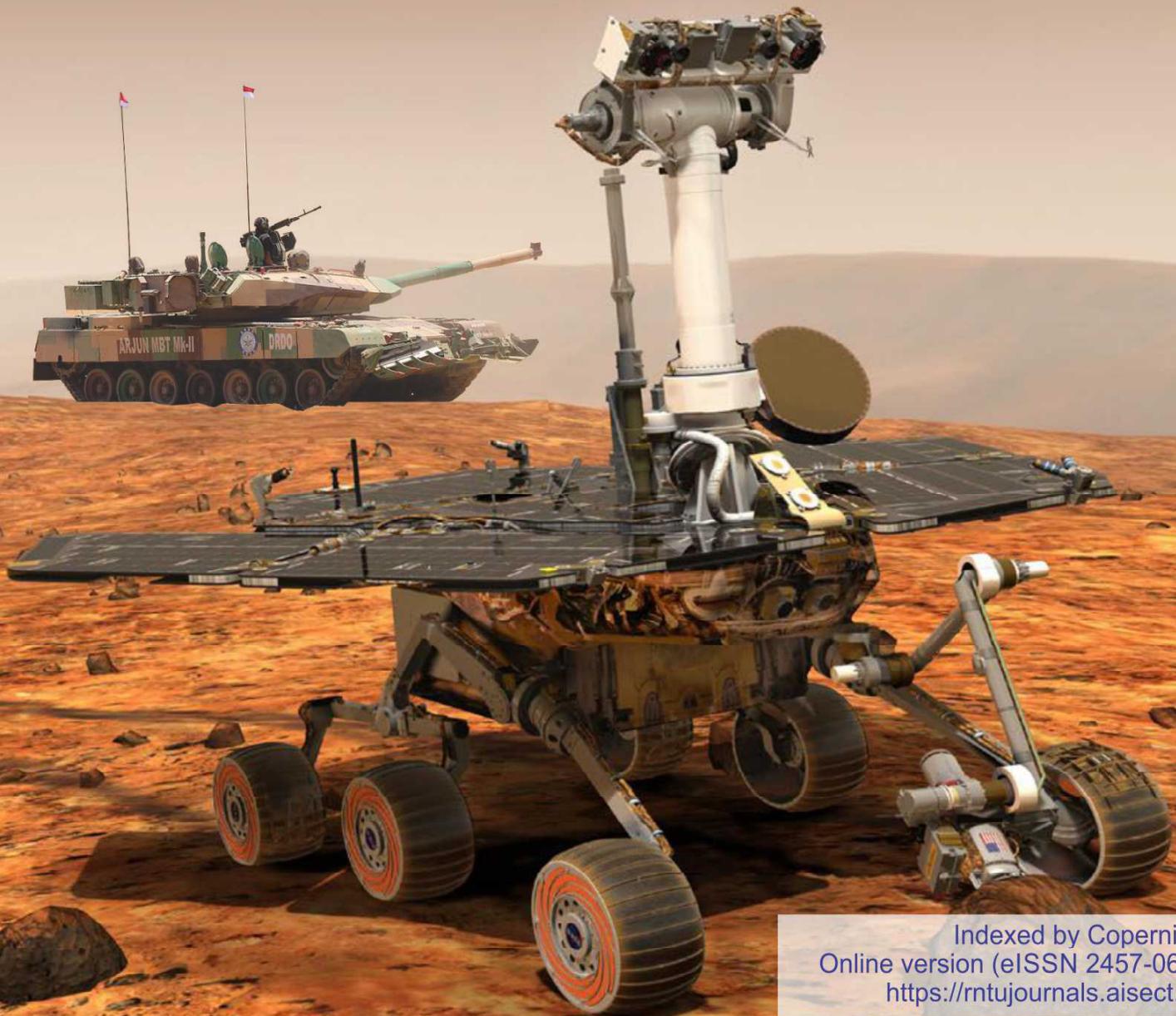


# ॐ Anusandhan

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## From the Desk of Patron

Dear Friends

Everything in this world has its share of pros and cons. The new normals emerging in the wake of Covid-19 are no different. Change of work culture post covid in educational institutions, brought on line education – the new normal in a big way, so was the dominance of Work from Home (WFH) in corporate and govt sector. In last one year a lot of research has been carried out on these new normals which reveals that on one side they provided many benefits, like increased productivity, higher efficiency, better comfort and greater flexibility; but on the other side they posed many difficulties and problems as well.

Problems which came up in the initial stages as regard to efficacy of infrastructure, availability of devices, connectivity and accessibility of internet, are being resolved by all concerned at unprecedented speed, owing to accelerated growth of technological developments and innovations. As a matter of fact most of problems came as blessings in disguise, which forced the system to reequip and reengineer quickly as per the new needs. Many technological problems were more of teething troubles and basic challenges, which provided opportunity to excel. The major problems which have taken their toll are, more of psychological and behavioral in nature and mostly that of human issues arising out of new work culture. The biggest problem being faced in online work culture is, the interference of family available at work place causing significant distraction. Lack of concentration due to informal work environment is also a major problem. Psychological problem of virtual world and adjusting to virtual environment also demands a proper solution. Lack of resources like labs, library, and computer center etc and in access to other campus resources also restrain human efficiency. Absence of a team and co-workers, ergonomic issues and lack of physical activity, longer screen time etc have also caused physical as well as psychological problems. Then, one very big problem is that of training of faculty and students on online culture. Standardization of the online system needs to be addressed on priority. However the rosy side of the picture is that, every researcher in the institutions and technocrats outside are coming out with one or other solution every day. Post pandemic, work environment posed big challenges to researchers but pleasantly they are rising to the occasion and providing wonderful way outs. It is going to take some time for education sector specially, to settle to the best combination of on line and off line, combining best of the both. Also it is going to take some time to arrive at a bench mark; but picture is quite bright.

The New Education Policy (NEP-2020) emphasizing on research, education in mother tongue, flexible entry exit system, liberal education, compulsion of skills and return to cultural roots of India, are being discussed vigorously at various forums these days. The job is not easy and institutions will have to apply themselves. Entrepreneurship and Start ups need to be promoted in a big way at educational institutions to usher in the new era of Atma Nirbhar Bharat. RNTU is an emerging leader with a Neeti Aayog sponsored Incubation Center and PMKK within the campus, producing 43 successful start ups so far. Academic teams in RNTU have taken up a big exercise to revamp the entire syllabus to ensure meaningful multiple entry exit in degree courses, inclusion of research component, skills and wide choice of credit based electives and extracurricular, co curricular and take home assignments in the curriculum. Collaboration is now call of the day and optimization of resources being the key. Institutes who look in to above aspects can only have competitive edge in time to come.

In this issue the last eight articles have been included to provide insight to our students and researchers in some key areas. These are golden treasure of experience of decades, coming right from experts, working in the actual field. These papers provide data and results which may not be available elsewhere normally, and provide insight in to finer aspects of practical issues. We are thankful to all the authors and Dr. SR Awasthi who is our co editor also and who motivated all other experts to share their experience from various fields. We had started a series of articles on energy by Dr. Awasthi from last issue of **ANUSANDHAN**. In this issue he has given an insight in to thermal energy, which may come quite handy to researchers and students.

We are happy to inform that a unique Tagore International Center of Research for Arts Culture and literature with five different centers within it, is coming up in RNTU campus which will provide platforms for research in all the form of literature, language culture theater and performing art. A new Sankrit language department is also coming up to introduce this ancient language to our students across all disciplines. This would be an excellent initiative by a leader University in view of NEP-2020.

DRDO has developed Arjun MK2, a third generation tank under Make in India Initiative and the government has also stopped import of other 101 items of defence. A big leap for Make in India. On world front NASA's Mars Perseverance Rover provided front Row Seat to landing of Red Planet. Both the events adore our cover page - pride for researchers across the globe.

Wishing a very research full year to all our readers and subscribers.



**Prof. Vijay Kant Verma**  
**vcau.bhopal@rediffmail.com**

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# Application of Wireless Sensor Network for River Pollution Management

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## ABSTRACT

*This paper presents an Extended Wireless Sensor Network with three-fold tasks for assessing water quality along any river system blended with multi-industrial effluent outfalls. First, it assesses river water quality at all confluence points of industrial effluents with river using sensors and transmits to control room using the Wireless System with inbuilt Wi-Fi. Secondly, it predicts water quality along each stretch between two consecutive outfalls using a computer algorithm developed with river quality dispersion model. Thirdly, it the predicted data transmitted to controller in the cloud to be accessible by the industries for necessary action to control pollution in the river.*

**Keywords-**Wireless sensor network, river quality, pollution management, data visualization, sustainable industrialization

## I INTRODUCTION

Although industrial development of a country influences its economic growth, on another hand it causes serious impact on the environment. Each industry must contribute towards green environment in order to balance industrial impact on the environment and ensure the sustainable industrial development. Pollution management is one of the factors of sustainable industrial development to bring the concentrations of toxic elements within the permissible limits [1]. Continuous discharges of industrial effluents pollutes the river water and it spreads diseases among the people and animals in the residential colonies situated along the sides of the river course as the water is being used for domestic use [2-4]. Thermal power plants are drawing water from river for cooling its units and discharges. The raised temperature lowers the level of dissolved oxygen and disturbs aquatic life in the water [5]. Study reveals that a coke plant generates minimum of 175 m<sup>3</sup> effluents and the concentration of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Phenol and Cyanide exceeds the limits with high concentration of Ammonia, TDS, and Oil & Grease [6]. It is obvious to say that Dissolved Solids (DO) decreases when BOD increases in industrial effluent. Assessing the impact of industries on river water quality requires planning sampling stations, regular sampling, laboratory analysis, reporting and action of pollution control.

Manually and frequently collecting samples at different points of the river stretches in the downstream involves huge project fund towards deputation of manpower and laboratory analysis. Further there will be a significant delay in obtaining the report of the collected samples from the internal or external investigating agencies. Therefore there is a need for quick analysis and earlier action of pollution control to maintain the river water quality within permissible limits for intended use in the downstream. Thus, ideas emerged to design and develop a wireless sensor network for appropriate

pollution management of the river stretch through quick assessment of water quality, which is one of the responsibilities of the industries to march together contributing towards the sustainable development. Water quality monitoring at each monitoring station must regularly be assessed at uniform interval of time for providing data creditable to be analyzed as time series to define present conditions and also to establish forecasting models to control pollution [7-9].

In the recent years, Internet of Things (IoT) has become very popular and is being used for integration of cloud computing. The IoT can effectively be used for promoting smart homes and smart cities in urban development [10-12]. Many researchers developed wireless sensor network for online monitoring of water quality [13,14]. Attempts have been made to apply online monitoring systems in urban development activities such as water distribution, water resource management and quality assessment. Sometime municipal supply water and sewage are merging together in the crossing points due to rusting of buried pipelines in water supply network and contamination can be detected in water distribution systems using a modeling approach [15-19]. Wireless sensor network has effectively been applied for online water resource management and distribution. Jianhua et al [8] made a survey on existing research on smart water quality monitoring system (SWQMS) and found the application of wireless sensor network effectively [20-24]. Xiuna et al [25] have applied a remote wireless system to assess and ensure quality of water for fish culture through online monitoring.

Focusing on software system for water quality prediction, a dynamic water quality prediction method may be useful wherever SWQMS is applied. There are several methods available to predict water quality [26-36]. Most of the water quality prediction studies use Neural Network (NN) [37]. NN is a vital as a high non-linear system for finding optimized solution of complex problem [38-42].

Genetic Algorithm (GA) optimizes calibration of water quality models and their monitoring networks [27-29]. Further, GA combined with Back Propagation Neural Network (BPNN) improves prediction accuracy and speed [43-46]. A study reports that a method combining both BPNN and GA predicts water quality assessment with real time early warning systems [37]. Since all these online SWQMS deal with only assessment of water quality at discrete points of a river system or an isolated water sample [9,16,18,19, 50-54], there a need to develop SWQMS to predict water quality of a dynamic river system.

Therefore, initially an algorithm, namely River Quality Management (RQM) to predict water quality parameters has been developed taking into accounts the ratio and velocity of settleable bio-flocculated particulate matters, velocity variation and the changes in river dimension [47-49]. Later an improved version of RQM information system, which is also called as Advanced River Quality Management (ARQM) information system is developed as an online SWQMS. The proposed system provides real time analysis of data at the set monitoring stations where sensors are installed and the prediction of water quality along the stretches is carried out using ARQM taking sensor data as input data. The present work aims to present cost effective and simpler solution for river pollution management through SWQMS using controller inbuilt with Wi-Fi module to send SMS alert when the water quality exceeds threshold and also to monitor parameters such as TSS, TDS, BOD, COD and DO.

## II PROPOSED SYSTEM

This section is divided into two different sub-sections to explain the proposed system in detail. The first one is hardware design, which presents schematic diagram of the entire function of the present system and explains the water quality parameters and employed sensors. The second one is software design and flow chart that updates sensor data at the set time

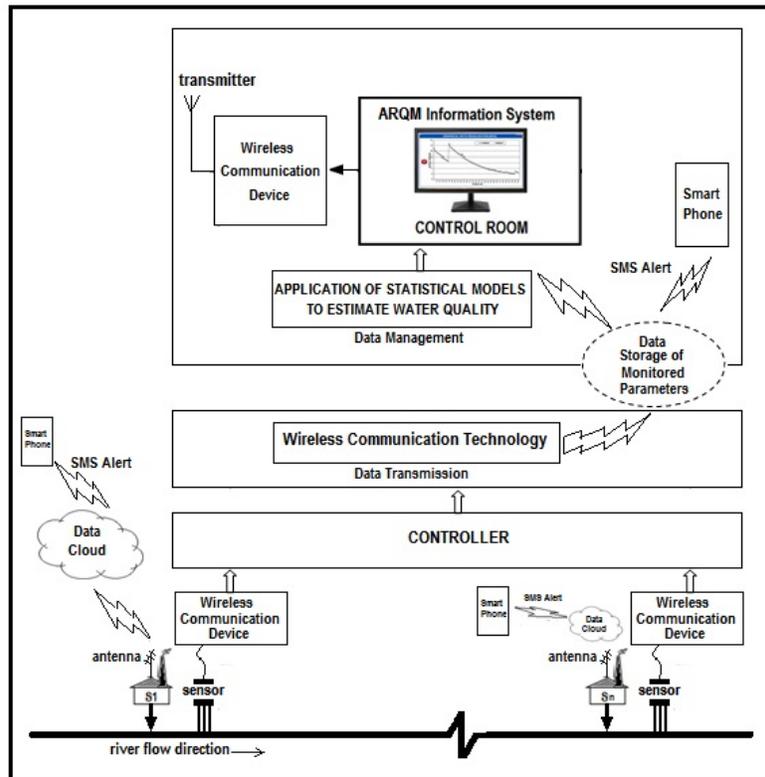
interval in the cloud, the language and the server used for developing the system.

### (a) Hardware design

The proposed system measures the parameters pH value, conductivity, turbidity and river depth using different sensors. Though the parameters BOD, COD, TSS and Conductivity are independent, BOD and TSS may be calculated while COD and Conductivity can be deduced from the values of BOD and COD using regression analysis of the data if database is created for a certain period of time and for a certain source of water [55-57].

A correlation study is carried out among seventeen parameters of groundwater water quality and have found that eight parameters possesses adequate correlation with EC, that is, EC with TH is 88%, with Mg 97%, TA 84%, TDS 99%, chloride 98%, sulfate 94%, SAR 90%, sodium 95% [58]. The conductivity and turbidity are used to predict the water quality parameters such as TSS, TDS, BOD, COD and DO. The parameters such as TH, Mg, TA, Chloride, sulfate and SAR also can be estimated using statistical formulae derived for particular river water at the outfall points where the sensors are installed and used to predict the same for point-to-point prediction along the river stretch with the help of the ARQM information system.

The schematic diagram that explains function of the present system is presented in **Fig. 1.1**. The functions of water quality monitoring system were made active by the central unit of the IoT as a controller. Researchers have used a varieties of controllers in smart water quality monitoring system, namely AtMega [59, 60], PIC [9, 51, 61], Raspberry pi with IOT [52,53,62], ARM LPC [44,63], Arduino [64-67], Controller 8051 [20] and MSP430 [68]. The IoT based solution normally is neither economic nor power effective as it uses controller additionally supported with externally attached Wi-Fi Further its circuitry design is very complex. Geetha and Gouthami (2014) use a single chip microcontroller TI CCS3200 with in-built Wi-Fi module and ARM Cortex M4 core, which searches nearest Wi-Fi hot spot for internet connectivity [54].



**Fig. 1.1. Schematic diagram of the ARQM system**

In the proposed ARQM Information System, four different sensors for measuring different parameters, namely conductivity, turbidity, pH value and river depth are installed at the reference and confluence points of industrial effluents just before mixing with the river and directly interfaced to wireless communication device (WCD). Sensor for measuring multiple parameters can also be used. An arrangement of Liquid Crystal Display (LCD) is made to display the measured water quality. The sensor data are transmitted to controller in the cloud using WCD. The threshold limit is set in the cloud based on the standards provided by Central Pollution Control Board (CPCB) for each parameter of surface water. Automatically SMS is sent from cloud to alert the environment manager of the respective industries whenever the river quality exceeds the permissible limit. Extending the circuit diagram reported by Geetha and Gouthami [54] for assessing drinking water samples, a mobile application is developed for assessing water quality of different locations along a river stretch and further to carry out point-to-point prediction of the same in a dynamic river system. The data obtained by each sensor in the cloud is viewable and the parameters TSS, TDS, DO, BOD and COD are estimated using statistical models with an assistance of a computer system. The ARQM information system is applied to predict river water quality using the input parameters from the database and the graphic of the same is plotted to display in LCD. The predicted data is again transmitted in the cloud with SMS alert so that the officer of each industry concern with environment management might take necessary action to control pollution along the river stretch adjusting the effluent discharg-

ing rates. Now the arrangements for measuring sensor data are explained in details as follows:

- (i) Turbidity is measured as a degree to which the transparency or quality of water goes down due to the presence of suspended particulates. The more total suspended solids in the water, it seems gloomy and the higher the turbidity. Thus, the parameter turbidity is considered as a good measure of the quality of water. Light Dependent Resistor (LDR) and Light Emitting Diode (LED) are useful optoelectronic tools for measuring turbidity by allowing light transmitted through the water samples. When the LED emits light upon suspended particulate matters of river water sample and LDR receives the reflected light and the semiconductor engrosses the photons that represents the quantum of light and gives adequate energy to the bound electrons for soaring into the conduction band while the light falls on the device of high frequency. In between the tools LDR and LED, a fixed gap of 90 mm is kept. The resistance decreases when free electrons conduct electricity.
- (ii) A mechanical system is fabricated and made to float on the surface water flexible to move up or down as the water level increase or decrease in the river with the help of two fixed rods on river bed and the water level is sensed to

determine the depth of the river using IP68 Ultrasonic depth sensor.

