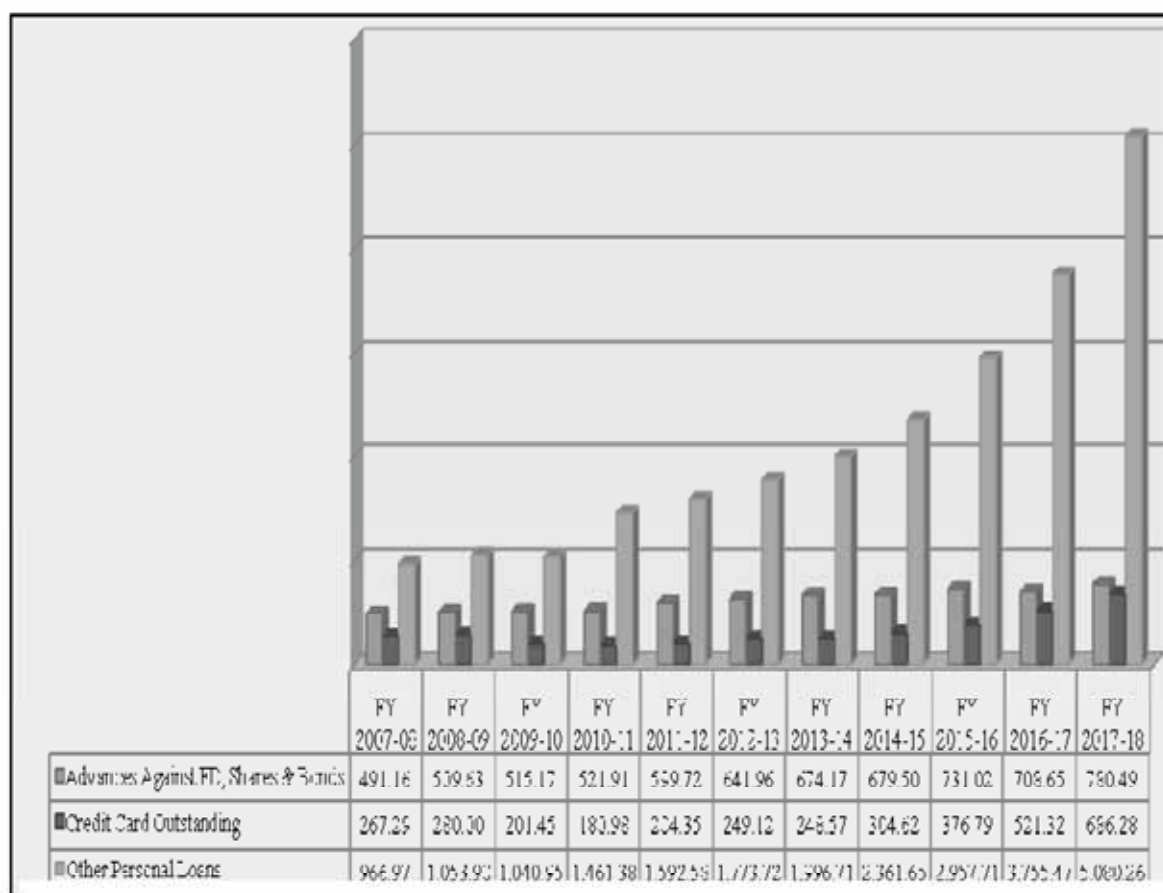


Fig No. 6 Increase in Loan against Collateral/ Credit Card & Personal loans Segment, Growth over Last ten Years (RBI: DBIE)

(e) **Combined Segment- Loan against Collateral (Fixed Deposits/ Shares/ Bonds/ Property Papers), Credit Card Outstanding & Personal loans-** If we see the Statistics in Fig. 6 (Above) which shows the increase in Loan against Collateral/ Credit Card & Personal loans Segment, Growth over Last ten Years, the biggest absolute increase comes in the personal loans category which shows an absolute increase from 966.96 Cr Rs in FY 07-08 to 5080.26 Cr Rs in FY 17-18, a whopping rise of 425.3%. Rightly the proportion of Personal loan has risen from 19% of Total Retail loan in FY 07-08 to 27% in FY 17-18. The Other segment of outstanding credit cards can be taken next. Here relative proportion as part of total retail loans has fallen

from 5% in FY 07-08 to 3 % in FY 17-18. In absolute terms the increase has been nominal from 276.29 Cr Rs in FY 07-08 to 686.28 Cr in FY 17-18, increase of 148 %. Coming to the last segment of Loan against Collateral (Fixed Deposits/ Shares/ Bonds/ Property Papers), its relative share as part of total retail loan scenario was 9% in FY07-08 which dipped to marginal 4% in FY 17-18. Numbers show an absolute increase of only 58%, rising from 491.16 Cr Rs in FY07-08 to 780.49 Cr Rs in FY 17-18. Relative proportion of each segment is shown in Fig 7 &8 which shows distribution of each loan segment in total retail loan category from FY 07-08 to FY 17-18.