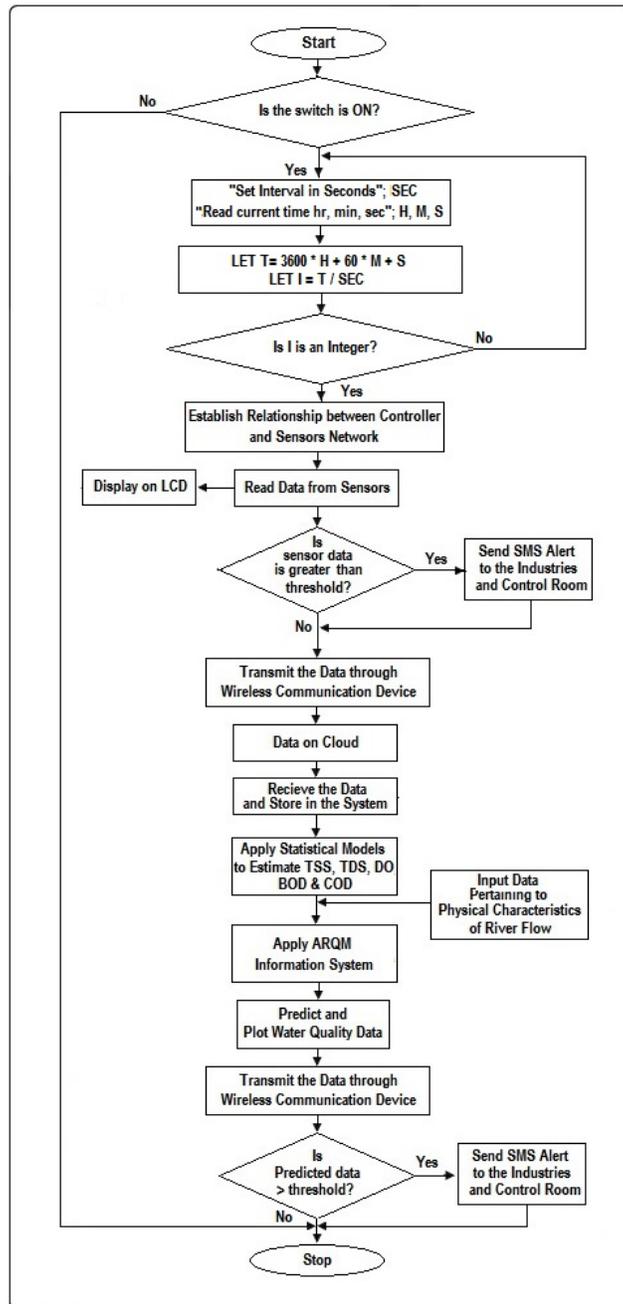
- (iii) The parameter pH is the amount of acid in the water. A pH meter of 3 in 1 which boosts the voltage from mV to V with inverting operating amplifier is installed to measure pH value. The pH sensor consists of two kinds of electrodes. The first is known as reference electrode and another is measuring kind. The first kind develops a potential which is proportional to pH while these electrodes are immersed in river water and the second kind measures. The pH value varies from 0 to 14 and the threshold limit is set in the range from 6 to 8.8.
- (iv) Electrical conductivity of water is nothing but its ability to carry or pass current and it is used to assess the concentration of salt in the water. A sensor YL-69 consisting of two electrodes is used in the design to measure the conductivity of the river water while an electric potential is generated. This potential increases with the measure of conductivity. The conductivity is measured in seimens per cm. The acceptable limit of conductivity varies from 150 to 500  $\mu$  seimens per cm. SMS alert is sent to the concerned industrial units for necessary action to control pollution level when these parameters exceed the limit. Necessary arrangement is made for

uninterruptible power supply at the monitoring sites to support the smooth function of the sensors.

### **(b) Software design**

A software system is developed for sensor data updation in the cloud and the process of the system is explained through the flowchart as shown in **Fig. 1.2**. Readings from the different sensors are constantly updated in the cloud for the set interval and also displayed in the LCD. Energia IDE which is an open source and community-driven integrated development environment and software framework is used for programming the proposed system and the data sent to controller are stored in "Ubidots" cloud. "Ubidots" provides a podium for developers for capturing sensor data and make them serviceable so that other water quality parameters can be estimated using statistical models [69].

The data pertaining to river flow attributes such as river width distance between outfalls points, dispersion coefficients, settling velocity of settle able parameters, average rate of water pumped out for industrial use, average rate of effluent discharge are time to time updated in the database to be used as input parameters for the proposed ARQM information system. The water quality data that statistically generated from sensor data including the current water level in river are also input parameters to the system. The system consists of a real-time control panel to control the devices, to analyze the data and share them through public links.



**Fig. 1.2. Flow chart for updating sensor data in the cloud**

Data transmitted in the cloud is retrieved for statistical analysis and arrangement for sending SMS alert is also programmed as and when the data exceeds the permissible limit. The following steps may help the users to connect the system with the Ubidots cloud:

- (i) Switch on to connect the access point with the help of SSID and password through mobile or computer
- (ii) Turn on Wi-Fi to connect the controller
- (iii) Login to cloud platform, where a user ID is generated
- (iv) Use the user ID in the program
- (v) Load the data from the controller into the cloud
- (vi) View data on the cloud platform

The ARQM information system is typically constructed with 3 layers of architectural design consisting of the provisions for presentation, business logic and data access based on the concepts, methodologies, tools involved in New Generation Wireless Sensor Network [73]. The presentation layer contains the component that implements and display the user interface and manage user interaction along with arrangement to control and display the outputs. The business layer represents the business rules that are enforced via programming logic regarding how those rules are applied. The data access layer consists of the definitions of database tables and columns and the computer logic that is needed to navigate the database [49]. An excellent user friendly interface and secured database

management are the most important features of the system and also the need of the hours. The ARQM was developed with a database and process design in Visual Basic.NET using Visual Studio 2010 with MS SQL Server 2008.

### III WATER QUALITY DISPERSION MODELLING

A river quality dispersion model is developed incorporating the variation in velocity and flow rate, average depth and width along the entire river stretch considered for study. The model computes flow rate at the reference point of the river system for the stream velocity fed to the system by the use and then simulates the velocity as well as the flow rates for each stretch according to the variation in depth and width of the stretch duly taking the intake water for industrial or domestic use and the water from the tributaries or effluents from the industries discharged into river system into consideration [48]. The

dispersion model is supported with velocity distributive functions and flow rate computing model to incorporate the changes in stream velocity as well as flow rates while computation [49]. The reader may refer these articles for detailed information. However, only the model is recited here for the ready reference as follows:

Let us consider a analytical river system in 3D space wherein its XY-plane represents cross section of the river and Z-axis the length of the river stretch in the downstream where the point of origin assigned to the point on the top most layer of water flow corresponding to its maximum depth level. According to principle of fluid dynamics, the river flow rate will be greater the flow rates at all other points of the cross section normal to the flow direction. The dispersion model for predicting water quality parameters at P(x, y, z) when initial concentration and stream velocity at reference point P(0,0,0) just after critical mixing distance are  $c_0$  and  $v_0$  respectively, is as follows:

$$C(x, y, z) = p \left( \frac{c_0 v(x, y, z)}{v_0} \right) \left[ 1 - \frac{v_0 e^{-k \int v(x, y, z) dz}}{D \frac{v_0}{v(x, y, z)} (d_0^2 - x^2)} \left( \frac{z}{d_0^2} \right) \right] + (1-p) \left( \frac{c_0 v(x, y, z)}{v_0} \right) e^{-\frac{kz}{v(x, y, z)}} \quad (1.1)$$

Prediction of Settleable Component
Prediction of Non-Settleable Component

### IV APPLICATION OF ARQM

The industrial developments always take place at the river banks as it is convenient for the industries to dispose the effluents. The various industries situated at the bank of a river stretch identified as highly polluted segment are responsible to maintain the quality of river water and protect the aquatics following the norms for environmental pollution control. The database consisting of both sensed and measured from the reference as well as outfall points of the industrial sources  $S_1, S_2, S_3, \dots, S_n$  is communicated to control room through the network of schematic block diagram as shown in Fig. 1.1.

The ARQM information system is executed as explained through a flowchart presented in Fig. 1.2 for point-to-point prediction of river water quality along the river stretch as output of the system and communicated to all the monitoring units of all industries connected in the network so that the necessary action such as controlling either the effluent flow or operation of industrial units to minimize impact of effluent on river quality. For an illustration of application of the system, a river, namely Damodar is chosen and a stretch of 38 km length starting from the effluent discharging point of Mahudah Coal Washery to the point of confluence a tributary, namely Gobai with the river. Research studies have revealed that the stretch is highly polluted [2, 6, 47-49]. The stretch is blended with effluent from seven coal washeries, one domestic sewage discharging point from Sindri Township and

four tributaries called Katri river, Jitpur stream, Patherdih stream and Gobai river.

The data pertaining to reference point of Damodar river stretch and different industries situated at the bank of river such as velocity and flow rate of river water, concentration of water and effluent quality, average river depth, distance of industries from reference point are used as input parameters. Different sources of water pollution that pollutes associated with the selected Damodar river stretch along with their intake flow, effluent discharge during summer and winter are presented in Table 1.1. The concentration of different water quality parameters which are established to have adequate correlation with sensor data, are estimated from the same for a summer season and presented in Table 1.2. The dispersion coefficients for the four conservative water quality parameters are estimated using the standard methods [70-72] and listed in Table 1.3.

There two categories of input data. The first one consists of input data that is assumed to be constant with season and time, which includes dispersion coefficients of different water quality constituents, distance between the outfall points, ratio of settleable bio-flocculated particulate matters, its settling velocity and dispersion coefficient, intake flow rates and discharging rates of effluents. The second one consists of the water quality constituents that vary frequently with season and time. The database consists of both categories of input data in the

required data structure to be read by the computer program. The system primarily receives the required input data from the database and predicts the river water quality using ARQM information system.

The system is user friendly with Graphical User Interface (GUI) to receive information such as names of monitoring stations, intake quantity of water and effluent discharging rate from various industrial sources along with concentrations of different water quality parameters, which are correlated and deduced from sensor data using regression

equations for reference point as well as industrial outfall points from the database. Now the system simulates the flow rates and calculates the cross-sectional area of river along different sections of reference point as well as outfall points. Using the varying cross sectional area and simulated flow rates, the system calculates stream velocity at each outfall point and predicts the water quality along each stretch. Further, the system also provides options for editing of raw input data. Some snapshots of the system are provided in **Figs. 1.3 to 1.5**.

**Table 1.1.**

**Different sources of water pollution that pollutes the selected Damodar river stretch and its flow rate**

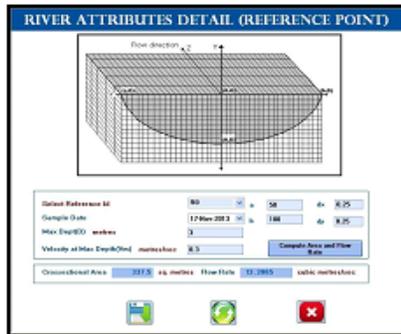
Source	Sources of Water Pollution	Intake (m <sup>3</sup> /s)		Discharge (m <sup>3</sup> /s)	
		Intake	Total	Sumer	Winter
S0	Mahuda Washery	0.005	0.005	0.004	0.004
S1	Loyabad Coke Oven Plant	0.046	0.080	0.040	0.044
	Loyabad Power House	0.038			
S2	Moonidih Washery	0.016	0.016	0.014	0.014
S3	Jamodoba Washery	0.011	0.104	0.099	0.101
	Jamadoba Power House-1	0.045			
	Jamadoba Power House-3	0.048			
S4	Patherdih Coal Washery	0.013	0.013	0.012	0.124
S5	Sudamudih Coal Washery	0.015	0.015	0.013	0.013
S6	Chasnallah Coal Washery	0.016	0.016	0.014	0.015
S7	FCI (Outfall - 1) & P&D Sindri Township	0.429	0.429	0.226	0.220
S8	FCI (Outfall - 2) Sindri	0.000	0.000	0.164	0.184
S9	Bhojudih Washery	0.014	0.025	0.022	0.025
	Santaldih TPS	0.011			

**Table 1.2.**  
**Concentration of estimated water quality parameters**

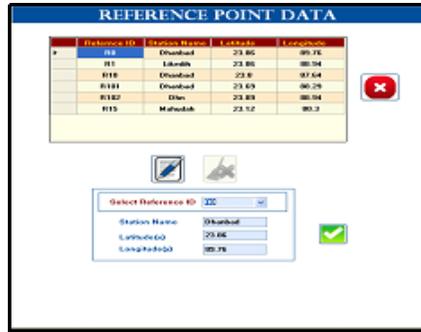
Source Code	Sources	Discharged through:	Water Quality Concentration (mg/l)				
			TSS	TDS	DO	BOD	COD
R	Damodar River (Upstream source)	Damodar	112	260	5.45	10.85	180
S0	Mahuda Washery	Directly	1270	300	3.35	7.25	3595
S1	Loyabad Coke Plant Loyabad PH Loyabad Township	Katri river	235	258	5.66	19.90	308
S2	Moonidih Washery	Directly	1203	335	3.72	4.46	3675
S3	Jamadoba Washery Jamadoba, Pump House – 1 & 3 and Jamadoba Township	Jitpur stream	370	283	5.72	6.25	125
S4	Patherdih Washery Patherdih Township	Patherdih stream	640	390	4.59	6.60	1930
S5	Sudamudih Washery	Directly	1780	560	3.25	7.20	3965
S6	Chasnalla Washery	Directly	1455	360	3.84	4.42	3673
S7	FCI (Outfall -1) P&D Sindri Township	Directly	890	421	6.31	3.83	1870
S8	FCI (outfall - 2) Sindri	Damohani river	589	352	4.52	5.52	75
S9	Bhojudih Washery Santaldih TPS Bhojudih Township	Govai river	555	425	6.54	4.85	552

**Table 1.3.**  
**Dispersion coefficients of water quality parameters**

Parameter	Dispersion Coefficient
BOD	$0.2 \times 10^{-3}$
DO	$-0.14 \times 10^{-4}$
TSS	$0.2 \times 10^{-4}$
TDS	$-0.2 \times 10^{-4}$



(a)



(b)

**Fig. 1.3. River attributes: (a) Cross section details and (b) Reference point data**

(a)

(b)

Fig. 1.4. Industrial source data: (a) Reference point and (b) Industrial source

(a)

(b)

Fig. 1.5. River flow data: (a) Reference point and (b) River stretch

## V RESULTS

The ARQM information system reads the required input data from the database after the set interval of time and predicts the water quality parameters. The point-to-point prediction of water quality data is graphically visualized for each parameter and the

same is transmitted in the cloud again to the terminals of the industries to receive and take necessary action to control the river pollution by controlling either the industrial operation or effluent discharging rate. The graphics generated by the system are presented for different parameters considered for the present study in Figs. 1.6 to 1.10.

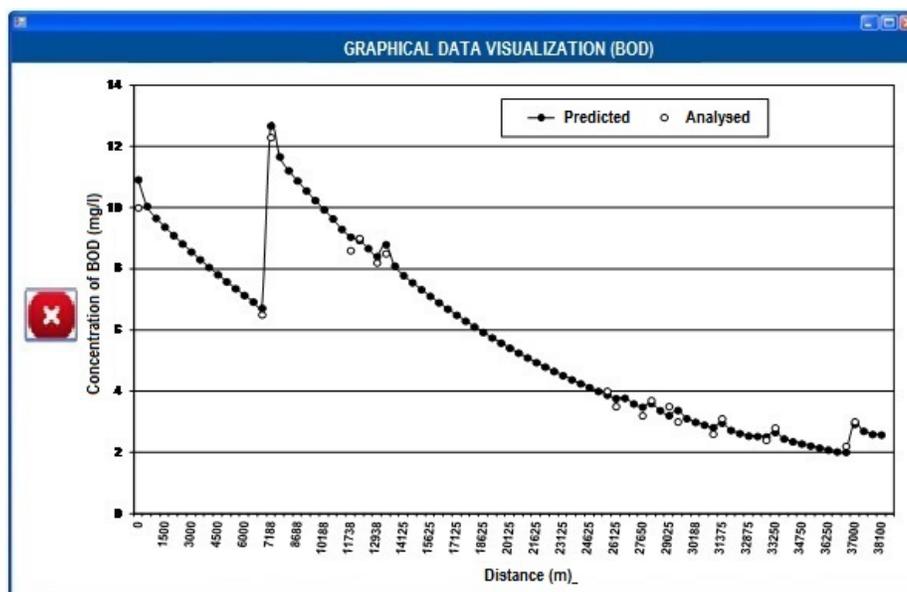


Fig. 1.6. Prediction of BOD along river stretch

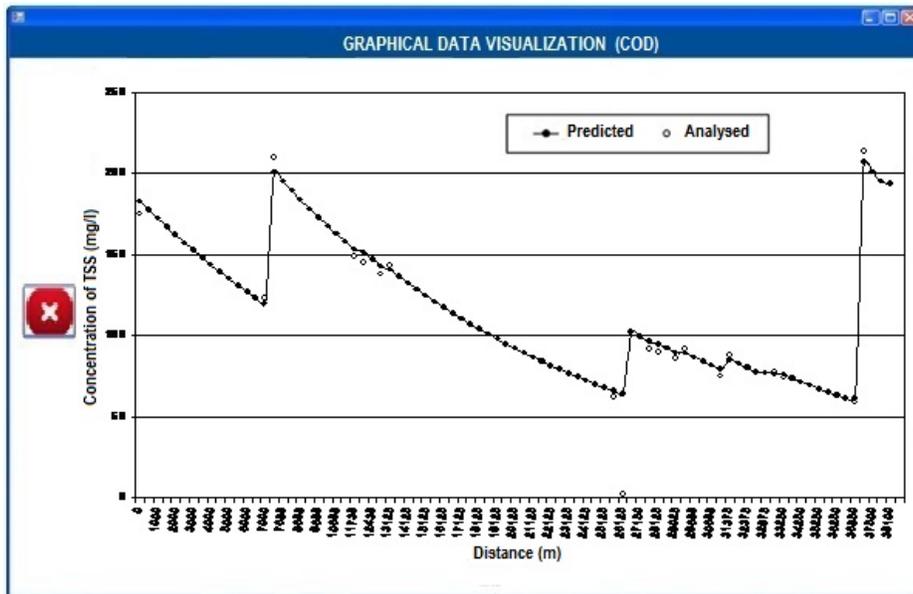


Fig. 1.7. Prediction of COD along river stretch

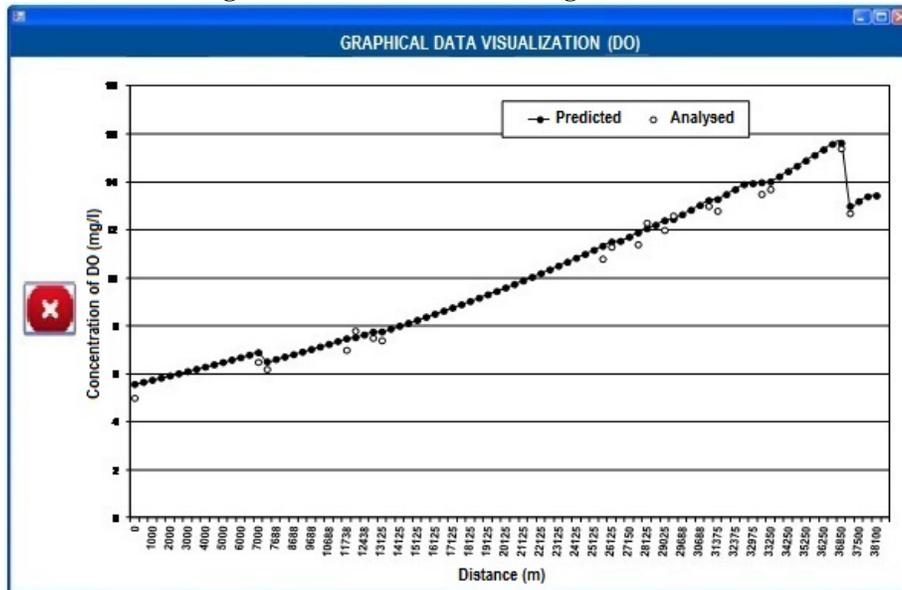


Fig. 1.8. Prediction of DO along river stretch

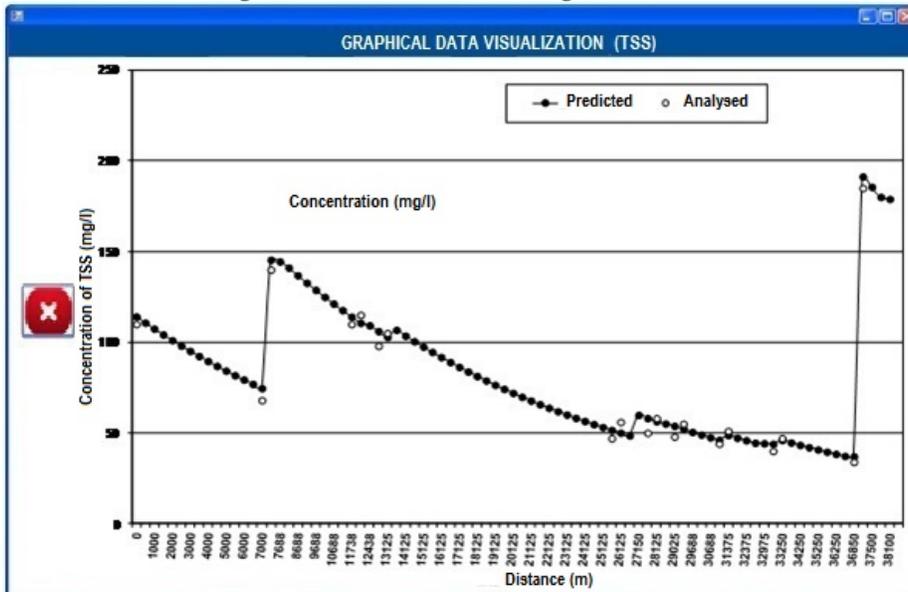


Fig. 1.9. Prediction of TSS along river stretch

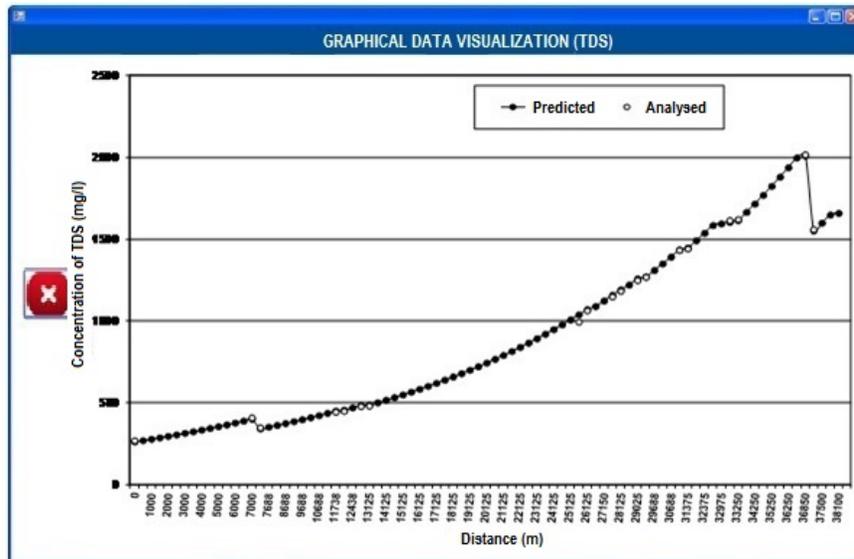


Fig. 1.10. Prediction of TDS along river stretch

## VI DISCUSSION

Function of the present system has three-fold stages. At first stage, the analog signals of the sensor are converted into digital signals by an inbuilt analog-to-digital converter (ADC) into digital signals at the receiving end so that the computer can process the data in its digital format. The data is transmitted in the cloud to the Control Unit/Room and also SMS alert is sent to the officer of the respective industry concerned with the environment for necessary action as and when the parameter exceeds the threshold limit. At the second stage, the Control Unit/Room receives the data from the cloud and the river quality parameters BOD, DO, COD, TSS and TDS are estimated using the regression models and stored in the database along with the other required input parameters which are not variable with season for each outfall points which are discharging their effluents to the river stretch starting from the reference to the end of the river stretch selected for the prediction study. Finally at the third stage, the ARQM information reads the data from the input file and predicts the water quality along the river stretch and the predicted data are stored in output file. The system was validated and it was found that the predicted data reveals 3-7% variation from the actual data, which may be acceptable for environmental studies. Further it is observed that there is a reduction in the impact of effluent when the outfalls meet with the river as dilution takes place after the effluent mixing well in huge quantity of water. However, the parameters TDS and DO increase with time or distance in the downstream whereas TSS, BOD and COD decrease.