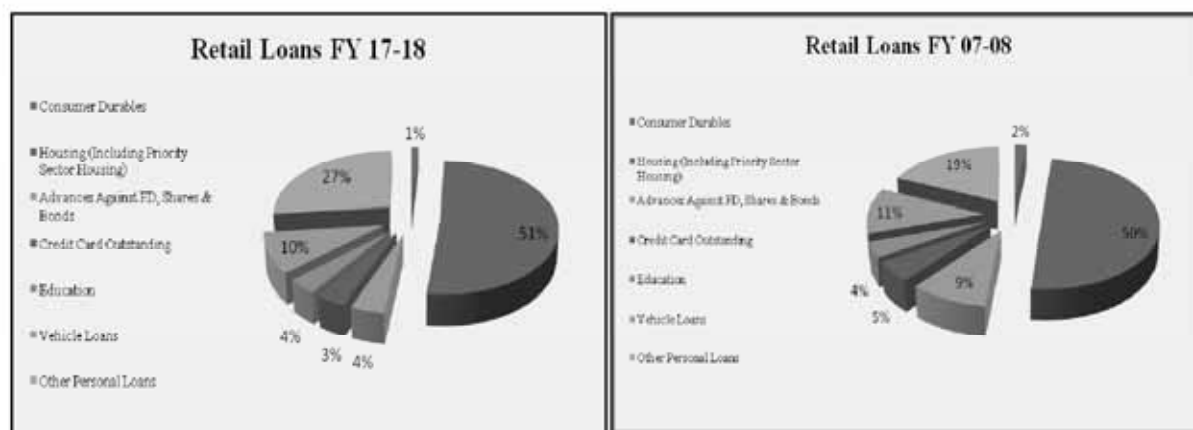


Fig No. 7 & 8 Comparative Analysis of Retail Loans Distribution by Public Sector Banks (Source RBI: DBIE)

V DATA ANALYSIS & FINDINGS

Factors Likely responsible for these Trends: Retail lending growth in emerging economies like India has been attributed to massive digitalization drive, financial sector reforms, evolving macroeconomic variables and their interaction with micro level factors such as demand and supply, growth patterns, consumer choices, economy events etc. In the context of the above trends we look at some of the factors which might have resulted in same.

- (a) **Growth of middle class consumers helps in growth of Retail Loans in purchase of Consumer Durables:** 'In India middle income population is growing rapidly. With a rise in consumer demands and greater income at hand in this population has given an opportunity in retail industry to grow and prosper. They now expect a high satisfaction in terms of quality and pricing. Consumers thus are availing wide range of products and value added services in India. With an ease of getting finance, with low rate of interest and availability, now consumer is able to get his choice of product very easily. The increasing consumerism would now be a driving reason for the organized retail sector in India. The rise in income and improvement in infrastructure are empowering the consumers in accelerating the needs and meeting the same for the consumer. This is one of the drivers for the overall increase of credit cards, Personal loans and even vehicle loans. Although with Digitization Indians are using more credit cards. Financial awareness and incidences of fraud has led to the reduced use of credit cards and more use of debit cards.

- (b) **Increase in number of working women:** In today scenario, the urban women are more literate and qualified. They maintain the balance between home and work. Now the purchasing habit and choices are different from earlier home-makers. They do not have sufficient time for leisure and now want all things under one roof. They now thus prefer one stop modern retail outlets for fulfilling their needs and wants. Also, public sector banks also have given various incentives and schemes for working women and enabling them to have their own house and various facilities. Central government schemes also various flexibility in loans like women getting a tax relaxation till Rs. 2,00,000 on interest payment on home loans, lower interest rates and ease in repayment procedure helps in boosting home loans by women. This is evident in increasing home loans year on year.
- (c) **Value for money & Organized retail shopping scene:** Organized retail deals in high volume and are able to enjoy economies of large scale production and distribution. This eliminates the intermediary in the distribution channel thus reducing the cost and time. Now the retailers are offering more quality products at reasonable and affordable prices. Example: Big Bazaar. Foreign retailers have also pitched in and created a niche. This is fuelling the economic growth of middle class and increasing their living standard apart from being helpful to industry.
- (d) **New emerging rural markets:** India has one of the fastest emerging rural consumers with more conscious towards quality and price. Rural Customers are now more bargaining to get the same services as urban consumers. Therefore the organized retail sector is devising new strategies and methods to reach rural consumers. After agriculture, the largest source of employment is now the retail industry with penetrating deep in the society affecting their income and buying

behavior. Various facilities like good connectivity increase in information sharing, internet and ease of loans from public sector banks help in increase in vehicle loan and education loan. Both the consumer is now more aware and wants him to be educated and respected in society. Now, rural people are thinking of other ways of income by educating their children and focusing more on overall development of individual. One of the biggest beneficiaries of education loan is rural students. Also owing to the agriculture focused economic scenario, in our country and the various schemes being run for them, they are buying more tractors etc from vehicle loans and other instruments from personal loans.

- (e) **Entry of Corporate sector:** Govt. of India is not the only entity in the game. Larger business groups like Tata's, Birla's and Reliance have now entered the retail sector, rural farming sector and even to some extent in banking sector and they are making their presence felt deeply. They are in a position to provide quality products and services to consumers. Consumers are thus availing all these at cheap loans.
- (f) **Increased Technological impact & financial literacy:** Today the technology is changing the dynamics of market. Various advancements like computerization, MIS, automation and digitization have changed the way, business operate. India has vast market and the growing needs of the consumers have developed the technology for the product quality and services. The technology has made digital truncations easy and paved way for ease accessing cash after the closure of banks in form of ATM, POS machine and e-wallets apps like Paytm, BHIM and Google Pay, etc. This has also led to spurt in support of mobile banking, net banking and phone banking, thus helping consumer to get loans more easily than ten years back. This is quite evident in overall increase in loans by public sector banks in India.
- (g) **Rise in income:** Rise in disposable income and market sustainable growth patterns have led to increased spending. This is the reason why, home loans are now preferred as investments for future and consumer durables and goods are more easily bought than ever before. All loan segments have been impacted from this.
- (h) **Media Explosion, Continuous Interaction over various mediums:** The advances in technology and science have led to continuous interaction of consumers with financial intermediaries. The BFSI sector has now expanded hugely and consumers are constantly informed regarding changes in financial policies, plans, new product offerings, reduction in rates and all latest financial developments. They also get new about the consequences of all such possible decisions they can take with regards to their (consumer's)

personal financial position. Thus with better understanding, people and consumers are making informed choices and seeking win-win propositions to suit their needs.