## VII CONCLUSION

In the progress of ICT, development of online river quality monitoring system for river pollution management is gradually gaining the importance as it is more effective and economic. Finding solutions save huge investment of fund towards assessment of river water quality in conventional method. The present study addresses an online pollution management tool, namely ARQM information system which is an effective in power consumption and simple IoT technology for smart water quality monitoring. The present wireless sensor network is used for estimating conductivity, turbidity, water level and pH and further used for estimating BOD, COD, DO, TSS and TDS using regression models.

These parameters are used as input parameters as a part of the required input parameters for predicting water quality. The system also warns remote users through SMS alerts whenever the water quality exceeds the thresholds. The proposed system was developed user friendly with appropriate GUI so that any non-programmer can easily handle the system. The system is unique from other existing algorithms as it assesses the water quality and carries out point-to-point prediction along the river stretch. The system is applied for the prediction of water quality along the stretch of Damodar in Jharkhand State, India, blending with multi-industrial outfalls and the effluents from township areas as environmental monitoring system [74]. It is necessary to check the energy competency to apply solar panel to meet the required energy for smooth function of the system so that it may be installed in remote area where electricity is not possible [75]. The statistical analysis of the predicted data and the analyzed one reveals that 3-7% error may occur in the predicted water quality data, which may be admissible. Employing

the technique of data visualization in the framework of .NET provides vivid choice of graphs to visualize the different water quality parameters to the end users with adequate clarity and accuracy. The present system would be a great help to the industrialists concern with the department of environment management control to minimize the pollution load along the river stretch by either optimizing the discharge rates of the effluents or controlling operational units.

#### (a) Notations Used

$a_o$  = half of the river width measured as length of topmost layer normal to flow direction

$C(x,y,z)$  = concentration of the water quality constituent of volumetric element whose centre is at  $P(x,y,z)$

$D$  = maximum depth of the river

$k$  = dispersion coefficient of the water quality constituent

$k'$  = dispersion coefficient of the bio-flocculate particulate matter able settle down in the water

$p$  = fraction of the settleable bio-flocculated particulate matters

$P(x,y,z)$  = a point on the cross section of the river normal to flow direction whose coordinates are  $x, y, z$  from the origin of the 3D analytical river system in the directions of  $X, Y, Z$  – axes respectively

$v(x,y,z)$  = velocity of the stream flow at the point  $P(x,y,z)$

$v'$  = settling velocity of the bio-flocculate particulate matter able to settle down in static condition

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# A Review on Processing, Characterization and Erosion Wear Response of Filled Metal Alloy Composites

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## ABSTRACT

*Metal matrix composites they were mainly included in structural engineering components where only a typical failure mode becomes solid particle erosion. That research throughout this article focuses also on manufacturing and classification of silicon carbide (SiC) reinforced metal matrix compounds (MMCs) at various weight percentages ranging from 0 to 9 percent by weight in phase 3. Also reported the% of each and their response to erosion wear of the solid particles. A simple and widely used liquid metallurgy technique called stir casting technique is used to produce these composite materials. The erosion tests are carried out according to the experimental design based on the Taguchi L16 orthogonal matrix. It describes the primarily important factors that control that wear rate. The findings suggest how this compound's erosion wear rate was most determined than other influences even by impact rate and fill material, meanwhile. This also illustrates the strong filling properties of both the SiC particles because as wear rate declines throughout the matrix material with increasing filler content.*

## I INTRODUCTION

Metal matrix composites they has several advantages over monolithic metals, such as for a higher specific module, significantly higher weight, improved elevated temperature properties, and even a lower thermal expansion coefficient. Because of certain properties, for even a large variety of uses, viz., metal matrix composites are considered. Nozzle chamber combustion (in rockets, space shuttles), housings, pipes, cables, heat exchangers, structural elements, etc. Metal matrix composites (MMCs) Thanks to a combination of superior mechanical properties, including such strengthened elastic modulus, tensile strength, high temperature stability or wear resistance relative to master matrix alloys, they also increasingly became candidates of vital structural applications.. Designers benefit from MMCs as they would be especially ideal for mobile that need good tolerance to high temperatures, good structural rigidity, dimensional flexibility but light weight. The new trend is really for the healthy the use MMC components in car engines that mainly work in high pressure and temperature conditions. [1]. The increasing demand towards lightweight, rigid but solid materials having contributed to the growth of ceramic dispersion reinforced MMC. This MMCs have exceptional mechanical characteristics and thus are deemed possible engineering components of different wear-related applications. Several researchers experimented upon this MMC sliding wear system reinforced particles such as SiC, Al<sub>2</sub>O<sub>3</sub> which garnet particles, etc., but instead found an increase in resistance to wear including abrasion [2]. Zinc casting alloys are advanced materials that really are flexible. The combination of strength, durability, rigidity, bearing efficiency but economical casting capability is not provided by any other alloy method. Due to its excellent bearing but wear properties, lower casting temperatures but lower costs [3], zinc alloys become critical matrix materials. Zinc-aluminum (ZA) alloys containing a limited quantity of copper has proved to

have been expense but energy-efficient replacements for such a number with ferrous and non-ferrous alloys because of the higher strength, improved wear resistance, [4]. ZA alloys become appropriate bearing materials, perfectly appropriate with applications with high loads with low speeds [5]. Thanks towards good tribomechanical properties, low weight, significant and positive effect to melt and flow, good processing characteristics, high strength characteristics including such castings, good corrosion resistance, low initial cost, casting energy saving, ZA alloys (mainly ZA-12 and ZA-27) are likely to substitute cast aluminium alloys and bearing bronzes [5] with environmentally safe technology including properties with equal or perhaps even greater bearing but wear. That cost savings of 25 percent to 50 percent to 40 percent to 75 percent, relative to aluminium and brass alloys, overall, is really a significant thing that determines these alloys desirable. [6]. That being said, some lower compressive strength at elevated temperatures and dimensional instability near temperatures beyond 100 C [3,4] are the key drawbacks of the alloy device. The strong strength of these alloys is Alloy ZA-27, and corresponds to both the ZA alloy family, that is used as a substitute for bronze bearings in bearing which bushing implementations. [7,8] Because of its lower cost with equal or higher efficiency. It's indeed incredibly common throughout the markets for bearings, wear-resistant parts, valves, pulleys and pulleys, throughout addition to using it with thin-walled casts and also in components like electrical, automotive or industry and agriculture machinery. [9]. Stir casting becomes widely agreed as both an especially promising route[10] among the variety of production processes available with MMC batches. The benefits are its convenience, versatility and applicability to something like a vast amount of manufacturing and this is also the cheapest of all MMC routes available.. [10]. Throughout this technique, these are shook vigorously to shape a swirl on the surface of both the melt because after matrix material was already melted, and then the reinforcement material is applied to the side of the

swirl. These are noted that throughout stirring, the formation of the vortex becomes useful and for movement of particles to both the molten matrix, because the change in temperature here between melt's inner and outer surface sucks the ions into liquid [11]. No consideration has been paid to the tribological traits of Zn-based CMMs. Researchers working on specific Zn-Al strengthened alloys [12, 13] recently confirmed that now the addition of reinforcing particles greatly increases the abrasive, slipping wear resistance. In general, the development of major ceramic particles including such SiC, Al<sub>2</sub>O<sub>3</sub>, tends to increase the resistance to corrosion (two bodies including three bodies) and MMC erosion corrosion dependent on either a matrix of ZA alloys. Throughout the manufacturing, automobile and defence industries, CMMs are commonly used. Carbide tips containing hard tungsten carbide particles throughout are often constructed from the tough cobalt matrix. Any tank fittings may even be constructed of composite metal matrix components, likely reinforced steel with boron nitride. MMC can be used for some vehicle disc braking. And for its high basic thermal but thermal conductivity, modern high-performance sports cars, like those manufactured through Porsche, utilize carbon fibre rotors inside a silicon carbide matrix. Ford gives technical improvement to both the composite driveshaft metal matrix. The MMC driveshaft comprises of the aluminum mould reinforced with boron carbide that helps the driveshaft's critical speed to still be improved through reducing inertia. In many of its engines, Honda has been using aluminum matrix composite cylinder liners, along with the B21A1, H22A and H23A, F20C but instead F22C, and the C32B used in the NSX. And since, Toyota has been using metal matrix compounds, such as the Toyota Matrix of the very same name, and in Yamaha-designed 2ZZ-GE engine which is used in later iterations of the Lotus Elise S2, as well as in Toyota car models. In the Boxster and 911, Porsche often employs MMC to improve the engine's cylinder liners. And for structural portion of both the aircraft's landing gear, the F-16 Fighting Falcon uses monofilament silicon carbide fibres in either a titanium matrix. Wear are characterized when damage to something like a solid surface that, despite the relative movement here between surface one and or maybe more substances throughout contact, typically implies a progressive loss between materials. [14]. That is a material reaction to external stimuli which could in essence be mechanical or chemical. The influence of wear mostly on durability of industrial products becomes widely known and also the cost of wear has indeed been identified as being very high. While wear was already clinically analysed thoroughly, wear problems in industrial applications continue. Currently, which shows the difficulty of both the phenomenon with usury [15]. In most plants and equipment, wear is really a typical phenomenon and is always a phase that's also gradual but progressive [2]. Among the most noticeable phenomenon of wear is erosion. These are attributed to the effect of

contaminants on the surface of materials deposited in a current of gas or liquid. This one in essence, in several manufacturing applications, limits their life of both the mechanical components included. Based on erosion forms including damage processes, there are many various groups of erosion wear, including such pulp erosion, strong particle erosion, liquid affect erosion, including cavitation erosion. [16]. Strong Particle Erosion (SPE) is a mechanism of atmospheric deterioration wherein the substances interfere with the surface and facilitate the loss of material. A particle holds momentum and kinetic energy throughout travel, that will dissipate attributable to it's own collision with the a target surface through contact. [17]. SPE is indeed a useful phenomena in the some situations, including such blasting but abrasive high-speed water jet cutting, but in other infrastructure processes, namely steam & jet engines, pipes and valves who hold particulate matter and valves, that is a significant issue fluidized bed combustion systems (FBC) [18]. For all of this cause, this article examines that impact of the implementation and quality of silicon carbide (SiC) particles on the ZA-27 alloy's erosion resistance potential. The effect of further only one parameter over erosion wear of SiC-filled ZA-27 alloy metal matrix compounds has been experimentally explored and in experimental portion of this research. In order to research the influence of different operating parameters [19], an easy-to-use and therefore less time-consuming experimental programme suggested by Taguchi was implemented. This experimental design suggested through Taguchi having subsequently been gradually added to a large range of MMCs in order to evaluate the parametric evaluation throughout the friction method. [20-27]. ASTM chemical composition of the alloy: The B86-13 ingot configuration is seen in Table 1. Throughout this group of zinc-aluminum alloys, ZA-27 is the lightest alloy and thus has greater wear resistance property. Therefore, The whole material is commonly used for the bearings and is now used in many automobile components including such "clutches, brake rotor, connecting rods, exhaust valves," etc. due to it's own light weight, increasing vehicle fuel economy. This material might be used for power lines as a lightweight heart. Filling material. Filling materials are generally discontinuous, stronger and harder than matrix materials. Improving electrical, mechanical or tribological properties seems to be the primary purpose of all these filling materials. About either the compound. Silicon carbide is often used as either a filler substance composed of silicon tetrahedra but atoms of carbon through solid crystal lattice bonds. Which creates a substance that would be very hard and solid. Low density, high strength and high strength are also the main properties, Thermal expansion is low, thermal conductivity is high, hardness is high. SiC forms at 1200 °C a protective film of silicon oxide and in air which can be used up to 1600 °C. That high temperature due to low thermal expansion and high resistance makes these material outstanding thermal shock resistance characteristics. Some typical uses of

silicon carbide are in stationary and mobile turbine components, gaskets, bearings, heat exchangers, etc. 2.3. Composite fabrication in this process, And use the muffle furnace, the melting of both the matrix alloy

ZA-27 becomes done independently at around 800 C, beyond its melting point. The total amount of filler particles (0, 3, 6 and 9 percent by weight) preheated from around 400 C after melting, are added to Ta

**Table 1**  
**Chemical composition of ZA-27 alloy. Materials**

Material	Al	Cu	Mg	Zinc
Wt%	25-28	2-25	0.01-0.02	Balanced

But use an electric stirrer, the molten metal is constantly stirred. In order to guarantee a uniform mixing of filler particles and in matrix material, the stirrer becomes rotated at a speed of 450 rpm for 2-3 minutes. In order to improve wett ability throughout stirring, There are minimal concentrations of magnesium that have been added to both the melt. That molten metal would then be poured into some kind of permanent shape of 120  $\chi$  305 mm<sup>2</sup> cast iron with inter-laminar shearing. Usage of the very same UTM.

CASTING AND THE TEMPERATURE ARE THEN SLOWLY DECREASED. THE CASTINGS ARE EXTRACTED AFTER SOLIDIFICATION.

Form and height criteria (25  $\chi$  25  $\chi$  5 mm<sup>3</sup>) for the erosion test.

## II DENSITY AND VOID FRACTION

In different weight sensitive uses, density is now a structural property of both the utmost significance. It depends on either the proportional proportion of the components with in composite of reinforcement and matrix. There still is a disparity between such a composite material's theoretical or observed density values consistent with neither voids nor pores becoming present. Any of the mechanical properties but even the efficiency of composites is influenced greatly by all these voids.

Porosity measurement is performed using the image analysis technique. The polished top layers are held under a microscope (Neo-mate) equipped with a CCD camera (JVC, TK 870E). To produce a scanned shape of the specimen, which device was being used. The scanned image becomes transmitted through VOIS image recognition programme to something like a computer. The programme will reliably measure the total area covered through, or a percentage of, its microscope objective. The total area each area occupied either by pores then is separately calculated as well as the porosity of both the surface being analysed is assessed.

(a) **Micro-hardness** - The micro hardness calculation is carried out along with the micro hardness of a Leitz. A diamond indenter becomes inserted under load F, shaped like it's a straight pyramid with such a square base but an angle and 136 between opposite sides, into another material. That measured load and also its arithmetic mean L are the two diagonals X and Y of the notch which exist also on surface of the sample following removal. The load assumed is F = 49.08 N with in current

thesis and even the Vickers hardness number becomes determined using following equation[28], where L has been the sample segment volume. P seems to be the maximum load; b and t are also the sample's width but thickness, respectively.

- (b) **Impact strength** - By breaking the V-notched specimen with the pendulum hammer, evaluating the expended energy but comparing it to the cross section of the specimen, the pendulum impact testing machine (ASTM: D256) ascertains another notch pressure power of the material. The machine becomes calibrated such that the blade on the free-hanging pendulum scarcely reaches the specimen (zero position). The specimens become clamped in either a square support and thus are struck by the 5 mm diameter hemispherical bolt at the centre point.
- (c) **Scanning electron microscopy** - According to any JEOL JSM-6480LV scanning electron microscope, both surfaces both of composite specimens are routinely inspected. Until studying by SEM, these specimens were immersed cautiously in chloroform. Those composite samples are placed as well as the eroded and uneroded surface with stubs are examined.
- (d) **Erosion test** - Strong particle erosion experiments are undertaken in conjunction with ASTM G76 that used a standard air-jet erosion test rig. Using this set-up, although that's capable of creating erosive conditions, the erosion wear tolerance of such composite samples could be tested. Mainly comprising of an air compressing machine, an air-drying unit, which set-up, an air-drying unit, a conveyor belt type particle feeder,
- (e) **Tensile strength** - Probably, the tensile testing is done on flat specimens. The dog-bone type and the straight side variety with end tabs are indeed the widely encountered tensile test specimens. A single axial load will be applied through several ends of the line mostly during procedure. The ASTM basic test system with metal matrix composite tensile properties seems to have the designation ASTM: D3552/D3552M the tensile testing is applied also on Instron 1195 Universal Measuring Machine (UTM) and also the results was analyzed to determine that composite sample tensile power.

(f) **Flexural strength** - The short beam shear (SBS) tests to determine the importance of flexural power, the composite samples was maintained constant. It is a 3-point bend test that usually promotes failure particles to both the mixing chamber while regulating the frequency of both the conveyor belt drive motor through varying. The compressed but dried air throughout the mixing chamber became combined with the eroding particles and afterwards accelerated through moving the mixture thru a tungsten carbide convergent nozzle with such an internal diameter of 3 mm and a length of 80 mm. Without perpendicular to the change of erodent movement, that erodent particles hit its sample surface from various angles varying around 15-90 and this angle with impingement could be varied through putting the samples horizontally within various sampling holders providing inclined faces 0-75. The velocity of both the erodent particles' effect is measured and use the double-disc process [29,30].

Dry silica sand with such an average particle size of 450  $\mu\text{m}$  will be used as erodent throughout this current job. In order to conduct erosion experiments, the composite sample are cut to both the scale of (25x25x5) mm<sup>3</sup>. Samples were washed, dried then weighted with acetone and used an appropriate weight measurement tool with such a precision of  $\pm 0.001$  mg during degradation for weight loss assessment. Otherwise the ratio with weight loss due to erosion to both the weight of a erodent inducing that loss were determined for a non-dimensional erosion rate. Each test run becomes repeated 3 times as well as the mean

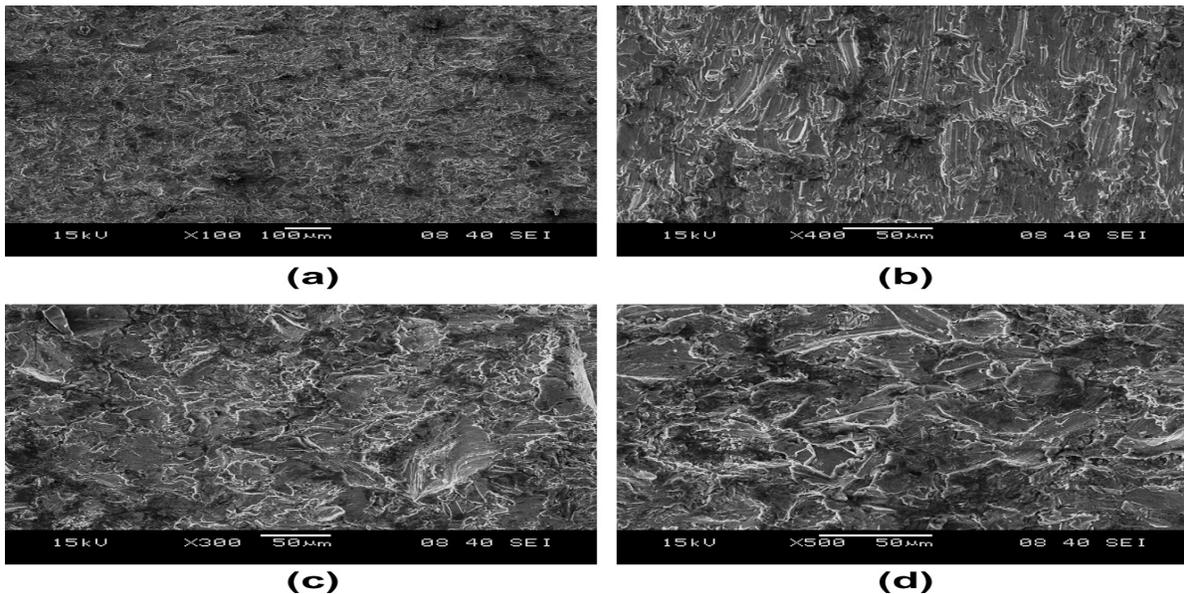
outcome becomes taken into account for any further erosion estimation.