- (i) **Rise of consumerism:** The emergence of consumerism economy has created the demand for more products and services, and has led to the procession of material goods as symbolic to be craved by one and all. This has perhaps led to the economic growth booms and busts and retail loans have been a significant factor in their capacity to fuel this trend. Loans for cars, scooters, laptops, mobiles and even televisions are now available. Take the jewelry now through credit cards and keep paying by EMI later. Go for dream education in USA by taking loan and pay later EMI's. All this and more has led to ever increasing retail loan increasing trend. Consumers are much more aware of every choice they make and have technology as a tool to select retail loans and other products. The factors like comfort, time, location, luxury have become very important for the consumers. Special schemes, carefully addressed discounts and attractive ranges and price quotients have kept the consumer market kicking.

VI IMPACT OF DEMONETIZATION

Demonetization in November 2016 was widely expected to record fall in retail loan growth rate as demand was likely to fall due to the disrupting effect of demonetization. In short the Short term loans were paid back by old bank currency notes and demand for short term or working capital loan was found to be low because of economic disruption. Asset Quality of Banks Increased in long term with CASA ratio of Banks Improving. In the long term retail loans are likely to fall due to demonetization as in short term many industries suffered.

The Impact of Demonetization needs to be studied as the full effect can only be captured over a long period with sufficient data and correlations with other macroeconomic data.

VII RETAIL LOAN NPA'S & RISE OF NARROW BANKING

RBI Categorizes the loans into four segments; (1) Industry (2) Agriculture (3) Personal (4) Services. As per the RBI records it has been found that loans to industry constitute a record near about 40 % of the total outstanding where as the Retail Lending i.e. Personal constitute near about 25 -30%. Rest is all taken up by agriculture loans and other services oriented loans.

On Studying the Record of bad loans it was found that Gross Percentage of NPA was considerably higher For Industrial loans (Near to 19%) as compared to priority Sector NPA's and Retail NPA's. The GNPA ratio of agriculture (6.4%), Services (5.7%) and retail (2.1%) stood in sharp contrast to the Industrial NPA created by defaults from big corporate.

It has also come to light that recovery rate of bad loans is significantly low, i.e. it fluctuates from 8 % to 11 % of the total loan outlay. Thus majority loans which come from industrial sector are not recovered eventually after they are written off. This is consequential even to the process of liquidation that starts with banks resorting to the provisions of IBC Code.

Also noted is that bad loan ratio is for loan segments like home loan, auto loan etc falls within normal range as and when compared to the bad loan ratio of industrial segments. For example; The bad loan ratio of home loan is only about 1.7 % of total home loans. Significantly the bad loan ratio of auto loans is 2.4% of total auto or vehicular loans. All these statistics point towards the importance of retail loans where bankers understand are less prone to NPA and the messy consequences which befall them.

It is for the above reasons that retail banking is being aggressively pursued by bankers for their own advantages. Namely the loss of lesser NPA's as compared by giving the same amount to industrialists. In fact this is a strategy which has been suggested by many a bankers and this concept is called **Narrow banking** Concept.

This entails that banks with less resources or those having limited funds should only resort to lending retail loans. Thus there would be no problem arising out of arm-twisting the bank to give loan to a big industrialist by political or otherwise interference. Thus loan NPA's would be avoided. And now this trend is being followed voluntarily. This has been responsible for increasing the retail loan % of banks in last 6 -7 years' time frame.

Other factors too have contributed to the same trend; some of them are convenient time frame of money being returned thus the asset liability management aspect remains good for bank balance sheet and slower pace of growth as country moves from a developing economy to a more developed economy. The aspirations of burgeoning middle class are also a reason as they usually seek retail loans for personal needs and they are found to be better creditworthy than others.

VIII CONCLUSION

In the end we can conclude that, we are in constantly changing and retail banking is no exception to the rule. Consumer behavior, sociological unrests,

political events and world economy are being contoured to new dimensions as the world moves on to. India has the one of the leading retail market in global economy and carries the contradiction of carrying the setup of traditional market in combination to modern outlets and markets, thus providing host of choices to the consumers.

Retail banking remains the most visible face of banking for the general public at large. Retail Banking specifically refers to provision of banking products and services offered to individual small scale customers and consumers, typically for non-entrepreneurial purposes. There has been introduction of various measures like payment banks (Ex. India Post) and small finance banks.

This has led to deeper penetration of the banking sector into Indian population. Schemes like PMJDY have focused on bringing the all Indians to banking domain. RBI's new measures have led to overall restructuring of banking sector and have influenced retail loan segment also.

IX FUTURE OUTLOOK

The Challenges to the retail banking remain daunting, even though growth opportunities are ever present. The increasing regulatory concerns regarding loan quality, credit worthiness concerns over NPA's, globally slow and sensitive economy, increasing customer expectations are more than evident factors which are affecting banking. Retail lending and loans have come on to very sharp focus on account of lesser NPA's in their profile and thus their great value as a source of interest income to bankers and NBFC Lenders. Their Unique Proposition and attractiveness in bank loan portfolio calls for careful measurement of customer expectations. Innovation and diversification of services to consumers across products and channels are two of the surest means to keep the momentum going strong in retail lending and trade.

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Fending Competition through Sensory Experiences- Easy Day Way

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ABSTRACT

Easy day has become an easy to remember name among organised retailers, as one-stop shop catering to day-to-day needs of every family. With the fast-growing organised retail sector, competition is also bound to increase exponentially. In order to stand apart from their competitors, Easy day needs to focus on sensory appeal. This includes the visual aspects of its logo with striking colours, the aural aspects with the constantly playing music and the smell of fresh fruits & vegetables in its aisles which add to the multi-sensory environment. This creative positioning will provide a unique environment for customers and challenge the competitors.

Keywords: Easy day organised retail, sensory marketing, strategies, opportunities.

I INTRODUCTION

(a) **Theoretical Background of Sensory Perspective-** Sensory marketing is defined as “marketing techniques that aim to seduce the consumer by using his senses to influence his feelings and behaviour” by American Marketing Association. A prominent author in this field, Krishna (2012) gave the definition of sensory marketing as “marketing that engages the consumers’ senses and affects their perception, judgment and behaviour”. In order to get a grip on sensory marketing, first an understanding of senses is required. The Oxford English Dictionary defines sense as “a faculty by which the body perceives an external stimulus; it may be any one of the faculties of sight, smell, hearing, taste and touch”. The rise of sensory perception started from curiosity regarding illusions that began from primitive philosophy to current field of neuroscience. Senses help people in perceiving the world but the representations they construct from the inputs received through their senses are not certainly valid reflections of properties of stimulus. In retail settings the impact of environmental stimuli found its origin in Kotler’s (1973-74) work on “atmospherics” and led to the introduction of the view that retail environments create atmospheres that have an influence on shopping behaviour. Later on, many researchers have used different environmental factors (such as crowding, music, colour and olfactory cues) for the creation of said atmospheres and research has been guided primarily on the lines of environmental psychology. To study the behavioural intentions of consumers, Donovan and Rossiter (1982) adapted Pleasure-Arousal-Dominance (PAD) framework developed by Mehrabian and Russell for retail environments. The PAD model continues to be customarily used in marketing for capturing various emotions experienced by

shoppers (Milliman, 1986; Morrin and Ratneshwar, 2000; Kang et al. 2011). Later many authors described the various effects of the five senses on consumer behaviour with most of the studies focusing on individual senses like the presence of color (Crowley, 1993), music (Herrington, 1996), smell (Bone and Ellen, 1999) and touch (Peck and Childers, 2003). These studies were conducted on customers at various service locations like malls, restaurants, retail outlets etc. Afterwards researchers started to focus on the presence of more than one environmental cue and the congruity of these cues. For example, music and smell (Spangenberg et al., 2005), smell and touch (Krishna et al., 2010), touch and vision (Balaji et al., 2011) which gave way to multisensory marketing. In a very recent study it was found that the effects of multi-sensory environment on purchase behaviour and emotions of shoppers were monumental (Helmefalk and Hultén, 2017). The results of the study revealed that designing a visually dominant store in line with a multi-sensory environment would offer more appealing experiences to the customers. Previous research scholars have shown that shopping behaviours are significantly related to emotional states, time spent in the store, intentions to make impulse purchase and satisfaction with the experience. Therefore, a look into the sensory experience in organised retail will depict its importance.

(b) **Sensory Experience in Organised Retail-** Several changes in the retail industry have been brought about by organised retail. A lot of scrutiny is paid to how the customer is treated and how he/she ‘feels’. Stressing on retail design, the consumer’s experience in a store, the look and feel of a store are few illustrations of the modifications that have come about in modern retail. Visual designers started influencing the purchase decisions of a consumer after they came to realise the role that a store

design plays in manipulating the feelings of consumers. So, nowadays they work to the smallest detail on how the store looks and feels (Indian Retailer Bureau, n.d.). A retailer cannot ignore the fact that more than sixty per cent of the purchase decisions are taken on the premises of the retail outlet. The decisions taken "in-store" for purchasing a product depend on a lot of factors like pricing, durability and the quality of the product and so on. But the factors influencing do not end at this point, aspects like the colour-scheme chosen for the walls, whether the ambience is pleasant or not, how does it smell, the type of music playing in the store, whether the in-store advertisements are properly put, how the merchandise is placed are critical and should be taken care of by visual merchandiser. A retailer can earn a lot of profit by enhancing the experience of shoppers by indulging all their senses when they are inside a store (Indian Retailer Bureau, n.d.).