And in regions near their wear surface, micro-constituents. Micro-cracking too is found in the top layer of both the subsurface region and yet another characteristic is really the movement of micro-constituents throughout the direction of eroding flow throughout the closest vicinity of both the wear surface.

### III EROSION WEAR RESULTS AND TAGUCHI ANALYSIS

Performing different lab conditions, the corrosion wear rates of SiC strengthened ZA-27 metal matrix composites. Experimental results are translated into ratios of signal-to-noise (S/N). In truth, last and column reflects the S/N erosion rate ratio of an average of three replications. The research is carried out using common technologies primarily used for creation of experimental application known as MINITAB 14.

The S/N ratio reaction, through which it could be inferred that friction coefficient is now the most significant factor of any and all variables, accompanied with filler material, stand-off distance & impingement angle, whilst the eroding temperature does have the least or negligible importance for the erosion rate of these ZA-27 metal matrix composites filled with SiC. Other researchers like Mishra



**Fig. 1. SEM micrographs of the uneroded and eroded surfaces of the ZA27 metal matrix composites filled with 9 wt% SiC.**

This kind of outcome is also recorded in another research. The consequence of the various signal-to-noise ratio control factors shown in Fig. 1 therefore points to the result that it the minimum corrosion wear

rate of the mixture component.

## IV CONCLUSION

The following basic findings contributed towards this theoretical and experimental research on particulate filled metal alloy.

- (a) This composites do have low porosity and enhanced micro-hardness, tensile strength or force of effects. These show significantly lower flexural capabilities than that of the pure alloy ZA-27, though.
- (b) It also is possible to actually evaluate the corrosion properties of these composites and use the Taguchi experimental design scheme. That Taguchi approach offers a clear, comprehensive and efficient technique for maximizing control factors. The successful application of both the signal-to-noise service elements recognises essential factors that influence the erosion rate of composites.
- (c) The most significant aspects for the erosion rate of ZA-27 metal matrix composites filled with SiC filler are considered to be effect velocity and filler content amongst the variables.

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# Studies on Novel UV-Curable Waterborne Polyurethane Coating

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## ABSTRACT

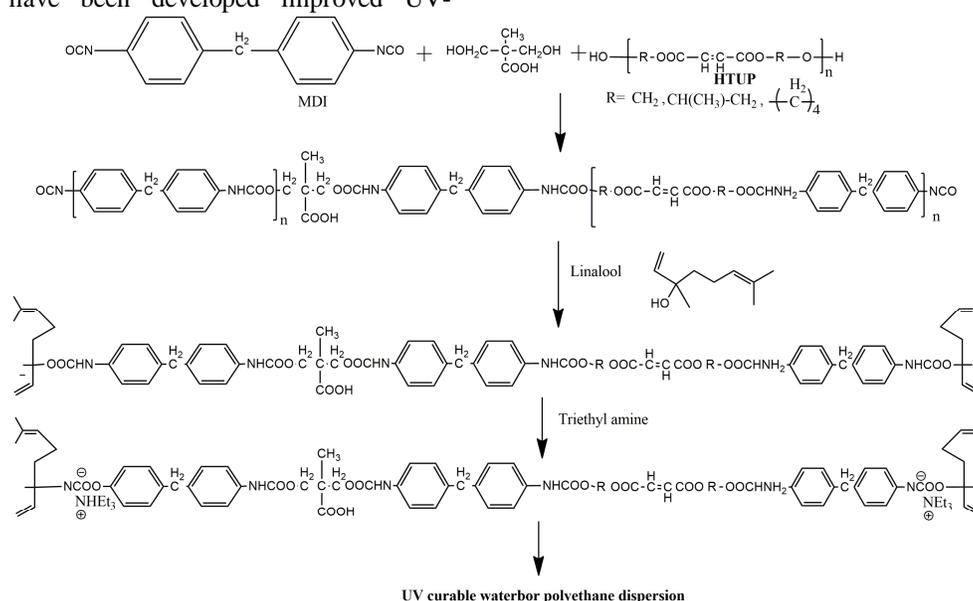
The novel ultraviolet(UV) curable waterborne polyurethane dispersion was formulated from 4,4'-methylenebis(phenyl isocyanate) (MDI), hydroxy terminated unsaturated polyesters (HTUP), 2,2-dimethylol propionic acid(DMPA) and Linalool(LL) (a terpinol). MDI has been selected for receiving more thermo resistant coating. LL has been selected for fast curing process. The resultant dispersion was coated as steel panel. The panels were irradiated by UV mercury lamp (15w) for 10-15 min. The resultant coatings were characterized by thermal and mechanical properties.

**Key words:** UV-radiation, curing, waterborne polyurethane, diisocyanate, unsaturated polyester, coating, thermal and mechanical properties.

## I INTRODUCTION

The research emphasises an ecofriendly surface coating materials [1]. Thus waterborne coatings are environmentally safe and thus attention received as substitute to solvent free coating [2]. Though waterborne coating are inferior to coating in terms of chemical and mechanical properties [3]. But the UV curable coatings overcome such drawbacks with affording excellent all over properties [4-7]. Several researches have been developed improved UV-

curable waterborne coatings [8-11]. Recently the present author reported the novel waterborne polyurethanes (WBPU) based as hydroxy terminated unsaturated polyesters [12]. Such WBPU have unsaturation so called dispersion may have tendency to cure via UV radiation. Thus the present paper is extension of our earlier work [13] with introduction of more unsaturation by Addition of natural product i.e. a terpinoid-linalool. The present paper comprises the modified formulate as shown in scheme.



## II EXPERIMENTAL DETAILS

- (a) **Materials-** 4,4'-methylenebis(phenyl isocyanate) (MDI), 2,2-dimethylol propionic acid (DMPA), Triethyl amine (TEA) and all

other chemicals were used of pure grade. The hydroxy terminated unsaturated polyesters (HTUP-1 to 3) were prepared as per our earlier communication [14]. Their specification are shown below: (Table-1)

**Table-1**  
**Specification of HTUP**

Resin	OH value mg/KOH	Mol.Wt.
HTUP-1	110	1020
HTUP-2	90	1250
HTUP-3	80	1400

**(b) Aqueous polyurethane dispersion** - The synthesis of dispersion was carried out in multinecked round bottomed flask set with stirrer, dropping funnel, N<sub>2</sub> gas inlet tube and HTUP (each of 1 to 3) (0.05 mole) were added. The dibutyltin dilaurate (as catalyst) was added into the flask with good stirring. The reaction was carried out at 85-90°C until yield -NCO terminated product obtained. Then DMPA (0.001 mole) was added and stirred the reaction mixture for 1hr. Again the -NCO terminated product obtained. The resultant product was added by required amount of linalool (as per -NCO group) and reaction was kept for 80°C for 2hrs. The dry acetone was added into the reaction product to receive desire viscosity of solution. It was cooled to room temperature and neutralized by Triethyl amine (TEA). Then the dispersion was obtained by distilled water adding under reduced pressure. The -NCO was determined during the reaction followed by method reported [13].

**(c) Preparation of UV cured resin on steel panel** - The prepared dispersion with Benzophenone as photoinitiator were mixed through stirring at room temperature and

was employed on metal panels and UV radiation was expose to panels into UV lamp chamber. (GT Ultra cure 350w/cm) The cured coating panels were stored in a glass chamber at room temperature. The cured films were also obtained by similar method by using Teflon panels. The steel panels were studies for mechanical properties. While the films were studied for infrared, gel content, chemical resistance and thermogravimetry.

**(d) Measurements**

**(i) The cured films:** FT-IR spectra of uncured dispersion and cured films were scanned by in KBr pellets on a Nicolet 400D spectrometer. Chemical resistance of cured film was determined by ASTM-D-1308 and D-5402 methods. Thermogravimetric analysis of cured films was carried out by DuPont 950 TGA analyzer at a heating rate of 10 K/min.

**(ii) The coating on steel penals:** The coating characteristics studies by chemical resistivity and mechanical properties were determines by methods mentioned below:

Test	Method
Scratch hardness	ISO 1518
X-hatch	ISO-2409
Flexibility	ISO-1303
Impact hardness	ISO-101
Pencil hardness	ISP-15184
Chemical/ solvent resistance	ASTM-D-1308,D-5402

### III RESULTS AND DISCUSSION

The waterborne polyurethane dispersion was performed by reacting varies HTUP with MDI to produced polyurethane. The IR spectra (not shown) of all polyurethane dispersion show the absorption bands at 3300, 1732 (-NHCOO- Urethane) and 1635 and 810 cm<sup>-1</sup> (double band). The band in this region of 2200-2300 cm<sup>-1</sup> is absent for C≡N of NCO. So all NCO groups are almost repeated.

The IR spectra of all three UV cured coating film as a function of time was carried out. The data are shown in Table-3. It was found that all three formulation showed the absorption band at C=C at 1630 and 810 cm<sup>-1</sup> decreased with increasing curing time. This is due to photo cross linking existing by HTUP linalool segments. The % age cross linking of C=C band was determined formula [14].

It was observed that the introduction of linalool may increase the cross linking by one of internal double bond. The end double bond may not be participating in cross linking due to allylic system. So % age conversions of curing and gel fraction are limits to 90%.

$$\% \text{ Cross-linking} : \frac{A_0 - A_t}{A_0} \times 100$$

Where  $A_0$  and  $A_t$  are relative absorption of C=C band at 810 and 1730  $\text{cm}^{-1}$  before curing and curing at time  $t$  respectively. The data are shown in Table-2. The data indicate that curing is increased by increasing the UV curing time. This is due to unsaturation present in HTUP and linalool segments.

The curing was confirmed by finding the gel fraction. The gel fraction was determined by method reported by Park and his coworker. [15] The cured film (100 mg) was dipped in to hexane at 50°C for 24hrs. The sample was dried and gel fraction was calculated from the wt. of total after drying versus original wt. The results (Table-2) show that gel fraction of three film increase rapidly by UV irradiation. The HTUP-1 has higher gel fraction.

The TGA data of all the three cured film are shown in Table-3. The examination of the results reveals that all the film starts their degradation around 200°C. The initial wt. loss is about 1.5%age. While beyond 250°C all the film degrades rapidly and 90% loss at around 500°C. The rapid losses mainly due to decarboxylation of urethane linkage. The stability upto serviceable temperature (~200°C) of film may be due to presence of aromatic segment of MDI.

The results of scratch resistance of all coated panels are shown in Table-4. It is mechanical property to fulfill coating role. The damage created by scratch on panel surface change in gloss or deformation by cracking. The results are good for produced coating material.

The X- hatch adhesion was determined by crosscut adhesion tester. It consistva die having 9 parallel blends of 1m long with 1/16" gap. The die was prepared into coated panel two dimensionally. A strip of self Adhesive was staked over the panel and stripped rapidly by pulling the tape bozol. The results are good and presented in Table-4 and Va. Results of flexibility test (by mandrel bend tester) are shown in Table. The results shows that the HTUP-3 have better than other two. This may mainly due to higher aliphatic segment.

Impact hardness of coating is effect at sudden impacts. By using standard method the impact area was observed for crack in coating and accordingly presented as passed or failed. The results are shown in Table-4 and indicate that the coating is good against impact.

For the pencil hardness a strip was drawn and H-grade pencil till which scratch the coated surface. The results are shown in Table-4. The results are good for all three coating materials.

The chemical resistance of cured film was dipped into test chemicals (5% aq. acid, alkali and common organic solvents: methyl ethyl ketone, ethanol, n-hexane etc.) for 24 hrs. After removal of panels from chemicals the observed results were monitored with any change of in the appearance or deterioration of the film. The observation is shown in Table-5.

**Table-1**  
**Specification of HTUP[16]**

coating	OH value mg/KOH	Mol.Wt.
HTUP-1	110	1020
HTUP-2	90	1250
HTUP-3	80	1400

**Table 2**  
**UV curing progress as a function of time by FT-IR spectroscopy and fraction of UV-coating as a function of time**

Coating	UV-curing progress by FT-IR spectroscopy (as a function of time,sec.) (% conversion)				Gel fraction (%age) of UV coating (as a function of time,sec.)			
	5	10	15	20	5	10	15	20
HTUP-1	50	56	70	80	70	80	90	92
HTUP-2	46	50	66	75	60	75	88	90
HTUP-3	43	48	64	74	48	75	85	85

**Table-3**  
**TGA data of all HTUP films**

Coating	% age Ion at Temperature °C			
	200°C	300°C	400°C	500°C
HTUP-1	0.95	5	50	95
HTUP-2	1.2	7	56	95
HTUP-3	1.3	7.5	58	95

**Table - 4**  
**Mechanical properties of UV cured HTUPs**

Coating	Scratch hardness (gms)	Impact hardness	Pencil hardness	Flexibility 1/8" mandrel	cross hatch adhesion
HTUP-1	3500	P	4H	P	Ex
HTUP-2	3450	P	4H	P	Ex
HTUP-3	3000	P	4H	P	VG

P: Pass, Ex: Excellent, VG: Very Good

**Table 5**  
**Chemical resistivity of UV-cured HTUP**

Coating	Acid 5%	Alkali 5%	Corrosion 5% NaCl	Solvents acetone/ ethanol/n-hexane
HTUP-1	5	5	5	5
HTUP-2	5	5	5	5
HTUP-3	4	4	4	5

5: Film practically unfeeted

4: slight loss on gloss of film

## IV CONCLUSION

The hydroxy terminating unsaturated polyesters were formulated UV curable waterborne polyurethane dispersion. Three samples have been prepared by using three diols viz; 1,2-ethane diol, 1,2-propanediol and 1,4-butanediol. The UV-curing of all three samples was carried out as steel panels. Then UV-curing conversion, mechanical and chemical properties were evaluated. The results of all three coats are excellent.

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# Comparative Study of Phytochemical Analysis of Nigella Sativa and Flax Seeds Used in Hypothyroid Treatment

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## ABSTRACT

*The medicinal importance of a plant is due to the presence of some special substances like alkaloids, glycosides, resins, volatile oil, gum, and tannins etc. Considering all these facts the present study is designed to investigate the presence of various phytochemical in two medicinal seeds out of which one is Flax seeds and the other one is Nigella Sativa seeds. Both the seeds are rich source of healthy fat, antioxidant and fibre. The nutrient in both the seeds help lower may risk of diabetes, cancer, heart disease and thyroid. and they have antioxidants, anticancer, anti-inflammatory and anti-thyroid activities. The present study deals with qualitative analysis which is done by (using standard method of Harborn) phytochemicals test of Alkaloids, Flavonoids, Terpenoids, Steroids, Phenols, Tannins, Saponins and Cardiac Glycosides followed by extraction of oil by Soxhlet apparatus. Quantitative analyses were also done to determine the amount of such phytochemical by using standard method of Harborn 1973. Phytochemicals, alkaloids, Flavonoids, Terpenoids, steroids and cardiac glycosides are present in varying amounts which may be used in future for preparation of herbal medicine*

**Key words:** Nigella sativa, Soxhlet apparatus, Cardiac Glycosides, Terpenoids, Tannins

## I INTRODUCTION

The thyroid is a small butterfly –shaped gland is located in front of neck, just below the voice box (larynx).. This gland plays a very important role in controlling our body metabolism i.e. the rate at which our body uses energy and it does this by producing thyroid hormones like thyroxin or T4 and Triode thyronine or T3, chemicals that travel through our blood to every parts of our body. It produces chemicals that help the body to control metabolism .Thyroid hormone is normally produced in response to another hormone released by the pituitary gland[1] Generally, thyroid problem are grouped in to two main categories i.e. hyperthyroidism (too much thyroid hormone ),and hypothyroidism,(too little thyroid hormone) here we discuss about hypothyroidism, the most common symptoms of hypothyroidism includes fatigue ,depression , constipation ,weight gain ,slow heart rate etc[2]

In the plant kingdom there is remedy for every disease. About last few decades there were few or no synthetic drugs for the treatment of diseases. The plants were the main source of drugs from ancient time. Today medicinal plants have provided a source of drugs compounds to human health and well beings. Medicinal plants are the richest biosource of drugs for traditional system of medicine. World Health Organisation (WHO) has suggested that medicinal plant would be the good source to obtain variety of drugs. Since the use of medicinal plant based drugs contain least or no side effects. It can be considered to be great importance to the health of individuals and communities. Plant product derived from various part of the plants like seeds, fruits, bark, and flower. Leaf and roots. Various bioactive constituents of plant known as phytochemical are present in different parts of the plants. These

phytochemical components are Alkaloids, Terpenoids, Carbohydrates, Tannins, Steroids and Phenolic compounds. In the present study we deals about two miracle seeds ie. Black cumin seeds (Nigella Sativa.L) is a miracle herb due to its wonderful power of healing. And the other one is flax seeds (Linum Usitassimum) which also have many medicinal values. Nigella sativa is commonly known as black cumin seeds or black caraway. Nigella sativa (a member of family Ranunculaceae) is an annual flowering plant with finely divided leaves and 20- 90 cm in heigh. The delicate flower s has 5-10 have 5-10 petals [3]

The seeds of Nigella sativa are known as black cumin seeds and they are very important in many pharmacological studies for its immune modulatory and therapeutic properties [4] The most important compounds is due to which medicinal value of these seed increased are Saponins Flavonoids, volatile oils and trace elements[5] Seeds of Nigella sativa are being used for thousands of years as remedies for number of traditional diseases [6]Nigella sativa in traditional medicines as well as in recent years has been used for the treatment of microbial disease. In Egypt from a long time oil of Nigella sativa has been used for severe cough and asthma [7].It is observed that many pharmacological activities such as antithyroid, antioxidants, anticancer, anti-inflammatory and anti asthmatic activities are also shown by this miraculous medicinal plant.[8,].Black cumin seeds decrease the absorption of lipids which can lower the cholesterol and triglyceride level which can help in weight loss [9]. Similarly flax seeds are another miracle herb. Flax seeds is one of the oldest crops of family Linaceae, having been cultivated since the beginning of civilization (10). The Latin name of the flax seed is Linum usitatissimum, which means very useful. Flax seed is one of the richest plant source of omega -3 fatty acids.i.e. alpha

linolenic acid and lignans (phytoestrogens) (11) The important flax seeds growing countries are Canada, China, U.S, India and Ethiopia. Flax seeds has potential health benefits besides the nutrition, due to mainly three reasons; Firstly due to its high content of omega-3-linolenic acid. Secondly being rich in dietary soluble and insoluble fibres and third, due to its high contents of lignin, acting as antioxidants, phytoestrogens. The health benefits of all omega-3 fatty acids have been widely reported for several conditions including cardiovascular diseases, hypertension, atherosclerosis, diabetes, cancer, arthritis, osteoporosis, autoimmune and neurological disorder and anti-inflammatory (12).

## II MATERIAL COLLECTION AND PROCESSING

- (a) **Collection of seeds** - Seeds of *Nigella sativa* and flax seeds were collected from local market of Bilaspur district of Chhattisgarh and pulverized by using house hold electric grinder. Solvent extractions were performed to extract oil from seeds using soxhlet apparatus using methanol as solvent.
- (b) **Methods of extraction by soxhlet apparatus**- 50gms of powdered sample seeds was filled in thimble and extracted exhaustively by soxhlet apparatus (6hr) using methanol as solvent at 60 degree. The extract obtained was collected and passed through Wattmann No.1 filter paper to remove all debris and unextracted matter. Filtered extract was concentrated using rotatory evaporator at 40 degree centigrade to obtain concentrated extract of seeds.
- (c) **Phytochemical screening of seeds** -- Phytochemical screening of both the seeds were performed by using standard method of Harborne (1973) and many phytochemicals such as Alkaloids, Terpenoids, phenols, Saponins, Flavonoids Steroids and Carbohydrates were detected from the extract of both the seeds.