II COMPONENTS OF SENSORY PERCEPTION

- (a) **Experience matters-** The Unique Selling Point of a brand besides the quality of its product should be the 'experience' given by the brand to its consumers in the retail store. A great experience can be said to be the one which is sensory and involves all the five senses i.e. sight, smell, sound, touch and taste. According to certain designers' viewpoint, retailers can attract the clients by trying to include all the senses. The emotional encounter of a customer should move from the stage of attraction to interest, then desire, action and ultimately to satisfaction at having garnered the best that the retailers have to offer their clients. A retail outlet should always be perceived as a catalyst for increasing revenues for the retailer. Therefore, the importance of layout can never be neglected (Indian Retailer Bureau, n.d.). The 'looks' of the store is the primary factor that motivates a consumer to walk into a store. A friendly and welcoming store is always advantageous over those which are not. In-store advertisements, well-placed merchandise and bright colours, all work for creating visual appeal for a consumer. For instance, in a furniture store, helpful tips and information by interior designers can be put up next to merchandise to aid the consumers. The consumers can read, see and take informed decisions. Secondly, indulging the sense of sound through pleasing music (in accordance with the brand and merchandise concept) is a must. According to the type of customers visiting the stores, the music must be suitable. For example, at an apparel store for young adults, tips by stylists and fashion shows on screens can be aired in the store to succour shoppers in selecting clothes for themselves. In order to guide the customers regarding the kind of book they should pick up, bookstores can play quotes or interviews by famous authors. Third, a pleasing scent at all times adds to the ambience of a retail outlet. Strong paint fumes and repelling odours can act as a deterrent for customers. The sense of smell of a shopper should always be kept in mind by a visual merchandiser while working in accordance to the retailer's details; as bad odour is just unacceptable. A good odour is definitely a bonus to the store as it may not be always remembered, but its absence will surely be remembered. The sense of touch is a tricky sense to indulge in, but most vital. It is more than a necessity to be able to 'feel' the merchandise for today's quality-conscious consumer. Some customers have an inherent urge to touch products before buying. Be it in judging the sturdiness of a chair, or feeling the texture of a glass table, holding a porcelain vase, or testing a perfume with a tester, trying on clothes in the trial room, the client should always be made to feel at home when it comes to the sense of 'touch'. Not all retail stores can hope at utilising the sense of taste. But for those who can, like snack and juice bars, food and beverage outlets, candy stores, chocolate stores should always focus on treating the sense of 'taste' of their customers. Free dishes or drinks on certain amount of purchases, free samples for tasting, chocolates and sweets for kids at any other kind of store are a few ways the retailer can engross in the sense of taste of the consumer.
- Overindulging the five senses of the consumers confirms a sensory shopping experience for them. Working out the visual merchandising of a store with this end in mind can work wonderfully for a brand. The retailers have the advantage of distinguishing their service from their competitors.
- (b) **Creative Brand Positioning-** The characterization of a specific brand is commonly associated with every graphical stimulus that it represents; that is, its logo, colors, images, icons, characters, etc., along with the transmission of its values through these representations. However, this representation is quite limited appreciation of the term. Besides traditional marketing other related disciplines has been to some extent unfair in reducing branding to a purely visual expression. This is even after being such a fundamental and vital variable to the success of a company, brand and organization. Modern marketing has begun to make use of techniques

that would have never been thought in the past as part of a strategy of differentiation and positioning. Such techniques break traditional schemes and think laterally in order to expand and solidify the mental territory occupied by each brand in our brains as customers. A technique that can be included in this category is sensory marketing which exploits the senses through stimuli designed to be directly connected to a particular brand. By creative repositioning of their products, companies can change how customers mentally categorise the products. They products struggling in the maturity phase of their life cycles can be rescued and brought back to the growth phase. In some cases, they might be able take their new products directly into the growth phase (Cobos, 2012). The use of five senses in creative brand positioning is described in the following paragraphs.

- (i) **Sight:** Previously, the most significant variable used by brands to generate recollection of products and develop an identity in the market was the sense of sight. Consumers appreciate logos, corporate colours, characters and other graphical tools with which they can identify a specific product. It's rare to find a person who does not recognize the white wave on the red background of Coca-Cola, the golden arches of McDonald's, the Apple logo, etc.
- (ii) **Sound:** Perhaps the variable most used after the sense of sight in advertising and marketing is the sense of hearing. In order to provide new attributes to their products and brands many corporations realized that visual objects were not ample to impact the consumer purchase decisions. Certainly, everyone recognizes the famous Nokia tune, Messenger alert sounds, the specific Intel notes at the end of each commercial, not to mention a few jingles.
- (iii) **Smell:** The human nose can set apart over 10,000 different odours, other than being the most sensitive of the senses. It has a tremendous power of evocating memories and experiences over the years. It is easy to remember, the shopping mall having the characteristic smell of the food court, which results in repeat visits from time to time just for the memories it evokes. Smell of Play-Doh and crayons at school, Starbucks with its coffee smell, not to mention the scents of some person, place or thing; all remind us of some product or the other.
- (iv) **Touch:** Textured book covers, labels and some printed shirts, forms that are better adapted to our hands in bottles of beverages, sauces, mayonnaise; plush, furry fabrics pleasant to the touch, sensitive touch screen

tablets and not to mention the mobile devices so common today. Bed Bath & Beyond, the brands that sells linens, curtains and other home decor, enables customers to experience and build trust with the warmth and comfort of their products by enforcing touch sensory by encouraging their costumers to feel the products (Dan-Bergman, 2014). No doubt brands recognize human's singular sensitivity and natural tendency to feel the environment as a means of interaction and involvement with it.

- (v) **Taste:** There is nothing like a nice and very distinctive flavour. It may be secret formula of eatables that is jealously treasured, "x" ingredients, grandma's recipe, exotic ingredients, a whole mystique developed around a favourite food or drink. On the other hand, there are medicines with a pleasant taste for children and bubble gum flavoured toothpaste.

III INDIAN RETAIL SECTOR

Over the last decade, there has been high growth in the Indian retail industry with a visible shift in the direction of organised retail formats. Some of the main domestic players in India are **Bharti Retail**, Reliance retail, Aditya Birla 'More', Tata Trent, Globus and Patanjali. Despite the downturns, organized retail which is a new occurrence in India is evolving exponentially, because more Indian people are entering into the consuming classes due to economic growth. Organized retailing formats lure more and more extant shoppers into its open doors. Over the coming years, Indian retail market is anticipated to develop at 7 per cent and reach a size of US\$ 850 billion by 2020. Organized retail is expected to develop at 25 per cent and reach a size of US\$ 200 billion by 2020 in comparison to traditional retail which is envisaged to grow at 5 per cent and reach a size of US\$ 650 billion (Source: FICCI).

Among the major retailers, more recently, in 2015, the parent company of the Kishore Biyani led Future Group named Future Retail that runs Big Bazaar had notified that its functions would be unified with Bharti Retail, that had been operating 'Easy day' supermarkets and convenience stores. The move helped Future Group deal with competition from other e-tailers and created a retail chain with 570 stores in 243 cities (Sarkar, 2015). The combined entity operates 197 Food Bazaar & 'Easy day' supermarkets, 203 Big Bazaar & 'Easy day' hypermarkets and 171 other stores comprising of Home Town, eZone, FBB and Food hall as presented in table 1.

Table No. 1
Key retail brands

Brand	Cities	Stores	Area Sq.Ft.
Big Bazaar	118	218	97 mn
Easyday	117	320	0.7 mn
E zone	30	92	0.5 mn
Fbb	31	51	0.5 mn
Food Bazaar	4	10	0.1 mn
Foodhall	3	04	0.07 mn
Hometown	21	43	1.3 mn

Source: Annual report Future retail limited, 2016

(a) **Easy day and its Private Brands** - In April 2008, a subsidiary of Bharti Enterprises, Bharti Retail, commenced its operations by inaugurating its first store in Ludhiana, Punjab. The stores, known as 'Easy Day', are a one-stop shop that caters to day-to-day needs of every family, according to company officials, they insisted that "it will bring together a relevant and wide product range, good quality products and great-in-experience and service-all under one roof". The store sells meat & poultry, fresh produce, personal care products, bakery and dairy products, daily-need groceries like staples, stationary, household articles, hosiery items and processed foods. Rajan Mittal, Joint Managing Director of Bharti Enterprises in an announcement of the plan for its retail ventures in 2007, had said that "Bharti was looking at approximately 10 million square feet of retail experience throughout the country and employing about 60,000 people". For the back-end operations Bharti proposed a joint venture with US retailer WalMart which was exclusive from the previous launch. In the third quarter of 2008, Bharti-WalMart joint venture kicked off its cash and carry (wholesale) business (Agencies, 2008). Bharti Walmart sells its own private brands besides strategically selling merchandise manufactured by several different companies. Bharti Walmart said in an interview, "Customers have begun to like private labels due to better quality, high food safety standards, international look and feel of products, customized packaging created after customer feedback and the credibility of the retailer." (Malviya, 2012) The various private brands include:

(i) **Great Value:** The brand named Great Value is the international brand of Walmart, it locally sells a range of every day-use products like floor & glass cleaners, toilet cleaners, flour, dish-wash bars, detergents, corn flakes, Indian snacks, staples, cereals, dry fruits, spices, jams, ketchups, tea, cold beverages and sodas. As a generic or house brand, the Great Value line consist of goods manufactured and packaged by a number of agricultural and food corporations but not

produced by Bharti Walmart which is only a labelling system for these items (Company brief,2012).

(ii) **Easy Choice:** The brand Easy Choice, sources products from Bharti Walmart, but the items are ordinarily a bit cheaper in comparison to Great Value products and it is driven in similar fashion as Great Value, also catering to the Fast-Moving Consumer Goods range.

(iii) **Mainstays:** It is another international brand by Walmart for common home goods like stationary, lighting solutions, cushion covers, towels, plastics, kitchen & bathroom accessories and bed linen (Choudhary, 2009).

(iv) **Equate:** Personal care products are sold by this global Walmart brand (Jain, 2012), including cosmetics, deodorants, baby care products, oral & dental care range, bar & liquid soaps and nail-cutters.

(v) **George:** George that started as Asda Stores Limited is a western brand of apparels that began as British supermarket chain of private clothing range and later moved to Walmart's Canadian and US stores (Choudhary, 2009).

(vi) **Astiva:** It is a regional brand by Bharti Walmart dealing with ethnic Indian wear, such as ready to stitch fabric, kurtis, kurtas and salwar kameez (Jain, 2012).

(vii) **Simply Basic:** It is a brand developed to cater to customer's everyday wear and clothing needs (Suppliers > Our Private Brands, n.d.).

(viii) **Home Trends:** This brand caters to glassware, crockery, cookware, table ware, home furnishings & décor and kitchen tools (Jain, 2012).

(ix) **Kid Connection:** It is a brand specially designed for toys, clothing and other items for children (Choudhary, 2009).

(x) **Faded Glory:** Footwear are provided by this brand (Choudhary, 2009).

(xi) **Athletic Works:** It is a brand for fitness & sports products that deals with fitness merchandise, gym goods, work-out equipment and athletic shoes (Choudhary, 2009).

Table No. 2
Easyday stores

Stores	320
Footfalls	49 mn
Space	0.7 mn. sq. ft.

Source: Annual report Future retail limited, 2016

- (xii) **Marketing Overview-** During the past year, the Company continued to carry out various promotional events and activities to engage with the customer across formats. Various promotional events include Sabse Saste Din, Independence Sale, Public Holiday Sale, Wednesday Bazaar, Weekly Promotional Event and other format specific promotional events. Besides the promotional events, the Company was also part of Future Group Shopping Festival at group level. Various promotional initiatives, activities and events resulted in acquisition of new customers as well as higher footfalls during promotions. Events like Future Group Shopping Festival ensured that at least once in a month customer visited any of the Future Group

shopping formats. Cross promotional events ensured that the customers of one format visit another format. The Company also expanded the base of its loyalty programs through Payback, T24 etc. Further these programs ensured acquisition of a new set of customers and customer loyalty of existing customers. Various loyalty programs that bring back customers to stores at least twelve times in a year, resulting in cumulatively higher annual sales and higher frequency. These programs further take advantage of direct communication with customers and drive promotions offering customized merchandise. The financial performance is presented in table 3.