## III QUANTITATIVE ANALYSIS

Quantitative analysis of both the seeds were performed by using standard method of Harborn (1973).

- (a) **Determination of Alkaloids** - Exactly 200ml of 10% acetic acid in ethanol was added to 250mg of seeds sample. And Beaker is allowed to stand for 4hrs. The extract was concentrated on a water bath to the quarter of the original volume followed by addition of 15 drops of concentrated Ammonium Hydroxide drop wise to the extract until the precipitation was complete immediately after filtrations. After 3hrs of mixture sedimentation precipitate were washed with 20 ml of 0.1 M of ammonium hydroxide and then filtered. After filtrations residue was dried in an

oven and the % of alkaloid is expressed by this formula

$\% \text{ of alkaloid} = \frac{\text{weight of alkaloid}}{\text{weight of sample}} \times 100$

- (b) **Determination of Flavonoids** - 100 mg. of seed sample was extracted with repeatedly extracted with 100ml of 80% aqueous methanol at room temperature. The mixture was filtered through a Whatman No.1 filter paper into a pre weighted 250ml beaker. The filtrate was transferred into a water bath and allowed to evaporate to dryness and weighted. [13]

$\% \text{ of flavonoid} = \frac{\text{Weight of flavonoid}}{\text{Weight of sample}} \times 100$

- (c) **Determination of Saponins** - The seed sample was ground and 500mg. of sample is put in to conical flask and 100ml of 20% ethyl alcohol is added to sample. The sample is heated over a hot plate for 4 hrs with continuous stirring at about 55 degree centigrade. The mixture is then filtered and the residue is re extracted with another 200ml of 20% ethyl alcohol. The combined extract is reduced to 40ml over a water bath at about 90 degree centigrade. The concentrated is then transferred into 250ml separating funnel and 20ml of  $(\text{CH}_3\text{CH}_2)_2\text{O}$  is added to the extract and vigorously shaken. The layer is recovered while the  $(\text{CH}_3\text{CH}_2)_2\text{O}$  is discarded and purification process is repeated. 60 ml of N-butane is added and combined N butane extract is washed twice with 10ml of 5% NaCl. The remaining solution is then heated in a water bath and after evaporation, the sample are dried in the oven to a constant weight.

$\% \text{ of Saponins} = \frac{\text{weight of Saponins}}{\text{weights of sample}} \times 100$

- (d) **Determination of total phenols** - The 200mg. of seeds sample was boiled with 50ml of water for the extraction of the phenolic component for 15 min. Five ml of the extract was pipette out in to 50ml flask then 10 ml of distilled water was added. Two ml of  $\text{NH}_4\text{OH}$  solution and 5ml of concentrated amyl alcohol were also added. The samples were made up to mark and left to reach for 30 min. for color development this was read at 505 nm. [14]

- (e) **Determination of Carbohydrates** - sample was hydrolysed in a boiling tube with 5ml of 2.5 N HCL in a boiling water bath for a period of 3 hrs. It was cooled at room temp and solid carbonate was added until effervescence ceases. The content was centrifuged and supernatant was made to 100ml by using distilled water. 0.2 ml of sample was pipette out and made up the volume to one ml with distilled water, then 1ml of phenol reagent was added and followed by 5.0 ml of sulphuric acid, the test tube were kept at 25-30 deg. Cen. For 20min The absorbance was read at 490.

## IV RESULT AND DISCUSSION

In the present study quantitative phytochemical analysis of methanol extract of *Nigella Sativa* shows the presence of alkaloids, Terpenoids, steroids, phenols, Flavonoids, Saponins, Diterpenes, carboxylic acid, Coumarins, Carbohydrates while E-medol was not found in Methanolic extract of *Nigella sativa*, and flax seeds.

**Table -1**  
Phytochemical constituents of methanolic extract of *nigella sativa* and flax seeds

Phytochemical constituents	phytochemical test	<i>Nigella sativa</i> seeds	Flax seeds
Alkaloids	Mayer's test	+	+
	Wagner's test	+	+
	Hager's test	+	+
Terpenoids	Salkowski test	+	+
Phenols	Ferric chloride	+	+
Steroids	Acetic anhydride+H <sub>2</sub> SO <sub>4</sub>	+	+
Flavonoids	Alkaline reagent test	+	+
Saponins	Froth test	+	+
Diterpenes	Copper acetate	+	+
Coumarine	Sodium hydroxide	+	-
Carbohydrate	Benedicts test	+	+
E modol	25% NH <sub>3</sub> solution	-	-

(+) detected, Not detected (-)

**Table -2**  
Quantitative study of *N.Sativa* and Flax seeds

Phytochemicals	<i>Nigella Sativa</i> Seeds	Flax seeds
Alkaloids	0.239 mg	0.16 mg
Flavonoids	0.040 mg	0.17 mg
Saponins	0.37 mg	0.41 mg
Phenols	0.043mg	0.23 mg
Carbohydrate	0.47 mg	0.49mg

Similarly quantitative analysis of *Nigella sativa* and flax seeds shows alkaloids 0.239mg, 0.16mg, flavonoids 0.040, 0.17mg, saponins 0.37 mg, 0.41 mg, phenols 0.043mg, 0.23mg and carbohydrate 0.47mg, 0.49mg. From the quantitative analysis of both the seeds we have seen that the amount of alkaloids, saponins, phenols, and carbohydrates are almost same but the amount of Flavonoids is more in flax seeds than *Nigella Sativa* seeds. Flavonoids are most commonly known for their antioxidant activity and act as transformers which modify the body's reactions to carcinogens, viruses and allergens. They possess anti-cancerous, anti-inflammatory, anti-microbial and anti-allergic activity [15]. Due to the presence of these phytochemicals, the importance of *Nigella sativa* seeds and flax seeds in the medicinal field is increasing day by day. It is observed that many pharmacological activities such as anticancer, antithyroid, antidiabetic are shown by these seeds. [9], [10].

## V CONCLUSION

In the present study it is observed that black cumin seeds decreased the absorption of lipids which can lower the cholesterol and triglycerides level, which help in reducing body weight and constipation, which is the major symptoms of hypothyroidism [9]. Similarly flax seeds are a rich source of essential fatty acids, especially in the form of Omega-3 fatty acids. These fatty acids help to promote healthy hormone production and act as anti-inflammatory agents, flax seeds are most often used for constipation because of its content in Omega-3 fatty acids. They are important for the normal function of the thyroid gland [12].

The medicinal value of these seeds has increased due to the presence of such phytochemicals in *Nigella Sativa* seeds and flax seeds. It is used in the future in pharmaceutical companies for the preparation of herbal drugs and the advantage of these herbal drugs is that they can be used for life long without any side effects.

Conflict of Interest: There is no conflict of interest in this research work.

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# Preparation and Antimicrobial Studies of Pyrazolo-Thiazole Fused Heterocyclic Compounds

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## ABSTRACT

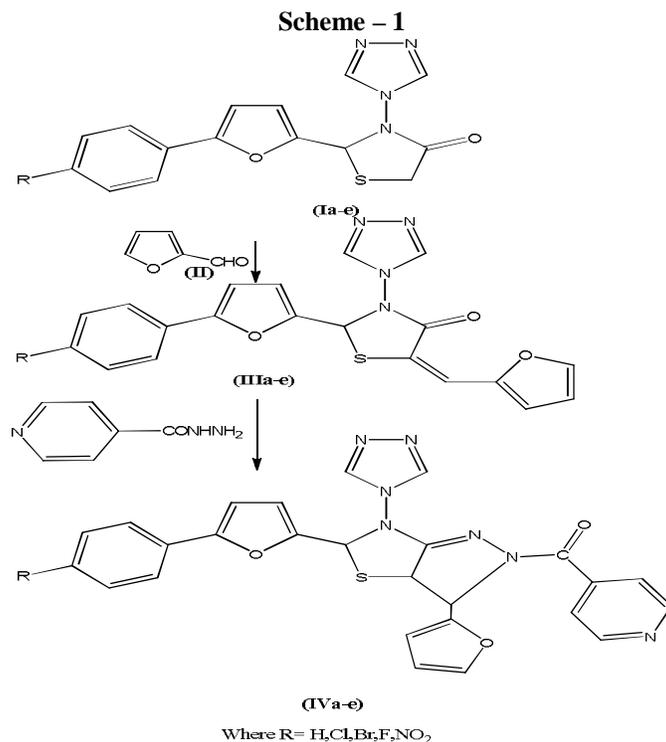
2-[5-(4-Ary)furan-2-yl]-3-(4H-1,2,4-triazol-4-yl)thiazolidin-4-one (Ia-e) compounds [1] reacted with furfural in the presence of sodium hydroxide affords, 5-[(furan-2-yl)methylen]-2-[5-(4-alkylphenyl)furan-2-yl]-3-(4H-1,2,4-triazol-4-yl)thiazolidin-4-one (IIIa-e). These (IIIa-e) compounds reacted with Isoniazide yield [3-(furan-2-yl)-5-[5-(4-alkylphenyl)furan-2-yl]-6-(4H-1,2,4-triazol-4-yl)3,3a,5,6-tetrahydro-2H-pyrazolo[3,4-d]thiazol-2-yl](pyridin-4-yl)methanone (IVa-e). The molecular structures of all these novel heterocyclic derivatives were confirmed by elemental content and FTIR-NMR spectral features. The antimicrobial activity of all these derivatives were monitored.

**Keywords:** Thiazolidine, Pyrazole, FTIR-NMR, Antimicrobial activity.

## I INTRODUCTION

We reported recently the 4-Thiazolidinone derivatives based on Schiff base of 5-Aryl furfural and 4-Amino-1,2,4-triazole<sup>1</sup>. In continuous of our work<sup>1</sup>, the present paper comprises the fused heterocycles i.e. pyrazolo-thiazole. For this the furylidine derivatives of 5-[(furan-2-yl)methylene]-2-[5-(4-alkylphenyl)furan-2-yl]-3-(4H-1,2,4-triazol-4-yl)thiazolidin-4-one(IIIa-e) were

prepared and condensed with isoniazide considering with the potential pharmaceutical activity of these derivatives.<sup>2-7</sup> All the final products [3-(Furan-2-yl)-5-[5-(4-alkylphenyl)furan-2-yl]-6-(4H-1,2,4-triazol-4-yl)-3,3a,5,6-tetrahydro-2H-pyrazolo [3,4-d] thiazol-2-yl](pyridin-4-yl)methanone (IVa-e) were characterized duly. The synthetic route is as follows.



## II EXPERIMENTAL

- (a) **Materials** - All chemicals used were of laboratory grade. 2-[5-(4-alkylphenyl)furan-2-yl]-3-(4*H*-1,2,4-triazol-4-yl)thiazolidin-4-one (Ia-e) prepared by our earlier research work<sup>1</sup>.
- (b) **Measurement** - Melting points of present novel derivatives were measured by laboratory paraffin method. All m.p were uncorrected.

### Preparation of 5-[(5-substituted furan-2-yl)methylene]-2-[5-(4-alkylphenyl)furan-2-yl]-3-(4*H*-1,2,4-triazol-4-yl)thiazolidin-4-one (IIIa-e)

An equimolar solution of 2-[5-(4-alkylphenyl)furan-2-yl]-3-(4*H*-1,2,4-triazol-4-yl)thiazolidin-4-one(Ia-e) and 2-furaldehyde in alkaline 1,4-dioxane 50 ml were boiled for 5 hrs. The 1,4-dioxane was distilled under reduced pressure. The so called obtained derivative was recrystallized from absolute alcohol. It was designated as 5-[(5-substituted furan-2-yl)methylene]-2-[5-(4-

alkylphenyl)furan-2-yl]-3-(4*H*-1,2,4-triazol-4-yl)thiazolidin-4-one(IIIa-e). The product yields, m.p. and other data of present novel derivatives are presented in Table-1.

### Preparation of [3-(furan-2-yl)-5-[5-(4-alkylphenyl)furan-2-yl]-6-(4*H*-1,2,4-triazol-4-yl)-3,3a,5,6-tetrahydro-2*H*-pyrazolo[3,4-*d*]thiazol-2-yl](pyridin-4-yl)methanone (IVa-e)

A solution of (IIIa-e) (0.01mol) in glacial acetic acid (25 ml) was stirred with isoniazide (0.15 mol) for 5 hours at 70-80°C. The solvent was removed under reduced pressure, and the residue was diluted with water. It was extracted with ether, washed with saturated NaHCO<sub>3</sub> solution, water, brine solution and dried. The solvent was removed and the crude product was purified by recrystallization from ethanol. The product yields, m.p. and all the details of present heterocycles are tabulated in Table-2.

**Table:-1**  
Characterization of novel heterocyclic compounds (IIIa-e)

Compd.	Molecular formula (Mol.wt.)	Yield	M.P. * °C	Elemental Analysis							
				%C		%H		%N		%S	
				Foun d	Calcd	Foun d	Calcd	Foun d	Calcd	Foun d	Calcd
IIIa	C <sub>20</sub> H <sub>14</sub> N <sub>4</sub> O <sub>3</sub> S (390)	70	231- 233	61.5	61.53	3.6	3.61	14.3	14.35	8.2	8.21
IIIb	C <sub>20</sub> H <sub>13</sub> N <sub>4</sub> O <sub>3</sub> SCl (424)	67	227- 228	56.5	56.54	3.0	3.08	13.1	13.19	7.5	7.55
IIIc	C <sub>20</sub> H <sub>13</sub> N <sub>4</sub> O <sub>3</sub> SBr (467)	72	233- 234	51.1	51.18	2.7	2.79	11.9	11.94	6.8	6.83
IIId	C <sub>20</sub> H <sub>13</sub> N <sub>4</sub> O <sub>3</sub> SF (408)	66	239- 240	58.8	58.82	3.2	3.21	13.7	13.72	7.8	7.85
IIIe	C <sub>20</sub> H <sub>13</sub> N <sub>5</sub> O <sub>5</sub> S (435)	69	229- 230	55.1	55.17	2.9	3.01	16.0	16.08	7.3	7.36

\* Uncorrected LC-MS data of IIIc-469,IIIe-437

**Table:-2**  
Characterization of novel heterocyclic compounds (IVa-e)

Compd	Molecular formula (Mol.wt.)	Yield	M.P. * °C	Elemental Analysis							
				%C		%H		%N		%S	
				Foun d	Calcd	Foun d	Calcd	Foun d	Calcd	Foun d	Calcd
IVa	C <sub>26</sub> H <sub>19</sub> N <sub>7</sub> O <sub>3</sub> S (509)	78	241- 243	61.2	61.29	3.7	3.76	19.2	19.24	6.2	6.29
IVb	C <sub>26</sub> H <sub>18</sub> N <sub>7</sub> O <sub>3</sub> SCl (543)	72	245- 247	57.4	57.41	3.3	3.34	18.0	18.02	5.8	5.89
IVc	C <sub>26</sub> H <sub>18</sub> N <sub>7</sub> O <sub>3</sub> SBr (587)	74	248- 249	53.0	53.07	3.0	3.08	16.6	16.66	5.4	5.45
IVd	C <sub>26</sub> H <sub>18</sub> N <sub>7</sub> O <sub>3</sub> SF (527)	63	238- 239	59.1	59.20	3.4	3.44	18.5	18.59	6.0	6.08
IVe	C <sub>26</sub> H <sub>18</sub> N <sub>8</sub> O <sub>5</sub> S (554)	73	246- 247	56.3	56.31	3.2	3.27	20.2	20.21	5.7	5.78

\* Uncorrected LC-MS data of IVa-512,IVd-529

### III BIOLOGICAL SCREENING

(a) **Antibacterial activities** - The antibacterial properties of all the produced heterocycles were screened against gram +ve and gram -ve bacteria (the bacteria name are given in table). The

monitoring such properties was carried out by far process reported in an our earlier communication<sup>1</sup>. Compounds IIIb & IVb were observed as more toxic for bacteria. All compounds found to be less or moderate active shown in Tables -3.

**Table:-3**  
**Antibacterial Activity of Compounds (IIIa-e) and (IVa-e)**

Compounds	Gram +Ve		Gram -Ve	
	<i>Staphylococcus aureus</i>	<i>Bacillus subtilis</i>	<i>E.coli</i>	<i>Klebsiella promioe</i>
IIIa	42	61	59	68
IIIb	50	75	69	80
IIIc	49	74	66	77
IIId	45	67	64	74
IIIe	46	64	61	70
IVa	43	63	60	68
IVb	51	76	70	81
IVc	51	74	67	82
IVd	46	67	65	75
IVe	46	66	63	71

(b) **Antifungal Activities** - The antifungal activities of all the new derivatives were measured as process reported by us earlier<sup>1</sup>. The fungicidal activity

displayed by various compounds (IIIa-e) and (IVa-e) is shown in Tables-4.

**Table:-4**  
**Antifungal Activity of Compounds (IIIa-e) and (IVa-e)**

Compounds	<i>Nigrospora Sp.</i>	<i>Aspergillus Niger</i>	<i>Botrydepladia Thiobromine</i>	<i>Rhizopus Nigricum</i>
IIIa	54	53	58	59
IIIb	67	72	68	66
IIIc	66	69	72	68
IIId	62	67	59	61
IIIe	56	56	60	63
IVa	55	54	60	61
IVb	67	74	69	67
IVc	65	70	66	67
IVd	64	69	60	62
IVe	57	57	61	64

### IV RESULTS AND DISCUSSION

The IR spectra of 5-[(5-substituted furan-2-yl)methylene]-2-[-(4-alkylphenyl)furan-2-yl]-3-(4H-1,2,4-triazol-4-yl) thiazolidin-4-one(IIIa-e) showing an absorption bands at 1680cm<sup>-1</sup>(C=O of thiazolidinone ring), 720cm<sup>-1</sup> (C-S-C of thiazolidinone ring), 3040-3080cm<sup>-1</sup> (C-H, of Ar.), 1185(C-O-C),1080(-Cl),1555,1375(-NO<sub>2</sub>),710(C-Br),1255(C-F), 1625cm<sup>-1</sup>(C=CH-Ar). <sup>1</sup>H NMR: 7.76(1H,s,-CH), 6.50-8.20(12H,m,Ar-H), 6.50(1H,s,CH). The C, H, N, S analysis data of all compounds are presented in Table-1. The IR spectra of (IVa-e) are almost identical with those of the corresponding (IIIa-e). Only the difference appeared that the new bands (but not strong) at 1640cm<sup>-1</sup> (-C=N) and 1045 cm<sup>-1</sup>(N-N) are observed in all the spectra of (IVa-e). <sup>1</sup>HNMR:6.50-8.92(16H,m,Ar-H),5.36(1H,s,CH), 5.50(1H,s,CH). The C, H, N, S analysis data of all compounds are presented in Table-2. LC-MS of selected samples IIIc and IV d show the peak respectively at 469 and 529 which assign the molecular

weight of compound, The inspection of elemental content of all the new derivatives suggest that the values are agree wrt proposed structure illustrated in Scheme-1. The FTIR also confirm the proposed structure and further in 1,4-dioxane with little NaOH were heated to boiling for 4 hrs. The solvent was distilled under vacuum and the resultant derivative was recrystallized from R.Spirit are mostly identical those of corresponding (IIIa-e). Only noticeable change observed that the new medium band around 1642 cm<sup>-1</sup> (-C=) appeared in all FTIR spectral scans (IVa-e).

### V CONCLUSION

The [3-(furan-2-yl)-5-[5-(4-alkylphenyl)furan-2-yl]-6-(4H-1,2,4-triazol-4-yl)3,3a,5,6-tetrahydro-2H-pyrazolo[3,4-d] thiazol-2-yl](pyridin-4-yl) methanone (IVa-e) was synthesized by reaction of 5-[(furan-2-yl)methylene]-2-[-(4-alkylphenyl)furan-2-yl]-3-(4H-1,2,4-triazol-4-yl) thiazolidin-4-one (IIIa-e) with Isoniazide. The structures of all synthesized compounds

were characterized by elemental and spectral data. All the synthesized compounds showed moderate to good antibacterial and antifungal activities.