Table No. 3
Financial Highlights
(US\$ in 10 Million)

Particulars	Financial year 2015-16	Financial year 2014-15
Revenue from Operations	105.526	27.433
Other Income	0.239	1.080
Total Revenue	105.765	28.512
Profit/(Loss) Before Depreciation and Amortization Expense & Tax Expense	0.791	(5.166)
Less: Depreciation and Amortization Expense	0.567	0.680
Profit/(Loss) Before Tax	0.224	(5.846)
Less: Tax Expense	—	—
Profit/ (Loss) After Tax	0.224	(5.846)
Earnings Per Equity Share of Face Value of Rs 2/- each		
Basic and diluted (in Rs)	0.010	(1.653)

Source: Annual report Future retail limited, 2016

IV MAJOR COMPETITORS OF EASYDAY

The major competitors of Easy day are as follows:

- (a) **Reliance Fresh:** Reliance fresh belongs to Reliance Industries of India which is run by Mukesh Ambani, it forms part of their retail business in the form of a convenience store. At present there exist five hundred Reliance Fresh outlets all around the country. These stores sell dairy products, bars, fresh juice, staples, fresh

vegetables and fruits as well as groceries (Reliance, n.d.). They follow the method of directly sourcing fresh agricultural produce through Collection Centers located in villages which is their unique selling point. In October 2006 when the first Reliance Fresh store opened in Hyderabad, the company focused on “farm-to-fork” theory and said that the store’s focal point would be fresh produce like fruits and vegetables at a much lower price. Besides providing low priced products the store provides an environment that lures the customer inside

although the aisles are not properly marked differentiating the products sold (Reliance fresh, n.d.). The salesmen are also not sensitive to the needs of the customer and are not properly acquainted with the items in stock (Khan et al., n.d.).

- (b) **Food Bazaar:** Food Bazaar provides for a shopping experience in a unique ambience. At Food Bazaar, one finds a hitherto unseen blend of an International supermarket atmosphere and a typical Indian bazaar. Started in April 2002, Food Bazaar is a supermarket chain with a difference, where the best of Indian and Western values has been put together to ensure customer comfort and satisfaction while shopping. The Indian values of "see-touch-feel" are rendered through the bazaar-like atmosphere created by displaying staples out in the open and the western values of hygiene, cleanliness and convenience are offered through pre-packed commodities (Food bazaar, n.d.).
- (c) **Patanjali:** Patanjali Ayurved Limited is an Indian fast-moving consumer goods company founded by Baba Ramdev along with Acharya Balkrishna with its manufacturing units and headquarters located in Haridwar. Patanjali Ayurved manufactures products in food and personal care category. According to Patanjali, all the products manufactured by the company are made from Ayurveda and natural components (Anand, 2015). The green component of the products is depicted through the green painted walls of its stores. As of May 2016, Patanjali sells through its 47,000 retail outlets. Patanjali Ayurved has tied up with Pittie Group and Future group on 9 October 2015. Patanjali Ayurved targeted US\$1540 million revenue in 2016 - 17, after sales grew 150 per cent in the previous financial year to US\$768 million (Dutta, 2016). The smell of herbs highlights their use in most products but sometimes it can be too overwhelming for the customers.
- (d) **Aditya Birla Fashion and Retail Ltd.:** Aditya Birla Group is an Indian Multinational Conglomerate. It owns both brick and mortar stores and online stores under the brand names of Pantaloons, Planet Fashion, Van Heusen, Allen Solly, Louis Philippe and Peter England. Their retail store enterprise named Madura Fashion and Lifestyle is a fast-developing clothing brand in India. It has more than 320 departmental stores and 1500 premium multi brand shops. It operates in around 100 cities. The company also outsources engineering, textiles and apparel (Tandon, 2015). They have a wide network which adds to their advantage.
- (e) **Infini Retail:** It is a retail chain of the Tata Group which operates under the brand name of Croma. It is a 100 per cent subsidiary of Tata Sons. Presently, there are 103 Croma stores in 25 cities. Croma caters to 8 categories which include gaming and accessories, photography, communication, kitchen appliance, home appliance, entertainment and computing with around 6000 products. It has well-lit stores that provide ease of accessing and looking at the features of its products. It is first large format specialist retail chain in India for consumer durables and electronics with successful expansion into Croma Zip stores, Croma Kiosks and latest online vertical, www.croma.com (Infini Retail, 2009). Trent (Westside) is also a subsidiary of the Tata group. Westside is operated by Trent since 1998, besides Landmark which is a leading bookstore chain. It has well designed outlets with neatly stacked products which appeal to the customers. The signboards are well placed for customers to move around. Pleasant music plays throughout the store. There are 42 retail outlets under the Westside brand. It offers self-service and customers can move around freely inspecting and picking items of their choice. The aisles are differentiated based on the customer type whether they are children, housewives, professional or general household items. Trent also operates Star Bazaar a hypermarket chain with branches in eight cities.
- (f) **Facing the competition-** The growing organised retail industry will lead to a tough competition for easy day stores. In this situation, its uniqueness and sensory appeal to customers is going to be an advantageous point over its competitors. The stores cater to a family's everyday needs but this is not enough to retain the customers and gain their loyalty. It is only possible through the pleasant shopping experience which remains in the mind of customers long after the purchase process is over. When one enters an easy day store, the logo is the first striking observation that a customer makes. The stores are well lighted and are decorated with colours according to occasion. The pleasant music playing throughout the stores is second enticing feature to be noted. It appeals to the customers' sense of hearing and makes shopping more fun and enjoyable. The third feature is the smell of fresh fruits and vegetables in its food and beverages section. This is both a symbol of the quality of the products and also a source of reliability of products for the customers. Next comes the sense of touch as all the products are arranged in assortments within the reach of customers. They can touch and feel the fabric, the texture and sturdiness of the products without any hassle. All the senses when

they come into play together, they create an environment that is unique to these stores.