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# Synthesis and Biological Activity of Furan Containing Azitidinone Compounds

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## ABSTRACT

The Schiff's bases (1a-e) based on 5-arylfurfural and Isoniazid prepared by us [1], were condensed with chloro acetyl chloride. The obtained 2-azitidinone derivatives were further treated respectively with sulphamethoxazole and morpholine. The so-called derivatives N-(2-(5-(4-alkylphenyl)furan-2-yl)-3-((4-(N-(isoxazol-3-yl)sulfamoyl) phenyl) amino) -4-oxoazetidin-1-yl) isonicotinamides (3a-e) and N-(2-(5-(4-alkylphenyl)furan-2-yl)-3-morpholino-4-oxoazetidin-1-yl)isonicotinamides (4a-e) and (2-azitidinone) were characterized by elemental content and spectral features. Their antimicrobial activity has also been monitored against common microbes.

**Keywords:** Isoniazid, furfural, 2-azitidinone, morphine, elemental analysis, spectroscopy and Antibacterial and antifungal activity.

## I INTRODUCTION

In earlier work of the author [1] 4-thiazolidone derivatives based on Schiff's base of Isoniazid and 5-arylfurfurals was reported. The work was carried out with considering excellent medicinal properties of Isoniazid. In extension of it [1] the present communication comprises the 2-azitidinone derived

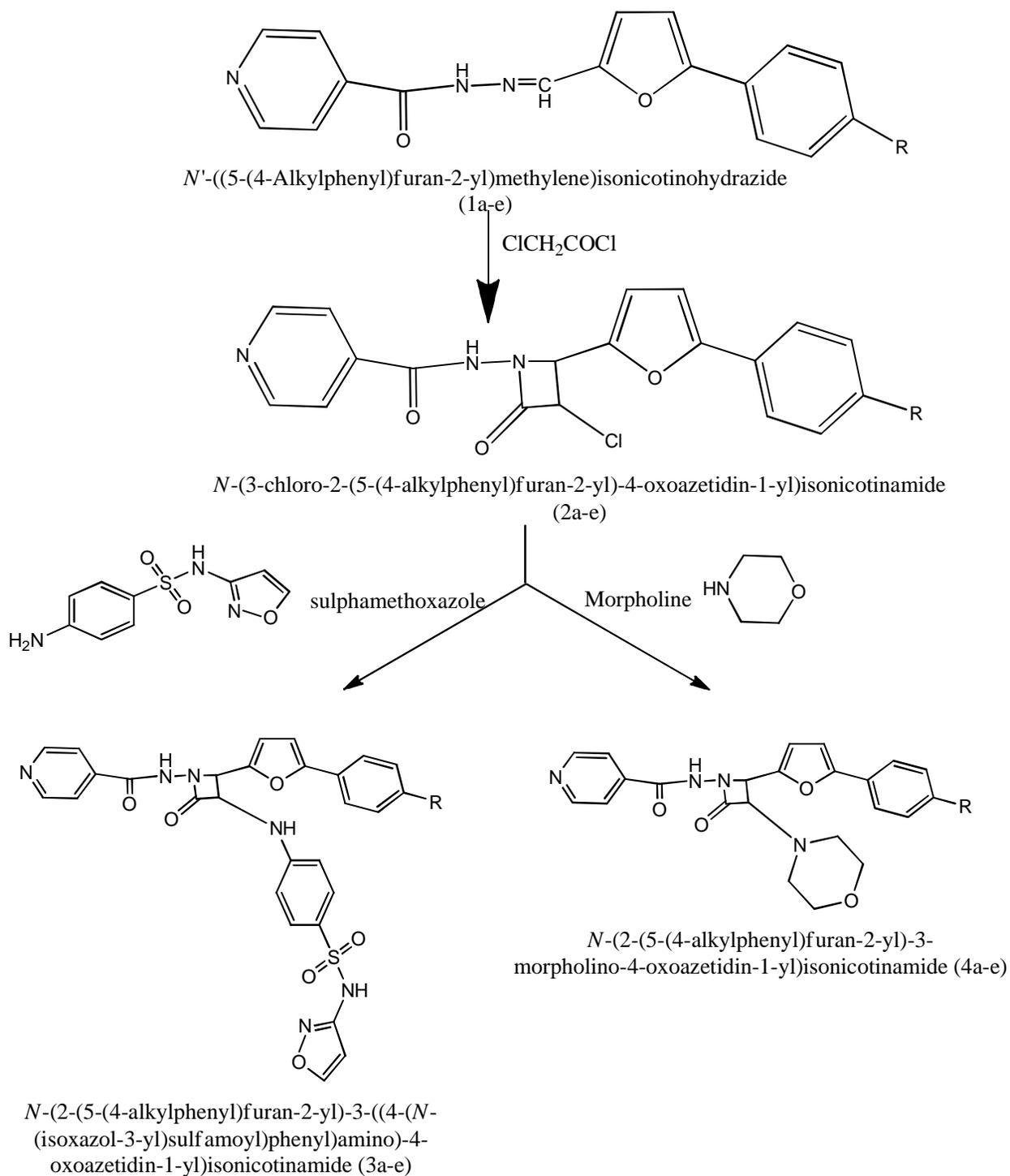
(a) **Material and Methods** - All the chemicals were used of pure grade. Melting points were estimated by laboratory method and all were uncorrected. The FTIR spectra were taken KBr disc by using Nicolet 400D spectrometer. The proton NMR spectra were as Bruker (400 MHz.) spectrometer using deuterated DMSO. LC-MS of choice compound were scan on LC-MSD-Trap-SL\_01046. N'-((5-(Aryl furan-2-yl)methylene) isonicotinohydrazide (1a-e) were prepared by our earlier communication.[1]

from same Schiff's bases followed by reaction with sulphamethoxazole and morpholine respectively considering with their important pharmaceutical activities [2-8]. The work is screened at fig. 1.

## II EXPERIMENTAL

### Synthesis of N-(3-Chloro-2-(5-(aryl furan-2-yl)-4-oxoazetidin-1-yl) isonicotinamide (2a-e)

A solution of N'-((5-(Arylfuran-2-yl)methylene) isonicotinohydrazide (1a-e) and Triethyl amine (TEA) was prepared in 1,4-dioxane, and cooled with stirring. The equimolar chloroacetyl chloride was added drop wise with stirring. They kept aside for several hours till viscous mass obtained. The so called viscous mass was then added slowly in to crushed ice with vigorous agitation. The precipitation were yielded then filtered, washed by plenty of water then by dry ether. The air dried product finally purified by column chromatography to give N-(3-chloro-2-(5-(4-Alkylphenyl)furan-2-yl)-4-oxoazetidin-1-yl)isonicotinamide(2a-e). The details of all these heterocyclic compounds are presented in Table -1.



Where, R = (a) H (b) Cl (c) Br (d) F (e) NO<sub>2</sub>

SCHEME - 1

**Fig. 1 – Display of Scheme**

**Table:-1**  
**Analytical Data and Elemental Analysis of Compounds (2a-e)**

Compd.	Mol.for. (Mol.wt.)	Product Yield % age	M.P.* °C	Elemental Analysis in % age					
				C		H		N	
				Calcd.	Obtained	Calcd.	Obtained	Calcd.	Obtained
2a	C <sub>19</sub> H <sub>14</sub> N <sub>3</sub> O <sub>3</sub> Cl (367)	85	185- 187	62.05	62.0	3.84	3.8	11.43	11.4
2b	C <sub>19</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> Cl <sub>2</sub> (401)	81	181- 182	56.73	56.7	3.26	3.2	10.45	10.4
2c	C <sub>19</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> ClBr (446.68)	77	194- 196	51.09	51.0	2.93	2.9	9.41	9.4
2d	C <sub>19</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> ClF (385)	79	202- 204	59.15	59.1	3.40	3.3	10.89	10.8
2e	C <sub>19</sub> H <sub>13</sub> N <sub>4</sub> O <sub>5</sub> Cl (412)	81	193- 195	55.28	55.2	3.17	3.1	13.57	13.5

\* Uncorrected LC-MS M<sup>+</sup> of 2b: 417 ,2d:396

**Synthesis of N-(2-(5-(Arylfuran-2-yl)-3-((4-(N-(isoxazol-3-yl)sulfamoyl)phenyl) amino) -4-oxoazetid-1-yl)isonicotinamide (3a-e)**

The mixture of N-(3-Chloro-2-(5-(arylfuran-2-yl)-4-oxoazetid-1-yl)isonicotinamide (2a-e) and sulphamethoxazole and diHCl at stoichiometric ratio in Tetrahydrofuran solvent was refluxed for three hrs.

the resultant mixture was poured in to ice water, the precipitate were collected , filtered and air dried. The products are designated as N-(2-(5-(Arylfuran-2-yl)-3-((4-(N-(isoxazol-3-yl)sulfamoyl)phenyl)amino)-4-oxoazetid-1-yl)isonicotinamide (3a-e). The details of all these heterocyclic compounds are presented in Table -2.

**Table:-2**  
**Analytical Data and Elemental Analysis of Compounds (3a-e)**

Compd.	Mol.for. (Mol.wt.)	Product Yield % age	M.P.* °C	Elemental Analysis in % age							
				C		H		N		S	
				Calcd.	Obtain ed	Calcd.	Obtain ed	Calcd.	Obtain ed	Calcd.	Obtain ed
3a	C <sub>28</sub> H <sub>22</sub> N <sub>6</sub> O <sub>6</sub> S (570)	65	213- 215	58.94	58.9	3.89	3.8	14.73	14.7	5.62	5.6
3b	C <sub>28</sub> H <sub>21</sub> N <sub>6</sub> O <sub>6</sub> S Cl (604)	63	210- 212	55.58	55.5	3.50	3.4	13.89	13.8	5.30	5.2
3c	C <sub>28</sub> H <sub>21</sub> N <sub>6</sub> O <sub>6</sub> S Br (648)	60	226- 227	51.78	51.7	3.26	3.2	12.94	12.9	4.94	4.9
3d	C <sub>28</sub> H <sub>21</sub> N <sub>6</sub> O <sub>6</sub> S F (588)	65	238- 239	57.14	57.1	3.60	3.5	14.28	14.2	5.45	5.4
3e	C <sub>28</sub> H <sub>21</sub> N <sub>7</sub> O <sub>8</sub> S (615)	66	221- 223	54.63	54.6	3.44	3.4	15.93	15.9	5.21	5.2

\* Uncorrected LC-MS M<sup>+</sup> of 3b: 620 ,3d:603

**Synthesis of N-(2-(5-(4-alkylphenyl)furan-2-yl)-3-morpholino-4-oxoazetid-1-yl)isonicotinamide (4a-e)**

A mixture N-(3-chloro-2-(5-(4-alkylphenyl)furan-2-yl)-4-oxoazetid-1-yl)isonicotinamide (2a-e) and Morpholine and dil HCl at stoichiometric ratio was refluxed for 3 day. It was then poured in to ice water ,filtered and, air dried, it was Recrystallization from

ethanol-acetone mixture to obtained N-(2-(5-(arylfuran-2-yl)-3-morpholino-4-oxoazetid-1-yl)isonicotinamide (4a-e). The details of all these heterocyclic compounds are presented in Table -3.

**Table:-3**  
**Analytical Data and Elemental Analysis of Compounds (4a-e)**

Compd.	Mol. For. (Mol.wt.)	Product Yield % age	M.P.* °C	Elemental Analysis in % age					
				C		H		N	
				Calcd.	Obtained	Calcd.	Obtained	Calcd.	Obtained
4a	C <sub>23</sub> H <sub>22</sub> N <sub>4</sub> O <sub>4</sub> (429)	60	198- 199	66.02	66.0	5.30	5.2	13.39	13.3
4b	C <sub>23</sub> H <sub>21</sub> N <sub>4</sub> O <sub>4</sub> Cl (452)	58	196- 197	61.00	60.9	4.67	4.6	12.37	12.3
4c	C <sub>23</sub> H <sub>21</sub> N <sub>4</sub> O <sub>4</sub> Br (496)	54	190- 192	55.54	55.5	4.26	4.2	11.27	11.2
4d	C <sub>23</sub> H <sub>21</sub> N <sub>4</sub> O <sub>4</sub> F (436)	57	187- 189	63.30	63.2	4.85	4.8	12.84	12.8
4e	C <sub>23</sub> H <sub>21</sub> N <sub>5</sub> O <sub>6</sub> (463)	58	191- 192	59.61	59.6	4.57	4.5	15.11	15.1

\* Uncorrected LC-MS M<sup>+</sup> of 4b: 468,4d:448

### III BIOLOGICAL SCREENING

(a) **Antibacterial activities** - Antibacterial and antifungal activity of all three series (2a-e, 3a-e,4a-e) of compounds were evaluated by the method described by us [1] and also earlier report [9]. Both the activities measured by using bacteria

and fungi mentioned in table 4 to 9. The similar parameters and type of microbes mentioned in tables 3 to 8 as presented in our communication [1].

**Table:-4**  
**Antibacterial behaviors of Compounds (2a-e)**

Compounds	Gram +Ve		Gram -Ve	
	Staphylococcus aureus	Bacillus subtilis	E.coli	Klebsiella promioe
2a	58	56	54	45
2b	59	51	49	53
2c	61	52	63	49
2d	65	57	55	48
2e	72	66	75	56

**Table:-5**  
**Antibacterial behaviors of Compounds (3a-e)**

Compounds	Gram +Ve		Gram -Ve	
	Staphylococcus aureus	Bacillus subtilis	E.coli	Klebsiella promioe
3a	64	60	48	37
3b	65	47	43	45
3c	67	48	57	41
3d	71	53	49	40
3e	78	62	69	48

**Table:-6**  
**Antibacterial behaviors of Compounds (4a-e)**

Compounds	Gram +Ve		Gram -Ve	
	Staphylococcus aureus	Bacillus subtilis	E.coli	Klebsiella promioe
4a	61	58	51	41
4b	62	49	46	49
4c	64	50	60	45
4d	68	55	52	44
4e	75	64	72	52

**Table:-7**  
**Antifungal behaviors of Compounds (2a-e)**

% age of growth of Zone of Inhibition of fungus				
Compounds	Nigrospora Sp.	Aspergillus Niger	Botrydepladia Thiobromine	Rhizopus Nigricum
2a	67	62	45	33
2b	68	45	40	41
2c	70	46	54	37
2d	74	51	46	36
2e	75	60	66	44

**Table:-8**  
**Antifungal behaviors of Compounds (3a-e)**

% age of growth of Zone of Inhibition of fungus				
Compounds	Nigrospora Sp.	Aspergillus Niger	Botrydepladia Thiobromine	Rhizopus Nigricum
3a	73	66	39	25
3b	74	41	34	33
3c	76	42	48	29
3d	78	47	40	28
3e	79	56	60	36

**Table:-9**  
**Antifungal behaviors of Compounds (4a-e)**

% age of growth of Zone of Inhibition of fungus				
Compounds	Nigrospora Sp.	Aspergillus Niger	Botrydepladia Thiobromine	Rhizopus Nigricum
4a	70	64	42	29
4b	71	43	37	37
4c	73	44	51	33
4d	77	49	43	32
4e	78	58	63	40

## IV RESULTS AND DISCUSSION

It was observed that Schiff bases [1a-e] on condensation with Chloroacetyl chloride afford 2-Azetidine derivatives namely 5-Arylfuran-2-carbaldehydes (2a-e). These on further on nucleophilic substituted reactions respectively sulphamethoxazole and morpholine yield the compound namely N'-((5-Arylfuran-2-yl)methylene)isonicotinohydrazide (3a-e) and N-(4-oxo-2-(5-Arylfuran-2-yl)thiazolidin-3-yl)isonicotinamide(4a-e) all the series compounds determined and furnishes tables 1 to 3. The results of these values .

The Infra-red (IR) spectra of all the these series are identical in most of aspects. All the spectra complies the the bands due to aromatic ring at 3030 and 1600,1500  $\text{cm}^{-1}$ , C=O of azetidinone around 1690  $\text{cm}^{-1}$  due to amide group. However the discernible differences in the spectra of 3a-e and 4a-e are observed. The bands due to sulfonamide at 3300, 3230,1340,1190,920  $\text{cm}^{-1}$  observed in spectra of 3a-e and the bands due to  $\text{CH}_2$  groups, around 2920,2850 and 1470  $\text{cm}^{-1}$  observed in the spectra of (4a-e) from morpholine ring .

NMR spectra of all the series of compound comprise following common features.

The signal due to aromatic proton appeared in the range of 6.9 to 8.1 ppm depending upon the number of protons.

The signal due to -CONH amide proton arised around 8.1-8.2 ppm.

The signals due to proton of azetidine ring are appeared in the range of 3.3 to 3.5 ppm.

The NMR spectra of (3a-e) compound have additional signal due to proton of -NH and - $\text{SO}_2\text{NH}_2$  group. These are appeared respectively the 6.1-6.31 and 9.03-9.2 ppm .

The NMR spectra of (4a-e) compound deals with the prominent signal due to 4- $\text{CH}_2$  groups the more intensive signal with  $\text{C}_6\text{H}_5$  arised around 2.1 ppm .

The LC-MS data of selected compound (Shown as footnote in tables 1 to 3) indicate for molecular weight of compound.

## V CONCLUSION

The reaction of Schiff bases (1a-e) with Chloroacetyl chloride yield 2-azetidine derivatives. The post reactions of 2-Azetidines (2a-e) respectively with Sulphamethoxazole and morpholine afforded (chlorine replaced products 5-Arylfuran-2-carbaldehydes (2a-e), N'-((5-Arylfuran-2-yl)methylene)isonicotinohydrazide (3a-e) and N-(4-oxo-2-(5-Arylfuran-2-yl)thiazolidin-3-yl)isonicotinamide (4a-e). There structure confirmed by spectra analytical data. The antibacterial and antifungal activities of all these compounds are more or less depending upon the nature of compound.

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# Synthesis and Antimicrobial Activity of Pyrazolone-Thioxopyrimidone Clubbed Heterocyclic Compounds

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## ABSTRACT

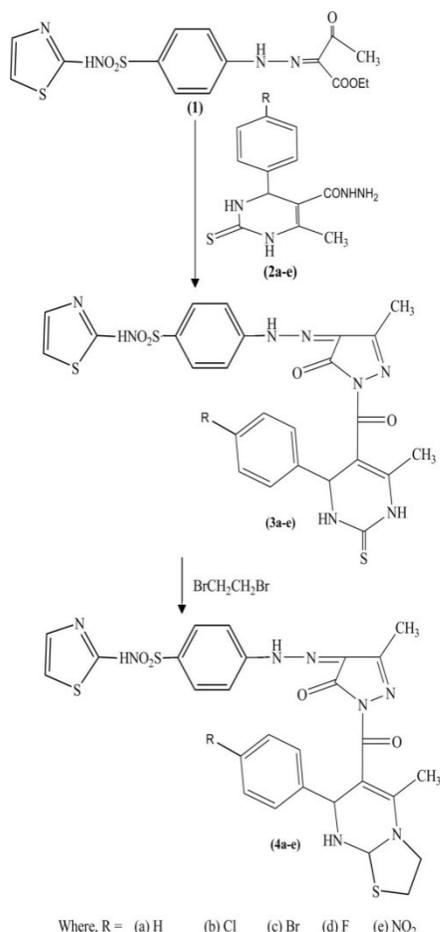
Ethyl 3-oxo-2-(2-(4-(N-thiazol-2-ylsulfamoyl) phenyl) hydrazono)butanoate (1) on condensation with 4-(4-alkyl phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydro pyrimidine-5- carbohydrazide (2a-e) to afford 2-(1-(4-(4-alkyl phenyl)-6-methyl-2-thioxo-1,2,3,4- tetrahydro pyrimidine-5-carbonyl) -3-methyl-5-oxo-1H-pyrazol-4(5H)-ylidene)-N-(thiazol-2- yl) hydrazine sulfonamide (3a-e). On reaction (3a-e) with 1,2-dibromoethane yield 2-(1-(7-(4-alkyl phenyl)-5-methyl-3,7,8,8a-tetrahydro-2H-thiazolo[3,2-a]pyrimidine-6-carbonyl)-3- methyl-5-oxo-1H-pyrazol-4(5H)-ylidene)-N-(thiazol-2-yl)hydrazinesulfonamide(4a-e).The structures of all the compounds series (3a-e) and (4a-e) were characterized analytically. The compounds were also monitored for anti microbial activity.

**Key words:** Pyrazole, aryl hydrazo pyrazole, pyrimidone, antimicrobial activity and spectral studies.

## I INTRODUCTION

Literature reviewed on pyrimidine derivatives here a wide range of pharmaceutical activities like antipyretics, antimicrobial, anticonvulsant, anti-TB, anti neoplastic and antiviral activities.<sup>1-8</sup> Pyrimidine rings are present in natural prickets (as drugs) to found in nature and present in various natural drugs to

synthetic drugs. Sulphur containing heterocyclic compounds are acknowledged as good antibacterial drugs.<sup>10-12</sup> hence in present paper we cubbing of sulfa drug, aryl hydrazo pyrazole and pyrimidone moieties into one molecule may have good medicinal property. The present communication deals with the synthetic approach shown in Fig 1.