With the increasing competition and new and upcoming retail formats like e-tailers, the brick and mortar retail outlets can still continue to appeal to the customers through their ambience and atmosphere which is not possible in case of e-tailers.

V CONCLUSION

In order to fend competition, retailers nowadays need to focus on various sensory aspects like sight, sound, smell, touch and taste. These provide a unique ambience for the customers which appeals to them. The exploitation of the senses through stimuli designed to be directly related to a particular brand may sound too sophisticated, however, they link product-consumer through the description of the product and human sensitivity to receive and process information from the environment. Such a case has been presented through the example of Easy day. Easy day has become an easy to remember name in a short span of nine years since its inception in 2008. It has earned a name for itself as one-stop shop catering to day-to-day needs of every family. Easy day is an organised retail venture launched by Bharti Retail which is a subsidiary of Bharti Enterprises. Bharti has extended operations into emerging business areas over the past few years in the fast-expanding Indian economy. In 2015, Bharti retail merged its operations with Future Retail and further expanded its operations. As per the annual report of 2015-16, there are 320 stores of easy day and it has a footfall of 49 mn. It has established several private brands like easy choice, great value, home trends etc. Among hyper market, super markets and discount stores, easy day provides a sound experience in retail and wider presence. All this has been possible through the various marketing strategies applied by them which include sensory marketing. Sensory marketing helps to develop an emotional connect with the customers so that they remember the products and purchase experience for a long time. This unique experience is necessary to withstand competition from other stores like Reliance fresh, Westside, Patanjali, Food Bazaar. The ability to withstand competition in an environment where most of the products have equivalent quality requires the use of distinctive strategies. Such strategy for creative positioning among customers will pave a new path for future of retailing.

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- [1] Bowman, M. Peterson L. (1997). A Study on Video Browsing Strategies. *Technical Report*: 13(1), PP.8-12.
- [2] Patil G., Forman M.J., (2004) *Handbook of Statistical Studies*, Himalaya Publishers, PP. 213.
- [3] Sannela M.,(2007) Constraint satisfaction & Debugging for Interface User Interfaces, Doctoral Thesis *Doctoral Thesis*. UMI Order Number: GAX95-09398. University of Washington.

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National Conference on Agricultural Horticulture and Biological Sciences (NCAHB-2020)

March 2020 at Rabindranath Tagore University, Bhopal, M.P.

Coordinator - Dr. Anil Kurchania. Research Cell. RNTU. Email: anilkurchania@gmail.com

National Conference on Computer Science and Information Technology (NCSIT-2020)

April, 2020 at Dr. C.V. Raman University (CVRU), Khandawa, M.P.

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National Conference on Environment and Life Science (NCELS-2020)

April, 2020 at Dr. C. V. Raman University, Bilaspur, Chhattigarh.

Coordinator - Dr. Manish Upadhvav. Research Cell. CVRU. Email: manishcvru@gmail.com

National Conference on Business Management and Social Innovation (NCBMSI-2020)

May 2020 at Rabindranath Tagore University (RNTU), Bhopal, M.P.

Coordinator - Dr. Sangeeta Jauhari. Research Cell. RNTU. Email: sangeeta.jauhari@gmail.com

National Conference on Science, Engineering and Agriculture (NCSEA-2020)

May, 2020 Dr. C.V. Raman University, Vaishali, Bihar.

Coordinator - Dr. DK Singh. Research Cell. CVRU. Email: dmsingh2001@gmail.com

Innovation in Computer Science, Engineering and Information Technology (ICSEIT-2020)

August, 2020 Rabindranath Tagore University (RNTU), Bhopal, M.P.

Coordinator - Mr. Mukesh Kumar. Research Cell. RNTU. Email: goutam.mukesh@gmail.com

International Conference on Science, Technology, Engineering and Management (ICSTEM-2020)

Sept, 2020 at Dr. C.V. Raman University (CVRU), Bilaspur, Chhattigarh.

Coordinator - Dr. Manish Upadhvav. Research Cell. CVRU. Email: manishcvru@gmail.com

International Conference on Water, Environment, Energy and Society (ICWEES-2020)

October 2020 at Cape Town South Africa Organized by (IMESA), (IAWEES) RNTU and CVRU

Coordinator - Dr. R N Yadava, Email: dryadava@gmail.com / Prof. Du Plessis, Kobus
Email: jadup@sun.ac.za.

National Conference on Advance in Science and Technology For Sustainable Development Goals (NCASTSDG-2020)

November 2020 at AISECT University, Hazaribag, Jharkhand

Coordinator - Dr. Akash Kumar, Research Cell, AISECT University. Email: -akashsingh9991@ymail.com

International Conference on Land, Water and Forest (ICLWF-2020)

December 2020 at Bhopal Organised by WALMI, NIH, RNTU and IAWEES

Coordinator - Dr. Shalini Yadava. Research Cell. RNTU. Email: shaliniv2000@gmail.com

National Conference on Science, Technology and Management (NCSTM- 2021)

February, 2021 at Dr. C.V. Raman University, Khandawa, M.P.

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