**Fig. 1 Synthetic Approach**

## II EXPERIMENTAL

Ethyl 3-oxo-2-(2-(4-(N-thiazol-2-ylsulfamoyl)phenyl)hydrazono)butanoate(1) and 4-(4-alkyl phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydro pyrimidine-5- carbohydrazide (2a-e) were synthesis by reported method.<sup>11,13,14</sup> All other reagents were used of laboratory grade.

The IR spectra of all compounds were taken in fused KBr pellets by using FTIR Spectrophotometer. H1 NMR spectral signals were recorded on Bruker (400MHz) spectrophotometer. LC-MS of few derivatives were scanned on branded instruments. All the compounds were checked for their purity by TLC. The analytical data of all derivatives are furnished in Tables 1 and 2.

The antibacterial activity of both the series of compounds (3a-e) and (4a-e) were studied against gram +Ve and -Ve bacteria shown in Table-3. The activity was measured at a conc, 50µg/ml by agar- cup plate method.<sup>15</sup> The percentage inhibition of growth of bacteria by the compounds is shown in Table-3.

The antifungal activity of both the series of compounds (3a-e) and (4a-e) were measured at 1000ppm concentration in vitro Plant pathogen shown in Table-4 have been selected for study.<sup>16</sup>

### Synthesis of 2-(1-(4-(4-alkyl phenyl)-6- methyl-2-thioxo-1,2,3,4-tetrahydro pyrimidine-5-carbonyl)-3-methyl-5-oxo- 1H-pyrazol-4(5H)-ylidene)-N-(thiazol-2- yl)hydrazine sulfonamide (3a-e)

Ethyl 3-oxo-2-(2-(4-(N-thiazol-2-ylsulfamoyl)phenyl)hydrazono)butanoate (1)and 4-(4-alkylphenyl)-6-methyl-2- thioxo-1,2,3,4-tetrahydropyrimidine-5- carbohydrazide (2a-e) were mixed at stoichiometric ratio with CH<sub>3</sub>COOH (glacial) and then refluxed for 9-10 hrs. The resultant was filtered, washes with water and then dry ether and crystallized from ethanol. Finally, the characteristics of these novel heterocyclic derivatives are presented Table -1.

### Synthesis of 2-(1-(7-(4-alkylphenyl)-5- methyl-3,7,8,8a-tetrahydro-2H- thiazolo[3,2-a]pyrimidine-6-carbonyl)- 3-methyl-5-oxo-1H-pyrazol-4(5H)- ylidene)-N-(thiazol-2-yl)hydrazine sulfonamide (4a-e)

In a round bottom flask each of (3a-e) (10mmol) and 1,2-dibromoethane (20mmol) in 1,4-dioxane (20ml) was refluxed for 5 hrs. The resulting solution kept at room temperature. The product is in form of salt filtered, it was then treated with saturated sodium bicarbonate solution than by rectified spirit. The product was checked by TLC frequently. The details given in Table-2.

## III RESULTS AND DISCUSSIONS

The ethyl 3-oxo-2-(2-(4-(N-thiazol- 2-yl sulfamoyl) phenyl) hydrazono) butanoate(1) react with 4-(4-alkyl phenyl)

-6-methyl-2- thioxo-1,2,3,4-tetrahydro pyrimidine-5-carbohydrazide (2a-e) to give 2-(1-(4- alkyl phenyl)-6-methyl-2- thioxo-1,2,3,4- tetrahydro pyrimidine-5- carbonyl)-3- methyl-5-oxo-1H-pyrazol- 4(5H)-ylidene)- N-(thiazol-2-yl) hydrazinesulfonamide (3a- e), which gives 2-(1-(7-(4-alkylphenyl)-5- methyl- 3,7,8,8a-tetrahydro-2H-thiazolo[3,2- a]pyrimidine-6-carbonyl)-3- methyl-5-oxo-1H-pyrazol-4(5H)-ylidene)- N- (thiazol-2-yl)hydrazine sulfonamide (4a-e) on reaction with 1,2-tetracyclin bromoethane.

The Molecular frameworks of (3a-e) were assigned by C,H,N values and FTIR spectral features giving medium bands at 3030cm<sup>-1</sup>(aromatic C-H band), 3330 and 3155 cm<sup>-1</sup>(NH), 1620-1630cm<sup>-1</sup>(C=N), 1680 cm<sup>-1</sup>(CO), 2950, 1370cm<sup>-1</sup>(-CH<sub>3</sub>,CH<sub>2</sub>),680(C-S), 1160(SO<sub>2</sub>),1695- 1750 cm<sup>-1</sup> (Carbonyl), 1070(thioketone), 1555,1375(-Nitro group), H1 NMR data in δppm : 9.95-11.9(S,4H,NH group), 2.52- 2.60(S, 6H, of 2CH<sub>3</sub>), 5.42(S,1H,CH), 6.80-7.40(CS) (s,7H,ArH). The elemental content of all these heterocyclic derivatives were illustrated in Table-1.

The FTIR of (4a-e) were 3030- 3080 cm<sup>-1</sup>(Alkane of aromatic), 3330cm<sup>-1</sup> (aromatic CH band), 1620-1630cm<sup>-1</sup>(C=N), 1680cm<sup>-1</sup>(CO),2950,1370cm<sup>-1</sup>(-CH<sub>3</sub>,CH<sub>2</sub>), 680(C-S),1160(SO<sub>2</sub>),1695-1750cm<sup>-1</sup> (Carbonyl),1080(-Cl),1555,1375(-NO<sub>2</sub>), 1070(C-Br),1150 (C-F). H1 NMR signals at δppm:10.1-11.9(s,3H,NH), 2.52-2.60(s,6H,Methyl group),5.42(s,1Hof =CH),6.80-7.40(s,7H,ArH), 5.20 (s,1H of =CH), 2.46-3.12(t,4H of 2=CH<sub>2</sub>). The elemental (C,H,N) analysis of all these heterocyclic compounds are illustrated in Table -2.

All the characteristic shown in table 1 and 2 suggest that the data are agree with the structural features shown in Scheme-1. The LC-MS of few samples indicate the peak of M<sup>+</sup> ion which assigned +VE molecular weight. All these features assigned the structures of 3a-e and 4a-e.

The examination of antibacterial activity data reveals that all compounds toxic against microbes and the compounds 3e and 4e found more toxic for gram+Ve and gram- -Ve bacteria.

**Table-1**  
**Characterization of Compounds (3a-e)**

No.	M.F.	Yield % age	M.P.* °C	Elemental Analysis % age							
				C		H		N		S	
				Calcd.	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found
<b>3a</b>	C <sub>19</sub> H <sub>18</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> (518)	62	213- 215	44.00	43.9	3.50	3.4	21.61	21.68	18.55	18.5
<b>3b</b>	C <sub>19</sub> H <sub>17</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> Cl (553)	65	219- 220	41.26	41.2	3.10	3.0	20.26	20.2	17.39	17.3
<b>3c</b>	C <sub>19</sub> H <sub>17</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> Br (597)	59	232- 234	38.19	38.1	2.87	2.8	18.75	18.7	16.10	16.0
<b>3d</b>	C <sub>19</sub> H <sub>17</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> F (536)	65	227- 228	42.53	42.5	3.19	3.1	20.88	20.8	17.93	17.9
<b>3e</b>	C <sub>19</sub> H <sub>17</sub> N <sub>9</sub> O <sub>6</sub> S <sub>3</sub> (563)	63	235- 236	40.49	40.4	3.04	3.0	22.37	22.3	17.07	17.0

\* *Uncorrected* LC-MS peak value of 3a:568  
3d: 553

**Table-2**  
**Characteristic of Compounds (4a-e)**

No.	M.F.	Yield % age	M.P.* °C	Elemental Analysis % age							
				C		H		N		S	
				Calcd.	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found
<b>4a</b>	C <sub>21</sub> H <sub>22</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> (546)	69	233- 235	46.17	46.1	4.06	4.0	20.50	20.7	17.60	17.5
<b>4b</b>	C <sub>21</sub> H <sub>21</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> Cl (580.35)	67	246- 248	43.41	43.4	3.64	3.6	19.28	19.2	16.55	16.5
<b>4c</b>	C <sub>21</sub> H <sub>21</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> Br (624)	65	243- 245	40.32	40.3	3.38	3.3	17.91	17.9	15.38	15.3
<b>4d</b>	C <sub>21</sub> H <sub>21</sub> N <sub>8</sub> O <sub>4</sub> S <sub>3</sub> F (564)	62	240- 242	44.67	44.6	3.75	3.7	19.85	19.8	17.04	17.0
<b>4e</b>	C <sub>21</sub> H <sub>21</sub> N <sub>9</sub> O <sub>6</sub> S <sub>3</sub> (531)	66	238- 239	42.63	42.6	3.58	3.5	21.31	21.3	16.26	16.2

\* *Uncorrected* LC-MS data for 4b:594, 4e: 545

**Table-3**  
**Antibacterial Activity of Compounds (3a-e) and (4a-e)**

No.	Zone of inhibition (mm)				
	Gram +ve		Gram -ve		
	<i>Bacillus Subtilis</i>	<i>Staphylococcus aureus</i>	<i>Kllebsiella promioe</i>	<i>Salmonella Typhl</i>	<i>E.coil</i>
<b>3a</b>	55	42	60	52	56
<b>3b</b>	66	48	68	60	64
<b>3c</b>	59	44	65	49	57
<b>3d</b>	64	45	66	58	61
<b>3e</b>	70	51	78	69	65
<b>4a</b>	59	43	62	55	58
<b>4b</b>	68	50	71	62	67
<b>4c</b>	63	50	69	52	59
<b>4d</b>	68	48	69	63	63
<b>4e</b>	73	52	81	73	68
<b>Tetracycline</b>	79	55	87	76	72

**Table-4**  
**Antifungal Properties of present heterocyclic derivatives**

% age inhibition of the growth of fungus (at 1000 ppm)				
Comp. No.	<i>Botrydepladia Thiobromine</i>	<i>Nigrosspora Sp.</i>	<i>Penicillium Expansum</i>	<i>Rhizopus Nigricuns</i>
<b>3a</b>	64	67	64	63
<b>3b</b>	75	72	70	71
<b>3c</b>	59	63	64	66
<b>3d</b>	70	69	68	67
<b>3e</b>	77	79	76	78
<b>4a</b>	67	69	66	67
<b>4b</b>	78	74	72	74
<b>4c</b>	61	66	67	69
<b>4d</b>	72	71	70	70
<b>4e</b>	81	83	79	80

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# Development, Characterization and Wear Response of Particulate Filled Metal Alloy Composites – A Review

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## ABSTRACT

*Metal Alloy Composites Tribological applications, such as internal combustion engines, pistons, liners, clutches, pulleys, rockers, and pivots have been used. In each of these uses, though, a need for substantial changes in duty loads and wear resistance, prompting material researchers to build composites based on aluminum. Conventional aluminum-based component sites have only one type of reinforcement. The addition of hard dispersions, such as silicon carbide, alumina, titanium carbide, finishes, improves the hardness, strength and wear resistance of the components. However, these hard reinforcement component sites pose various problems when machining metal mold components. Furthermore, the addition of ceramic reinforcements will result in the deterioration of the thermal and electrical conductivity of the aluminum alloys, which will lead to limited applications.*

## I INTRODUCTION

History also is distinguished through design and techniques that demonstrate human capacity of comprehension. That stairs frequently begin with both the Stone Age, leading to the Age of Bronze, Iron, Steel, Aluminum and Alloy, as advances in mining, smelting or science also made it necessary to step into the quest for some more advanced materials. Again from days of both the phenolic glazed radome/E systems of both the early 1940s to both the graphite/polyimide composite sites seen on the Shuttle space orbiter, advancement and in production of sophisticated components is spectacular. Recognition of both the possible savings in weight which can then be accomplished by using advanced components, The whole development in reinforcement, mould & product production technologies seems to have been responsible for all this, which would in turn means decreased costs and improved performance. When the first two decades saw changes throughout the development chain, the emphasis had been a detailed analysis and in 1960s of fracture properties and mechanics. And since, there was a rising appetite in industries like aerospace, shipping, automobile and construction for modern, heavier, stiffer and lighter materials.

## II LITERATURE REVIEW

McKie, Amanda et al. [18] for a large variety of composite materials focused on polycrystalline cubic boron nitride with aluminium as that of the binder step, the relationship among microstructural characteristics has indeed been studied (PcBN-Al). High-pressure, high-temperature burial techniques have been used to create the cBN-Al compositions (HPHT), Production of materials with the a cBN grain size of between 2 and 20  $\mu\text{m}$  and an original Al binder quantity between about 15 and 25 percent through length. The durability and fracture resistance have between 6.4 and 8.0 MPa m<sup>1/2</sup> and 355-454 MPa, respectively, whereas the stiffness were about 15 and 40 GPa. That fracture had

been used to research large fracture force dispersion as well as to compare fracture strength against fracture strength Including fracture strength around the scale of both the root of the fracture.

Li, Zhengyang et al.[19] The synthesis of modern super-hard and high-performance components of cubic boron nitride (Ti<sub>3</sub>SiC<sub>2</sub>-cBN) titanium silicon carbide were tested under three separate circumstances throughout this paper.,

- (i) High pressure synthesis at ~ 4.5 GPa,
- (ii) Hot pressure at ~ 35 MPa e
- (iii) S bury at ambient pressure (0.1 MPa) in a tubular oven.

The studies observed, from either the study of both the experimental findings, that now the new Ti<sub>3</sub>SiC<sub>2</sub>-cBN components can also be enhance loyalty from the mixture of Ti<sub>3</sub>SiC<sub>2</sub> and cBN powders at 1050 ° C under a pressure of ~ 4.5 GPa. Subsequent micro-structural or hardness tests suggest that certain sites are especially promising of super-hard products.

Li, Rongqi et al. [20] there are extraordinary mechanical and thermal properties of Cubic Boron Nitride (cBN). Previous research has focused on mechanical properties, with results scarcely published upon this thermal property of cBN. A wide variety of components of aluminium / cubic boron nitride (Al / cBN) was manufactured throughout this work through pressure penetration at 5.0 GPa and 960-1600 ° C. Microstructure, phase arrangement, heat capacity and thermal expansion coefficient of composite sites of Al / cBN. The findings showed that the overall thermal conductivity of 266 W / m K as well as the thermal expansion coefficient of 4-6  $\times 10^{-6}$  K<sup>-1</sup> is well compatible to semiconductors, suggesting that the Al / cBN components were high-efficiency heat sink materials planned to high temperature of broadband semiconductors.

Ding, WF et al. [21] Single layer welded wheel fabrication experiments were conducted using cubic boron nitride (CBN) binders, Cu-Sn-Ti alloy and AISI 1045 steel. Forte was 900 ° C and residence time was of 8 min. The connection interface microstructure was

characterised. That efficiency of the wheels with super nickel alloy became evaluated throughout high-speed grinding. The fracture activity of both the abrasive grains were analysed in a quantifiable manner without regard to both the embedding depth. The analysis shows that perhaps a strong bonding interface has been established in between binder-free CBN grains, the Cu-Ti alloy and also the AISI 1045 steel, that relies on elemental dissolution through chemical reaction during brazing, ensuring a tight grip onto abrasive grains. In respect of grinding power and force ratio, the binder-free CBN grinding wheel demonstrated strong benefits out over monocrystalline CBN grit. As grain fractures occur, that critical force operating upon this unbound CBN gain at the exposure height of 50 and 705 is measured.

Thiagarajan, C., R et.al. [22] In respect of grinding power but force ratio, the binder-free CBN grinding wheel demonstrated strong benefits out over monocrystalline CBN grit. As grain fractures occur, that critical force operating upon this unbound CBN gain at the exposure height of 50 and 705 was measured, the following conclusions are drawn:

- (a) According to both the low grinding force throughout high wheel speeds and also the work piece to white Al<sub>2</sub>O<sub>3</sub> wheels during cylindrical grinding, improved surface finish but damage-free surfaces were obtained.
- (b) Surface finishes but weakened surfaces during cylindrical grinding become elevated throughout high feed through cutting depths;
- (c) Experimental work shows because, using only a variable frequency drive (VFD), that tangential grinding force produced during cylindrical grinding can indeed be determined from of the measurements of grinding wheel motor power;
- (d) A approach to cylindrical grinding of Al/sic components contained in this document can indeed be applied to super abrasive wheels including such diamond and CBNN wheels.

The aim of this work is to carry out a feasible workability study through experimental investigations on surface roughness and dwarf formation in the turning of aluminum alloys AA6061 (100%), AA6061-B4C (90% and 10%) and AA6061- B4C- Gr (87%). - 10% and 3%) hybrid components.

Hung et al. [23] Experiments with different cutting conditions were performed using carbide, CBN (cubic boron nitride) and PCD (poly crystalline diamond) tools. Surface grinding is better suited to carbide tools than PCD instruments that really are minimal. PCD tools perform than for tools for cBN and carbide. This really is attributed to just the smear but deposition influence of softer, somewhat amorphous graphite particles mostly on composite work sample surface, and creates gaps throughout the machining process and therefore decreases the final level of both the surface. On the other hand, the compound of graphite particles produces discontinuous chips which led to smooth machining. PCD tools are better than carbide and

coated carbide tools in reducing surface roughness. Machining parameters such as cutting speed, feed rate, and spindle and cutting tool speeds also affect the level of surface finish. The influence of these parameters on the turning of aluminum alloy AA6061, hybrid compositions AA6061-B4C and AA6061-B4C-Gr are analyzed with the results of the experiment here.

Gangil, Manish, and M. K. Pradhan [24] A produced commodity not just to demands high accuracy and consistency in today's world, it should also be generated in a limited period of time. Consequently, the required power must be obtained while changing the process parameter as per the requirement. These have occurred in either a situation where understanding of both the optimal values of different input parameters becomes needed in order to maximize or minimize a particular output. One of it's powerful modelling approaches in a really scenario is Surface Response Methodology (RSM). That biggest focus is already on the optimization dimensions of both the different parameters of both the RSM EDM systems, so only certain research papers will be included in research work. Where RSM is used to optimize EDM procedures; which have been published in the last 10 years since 2006. Die Sinking EDM, WEDM, PMEDM, Micro-Machining and various hybrid and modified versions of these procedures. In analyzing certain methods together, analysis work on a very broad scale has not yet been undertaken previously, and so this review work will become knowledge accessible from one position and usable for future company to investigate that study's course. Investigations Inquiry.

Gangil, Manish, and M. K. Pradhan [25] Within recent times, why does an industrial commodity need high accuracy and efficiency, and it must always be assembled in the shortest possible period to stay in a highly competitive environment. Consequently, the required power must be obtained through changing the process parameter as per the specification. In deciding that consistency of both the surface and indeed the speed of material removal, that input parameters are useful. Electro-erosion (EDM) is among the most desirable alternatives for both the industry amongst these different machining processes owing from its desirable attribute of no loss of interaction between both the instrument and also the workpiece that allows little if any use of those, Push the instrument as well as the workpiece on. For the some modern production procedures, that present study provides a detailed literature analysis. That key emphasis remains also on optimization dimensions of different parameters of EDM operations, since only certain research papers should be included in it now.

Gangil, Manish, and M. K. Pradhan [26] (EDM) parameters for maximum productivity and minimum surface integrity through the combined use of R CombinedM (Surface Response Methodology) and VIKOR method. The effect of four procedural parameters; i.e., pulse time (ton), peak current duty cycle (Ip) (Tau) and supply voltage (V) in responses such as material removal rate (MRR), tool wear rate

(TWR) ) and Surface roughness (Ra) were considered. Thirty experiments were conducted on a Ti-6Al-4V (titanium alloy) piece with a copper instrument using the Central Composite Design (CCD). By using Pi data collected from VIKOR process, a multi-criteria decision-making method that calculates the rake based on fundamental calculation of closure to both the ideal solution, this same optimum state of both the study was established. These are determined from of the study whether  $I_p = 12A$ ,  $T_{on}$

Gangil, Manish and M. K. Pradhan [27] Aluminum die components have been widely Due to its excellent strength/weight ratio, superior mechanical properties but increased wear resistance, they have been used in numerous advanced industrial applications in recent years. In this work the characteristics of preparation and workability were studied. The experiments were conducted with Electric Discharge Machining (EDM). The compound is prepared by stirring technique. The Taguchi L9 orthogonal matrix was considered for experimentation. Multiple responses such as material removal rate, tooling speed and surface roughness were considered. A multi-objective optimization technique (simple additive weighting) integrated with the principal component analysis method was used. Procedural parameters such as pulse current, pulse duration, duty cycle and discharge voltage were considered to maximize MRR and TWR and Ra were considered as responses for the analyzes. It is observed that the optimal input parameter setting provides the optimal combination ( $I_p = 10 A$ ,  $T_{on} = 100 \mu s$ ,  $\tau = 5.25\%$  and  $V = 40$  volts) for the responses.

Li, Xuekun, et al [28] Machining of grey cast iron can, once usable, now become significant application of cBN coated tools. Again, PcBN tools are among some of the only tools that can machine powdered metal (PM) parts economically. General Motors' 3-11-V-6 engine and latest transmissions are some of new applications of PM technology throughout the automobile industry, Plates & sprockets for strain. Clutch hubs for Ford & turbine hubs. Turning is also another expanding application with PCBN devices, and requires cutting steel with a C-45 or higher Rockwell temperature. Some of these pieces are become through. Which substitute several of the present grinding techniques, turning was added. That cost per component of a PCBN instrument is always twice the cost of both the grinding wheel, over addition, though, the cost and repair of a grinding machine is 2 to 3 times that of a lathe. Machining even allows quicker removal of content, a one-step process for difficult materials, and faster set-up times on short runs. The substitution of hard turning grinding processes would affect the potential market for PCBN Prabhat et.al tools. [29]

### III COMPOSITE MATERIAL

A material structure consisting of two or more components (mixed and bonded) on a macroscopic scale is a standard composite material. Probably, a composite substance consists of reinforcements incorporated in a matrix (fibres, dust, flakes and / or fillers) (polymers, metals or ceramics). That form that ideal shape, each matrix holds its reinforcement, although the reinforcement strengthens that matrix's overall material properties. A new combined material provides greater strength once designed correctly than every single material. While set out in Verma, D., et al. [1] Composites become multifunctional material systems that provide features that just aren't able to capture from every particular material. These is cohesive structures created either by physical association of three or maybe more suitable materials, similar on composition and properties or, often, even shape.

(a) **Classification of Composite** - Composite sites are classified as a two-phase system. These become categorized as continuous or discontinuous components as per the forms of reinforcement. These become defined on the basis of a matrix content used for:

- (i) Organic matrix components
- (ii) Components of the polymer matrix
- (iii) Carbon matrix components
- (iv) Metal matrix component sites
- (v) Ceramic matrix components

The matrix, also termed the scattered and distributed phase, becomes continuous but surrounds some other phase. The component values mainly depend mostly on quantity, geometry, or scattered phase properties for Shaofan et al.[2]. Particle scale, aspect ratio, size and position of Whitehouse and T distribution provide the geometry of distributed process. [3]

Therefore, and per the size and shape of both the distributed process, there can indeed be categorised as:  
Microscopic  
Macroscopic

### IV MICROSCOPIC COMPOSITS

(a) **Dispersion–Strengthened Composite-** That consists of such a matrix process where quite fine intermetallic precipitates were dispersed with a diameter ranging around 0.01 and 0.1 mm. Those other white precipitate becomes distributed evenly, normally at a volume concentration of up to 15%. Metals or their alloys can be strengthened by the uniform dispersion of various volume percentages of fine particles of very hard intermetallic precipitates. Metallic or non-metallic could be the scattered form. The strengthening process becomes close to those of the hardening of precipitation. That matrix absorbs much of the load, although the rotation of both the dislocation is inhibited by small dispersed particles. Plastic

deformation is then minimal, leading to higher tensile performance and toughness.

- (b) **Particle Reinforced Composites-** That comprises of fragments of one or maybe more materials in either a matrix of another substance suspended either dispersed. Particles 1  $\mu\text{m}$  or greater, with a diameter of up to 71  $\mu\text{m}$ , are being used up to a volume ratio of 25 to 50 or larger Laad et al[4]. The strengthened material typically influences the material properties of the composite through growing the modulus of strength and resistance to hardness. However, there is a reduction in yield strength and impact strength. The enhancement of both the components' mechanical activity is far more dependent upon this interfacial bond here between reinforcing particle or the matrix. The higher that bond, the greater that mechanical characteristics of Swamy et al.[5]. These even play a significant role in enhancing mechanical properties, throughout addition to both the scale, shape, extent of uniformity and in distribution of both the scattered particles. With such an enhanced volume fraction, uniform distribution as well as a decreased size of both the distributed process, the mechanical properties were enhanced. YATHIRAJAN, Hemmige, et al [6]. For particle reinforced components (discontinuous reinforcement), the dispersoid, like the matrix, may be metallic or non-metallic. For non-metallic materials, common variations of these will be non-metallic. Ex: -Graphite in polymers with epoxy. Metallic with non-metallic sections. Ex: -Fine aluminum metal in polyethylene Lorenz, U. L. R. I. K. E., et al [7]. Metallic in metal components. Ex: - Tribological properties are strengthened by lead particles through copper alloys. Non-metallic elements in metallic form. Example: -Graphite / MoS<sub>2</sub> in copper matrix with silicon carbide aluminium. In such a metallic matrix, non-metallic particles, particularly ceramic ones, become distributed or the resulting compound becomes known for cermet. The ceramics also used to have high strength, high properties and good hardness qualities, and are brittle naturally. Through different metal matrices, various ceramic particles are being tested, including such quartz, alumina, zircon, mullite, Sic, flaSh. Tian, C., Irons, G. A., D. S. Wilkinson and S. [8]
- (c) **Fiber-reinforced Composite** - In either a continuous matrix point, the fibre is in a distributed process with all its length several times greater than any of its diameter. This can be constant or discontinuous to both the fibre. That key features of such materials are that they have a very high strength/weight ratio. Researchers reported the friction and wear behavior of short, discontinuous carbon fibers reinforced with aluminum alloys. In addition, the hybrid component sites reinforced with 12 vol% Al<sub>2</sub>O<sub>3</sub> and 8 vol% carbon fiber in Al-Si alloy exhibit high wear resistance PRASAD, TB [9].

## V CONSTITUTENTS OF COMPOSITES

A matrix binder and reinforcing filler constitute the principal components of a composite material.

- (a) **Matrix-** The substance that binds the padding together and protects that is a matrix. In a possible matrix material, any solid may be produced to add and retain a reinforcing phase. Basically, with both the reinforcement as well as an interface between both the reinforcement or the reinforcement, a matrix substance must've been chemically compliant. In addition, the matrix consists of metals, ceramics, including polymers. The following major functions are handled by the matrix throughout the composite site: That acts as a way of distributing and distributing the stress applied externally to the reinforcements, so only a small part of both the load becomes borne either by matrix process. The results from human reinforcement with surface damage resulting from abrasion or chemical reaction to the atmosphere become transmitted. Will provide finish, colour, texture, longevity and some other performance characteristics.
- (b) **Metal Matrix** - The metals were solid but resistant. A number of metals may plastically bend and stabilize them, mostly by obstructing the passage through linear defects called dislocations. Titanium and its alloys, copper as well as its alloys, titanium alloys, magnesium alloys or super alloys based on nickel can constitute the metal matrix. These become useful for high of high-temperature (300 to 500<sup>0</sup>C) Murray & Heather [10].
- (c) **Ceramic Matrix** - Ceramics were classified as products manufactured through inorganic non-metallic matrix and processed at high temperatures during they manufacture at certain times. The ceramic has been used as a matrix medium and then was distinguished by it's own high refractoriness, low chemical resistance, high hardness but non-conducting property. Aluminum oxide, aluminium nitride, silicon carbide, silicon nitride, titanium carbide, or titanium nitride, respectively, are among some of the ceramics included. Agrawal, Parul, and C. T. Sun [11]
- (d) **Polymer Matrix** - There are so many more diverse polymers than metals or ceramics. They're inexpensive and easy to deal with. That equipment needed for polymer part manufacturing is easy. These include lower yield strength, but really the polymers are generally accepted as both a matrix as well as the reinforced polymers are qualified to structural applications. Polymers become typically weak conductors of electricity and energy due to their mainly covalent bonds. Which are much more resistant than metals to chemicals? These become

structurally giant chain-shaped molecules with either a carbon atom covalently connected which forms that chain's backbone. [12].

- (e) **Reinforcements** - The reinforcement material would be the one that provides its two-phase material with strength. It increases stiffness then provides. The enhancement of chemical and tribological properties, including such thermal and electrical conductivity, prolongs its existence of a composite. Reinforcements were graded per the aspect ratio (length to thickness) as,
- (i) **Fibers**- Fibers become fabrics which are smoother in the longitudinal orientation and have a really long axis. These were all usable, also continuous, across many diameters, that can be used as was or the cut to both the required width. This may be polycrystalline or amorphous and it is the core components of polymer or ceramic or metal matrices of a fiber-reinforced composite. In either a compound, they occupy their greater volume fraction so share much of the acting charge. These were productive which influence the following features of even a complex due to various their incredibly large proportions.
- Specific gravity
  - Tensile strength and modulus
  - Compressive strength and modulus
  - Fatigue strength and fatigue failure mechanism
  - Electrical & thermal conductivity
  - Cost

Some of the important fibers are glass, carbon, Kevlar, boron, Sic, and  $Al_2O_3$ .

- (ii) **Whiskers**- Whiskers are indeed very small single acicular crystals (needles) with just an viewing angle typically higher than 10 or a diameter around 0.01 and 1.0  $\mu m$ . They have a rather wide ratio of surface to volume as well as a non-circular cross section (such as triangular), rhomboedral and hexagonal). The diameter are known as the cross-sectional region's square root. They were effective, due to its huge proportions. The design of both the whiskers influences the whisker matrix's total interfacial region. In essence, that interface seems to have a significant effect upon this component's mechanical properties. The low density of defects throughout the targets was due to both the form or the small dimensions of both the single crystal that give them control. Whiskers were mainly inserted into metals for stiffness, creep, and wear resistance. Wold, L et.al. [13]. While sealed with a ceramic matrix, whiskers maximise fracture, wear and creep resistance. In silicone materials, whiskers have been used to strengthen thermal conductivity properties. Any of the largest things are

asbestos, carbon, silicon carbide, silicon nitride, alumina, mullite, titanium, titanium carbide, titanium nitride, aluminum borate, calcium carbonate,  $SiO_2$ , niobium carbide, aluminum nitride, tin oxide, Somalashak cadmium oxide. [14].

- (iii) **Flakes and platelets**- There in range of 30-120, platelets or flakes have an aspect ratio. Typically, the diameter varies from 20 to 500  $\mu m$ . For ceramic matrix materials, certain reinforcements may be appealing. Flake or platelet filled composites show less anisotropic microstructure or a decreased inclination to warp due to their flat surfaces. Mica, Sic, boron carbide, aluminium, copper are amongst the most common platelets. Ramesh, C. S., et al. [15].
- (iv) **Particulates**- The particles can be thought of as a small, microscopic powdered material. Those who have such a respect ratio that is poor. The dimensions for both directions of even a particle reinforcement become nearly the same. Spherical, cubic, plate-shaped or irregular but rather regular geometry can become the shape of both the atom. Factors including such size, geometry, diffusion of volume fraction depend on the performance of both the particle reinforcement. The particles become chosen according to the type of matrix phase adhesion and also have two types.
- Non-metallic
  - Metallic
- (v) **Metallic**- In some other metallic matrix, metallic ions cannot really be destroyed. Rocket propellant, consisting of aluminium powder through polyurethane Ramesh, C. S., and Mir Safiulla, are some examples. [16].
- (vi) **Non-Metallic** - Ceramics are always the most common non particles, Conductive compounds, including such graphite, black conductive carbon, etc. Ceramics are by far the most common materials displaced and in matrix, as well as ceramics are the consequent composites. Any one of the meaningful ones non-metallic particulate are  $Al_2O_3$ , BN, Sic, graphite, Tic, Tin, W, glass,  $ZrO_2$ ,  $CaF_2$  Satyanarayana et.al. [17].

## VI SUMMARY

In this study, the effect of metal alloy composite particle reinforcement on microstructure and mechanical properties, tribological behavior and thermodynamic properties at various sites of the metal matrix and their corresponding applications was thoroughly investigated. In most metal alloy reinforced metal matrix composites it was found that there was a homogeneous distribution of metal alloy composite particles in the metal matrix without forming residual lumps or pores. The micrograph revealed that most of the particles of the chemosphere were infiltrated with

the alloy of the matrix, in particular most of the components of the metal-filled matrix of the chemosphere. In most cases, micro structural examination observed that the metal alloy compound particles could react with the molten metal matrix, which could result in the formation of hard and dendritic phases of  $Mg_2Si$  and  $MgAl_2O_4$ . The nature and severity of the reaction depend on the type of metal alloy compound particle used, its chemical variation and the components of the mineral phase. The particle wall of the chemosphere was weakened by the reaction between the Mg matrix and the FAC particle.

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# Common Fixed Point Theorems in Soft S-Metric Spaces

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## ABSTRACT

The aim of this paper is to define soft S-metric space and investigate some important properties. Also We established some fixed point theorem for two maps on soft S-metric spaces. Our results is generalized form of some previous well known results from S-metric spaces.

**Keywords:** Soft S-metric spaces, fixed points. AMS subject classification: 47H10, 54H25, 55M20.

## I INTRODUCTION

In daily life, the problem in many fields deals with uncertain data and are not successfully modelled in classical mathematics. In 1999, the theory of soft sets initiated by Molodstov [15] as mathematical tool to handle uncertainty associated with real world data based problems and established the fundamental results of this new concept. The soft set is a parametrized family of subset of universal set. Majiet al.[16] introduced several operations in soft sets. They made theoretical study of the soft set theory and presented the application of soft set in decision making problem. Das and Samanta[7, 9, 10] introducing the concept of soft metric spaces which is based on soft point of soft sets. Fixed point problem for contractive mapping in metric spaces with partial order have been studied by many authors ([1],[5]). Jungck [11] gave the concept of fixed point for commuting map. In 2006, Z. Mustafa and B.I. Sims

[17] introduced the notion of G-metric spaces which is generalization of metric spaces.

In 2012, S. Sedghi, N. Shobe and Aiouche [21] introduced the notion of S-metric which is generalization of G-metric spaces [11] and  $D^*$  metric [20]. Also, Sedghi and N.V. Dung [22] investigated some generalized fixed point theorems in S-metric spaces which is generalization of [21]. Jong Kyu Kim et al. [14] gave some fixed point theorems for two maps on complete S-metric spaces. Recently Mujeeb, Mohammad and Muhib[27] introduced the notion of common fixed point theorems for compatible and weakly compatible mapping in context of S-metric spaces. In the present paper we introduced the notion of soft S-metric spaces which is generalization of S-metric spaces and also, fixed point theorems for two mappings on complete soft S-metric spaces will be proved. Our result extends and generalized form of result of [14].

We recall some definitions will be needed in the sequel.

## II PRELIMINARIES AND DEFINITIONS

- (a) **Definition 2.1.** [15] Let  $A$  be a set of parameters and  $X$  be an initial universe. Let  $P(X)$  denote the power set of  $X$ . A pair  $(F, A)$  is called a soft set over  $X$ , where  $F$  is a mapping given by  $F : A \rightarrow P(X)$ .
- (b) **Definition 2.2.** [16] Let  $(F, A)$  and  $(G, A)$  be two soft sets over a common universe  $X$ .
- $(F, A)$  is said to be null soft set, denoted by  $\emptyset$ , if for all  $\lambda \in A$ ,  $F(\lambda) = \emptyset$ .  $(F, A)$  is said to an absolute soft set denoted by  $\tilde{E}$ , if for all  $\lambda \in A$ ,  $F(\lambda) = E$ .
  - $(F, A)$  is said to be a soft subset of  $(G, A)$  if for all  $\lambda \in A$ ,  $F(\lambda) \subseteq G(\lambda)$  and it is denoted by  $(F, A) \subseteq (G, A)$ .  $(F, A)$  is said to be a soft upper set of  $(G, A)$  if  $(G, A)$  is a soft subset of  $(F, A)$ . We denote it by  $(F, A) \supseteq (G, A)$ .  $(F, A)$  and  $(G, A)$  is said to be equal if  $(F, A)$  is a soft subset of  $(G, A)$  and  $(G, A)$  is a soft subset of  $(F, A)$ .
  - The intersection  $(H, A)$  of  $(F, A)$  and  $(G, A)$  over  $E$  is defined as  $H(\lambda) = F(\lambda) \cap G(\lambda)$  for all  $\lambda \in A$ . We write  $(F, A) \tilde{\cap} (G, A) = (H, A)$ .
  - The union  $(H, A)$  of  $(F, A)$  and  $(G, A)$  over  $E$  is defined as  $H(\lambda) = F(\lambda) \cup G(\lambda)$  for all  $\lambda \in A$ . We write  $(F, A) \tilde{\cup} (G, A) = (H, A)$ .
  - The Cartesian product  $(H, A)$  of  $(F, A)$  and  $(G, A)$  over  $E$  denoted by  $(H, A) = (F, A) \tilde{\times} (G, A)$ , is defined as  $H(\lambda) = F(\lambda) \times G(\lambda)$  for all  $\lambda \in A$ .
  - The difference  $(H, A)$  of  $(F, A)$  and  $(G, A)$  over  $E$  denoted by  $(F, A) \tilde{-} (G, A) = (H, A)$ , is defined as  $H(\lambda) = F(\lambda) \setminus G(\lambda)$  for all  $\lambda \in A$ .
  - The complement of  $(F, A)$  is defined as  $(F, A)^c = (F^c, A)$ , where  $F^c : A \rightarrow P(E)$  is a mapping given by  $F^c(\lambda) = B \setminus F(\lambda)$  for all  $\lambda \in A$ . Clearly, we have  $\tilde{E}^c = \Phi$  and  $\Phi^c = \tilde{E}$ .
- (c) **Definition 2.3:** [7,9] Let  $A$  be a set of parameters and  $\mathbb{R}$  be the set of real numbers and  $B(\mathbb{R})$  be the collection of all non-empty bounded subsets of  $\mathbb{R}$ . Then a mapping  $F : A \rightarrow B(\mathbb{R})$  is called a soft real set, denoted by  $(F, A)$ . If specifically  $(F, A)$  is a singleton soft set, then after identifying  $(F, A)$  with the corresponding soft element, it will be called a soft real number. The set of all soft real numbers is denoted by  $\mathbb{R}(A)$  and the set of non-negative soft real numbers by  $\mathbb{R}(A)^*$ .

Let  $\tilde{r}$  and  $\tilde{s}$  be two soft real numbers. Then the following statements hold:

- (i)  $\tilde{r} \lesssim \tilde{s}$ , if  $\tilde{r}(\lambda) \leq \tilde{s}(\lambda), \forall \lambda \in A$ ,
- (ii)  $\tilde{r} \prec \tilde{s}$ , if  $\tilde{r}(\lambda) < \tilde{s}(\lambda), \forall \lambda \in A$ ,
- (iii)  $\tilde{r} \gtrsim \tilde{s}$ , if  $\tilde{r}(\lambda) \geq \tilde{s}(\lambda), \forall \lambda \in A$ ,
- (iv)  $\tilde{r} \succ \tilde{s}$ , if  $\tilde{r}(\lambda) > \tilde{s}(\lambda), \forall \lambda \in A$ ,

**(d) Definition 2.4:** [9] Let  $X$  be a non-empty set and  $A$  be non-empty a parameter set. A mapping  $d: \mathbb{SE}(\tilde{X}) \times \mathbb{SE}(\tilde{X}) \rightarrow \mathbb{R}(A)^*$  is said to be a soft metric on the soft set  $\tilde{X}$  if  $d$  satisfies the following conditions:

- (i)  $d(\tilde{x}, \tilde{y}) \geq \tilde{0}$ , for all  $\tilde{x}, \tilde{y} \in \tilde{X}$ .
- (ii)  $d(\tilde{x}, \tilde{y}) = \tilde{0}$  if and only if  $\tilde{x} = \tilde{y}$ .
- (iii)  $d(\tilde{x}, \tilde{y}) = d(\tilde{y}, \tilde{x})$  for all  $\tilde{x}, \tilde{y} \in \tilde{X}$ .
- (iv)  $d(\tilde{x}, \tilde{y}) \leq d(\tilde{x}, \tilde{z}) + d(\tilde{z}, \tilde{y})$  for all  $\tilde{x}, \tilde{y}, \tilde{z} \in \tilde{X}$ .

The soft  $\tilde{X}$  with a soft metric  $d$  on  $\tilde{X}$  is said to be a soft metric space and denoted by  $(\tilde{X}, d, A)$  or  $(\tilde{X}, d)$ .

**(e) Definition 2.5:** [21] Let  $X$  be a nonempty set. An S-metric on  $X$  is a function  $S: X \times X \times X \rightarrow [0, \infty)$  that satisfies the following conditions holds for all  $x, y, z, a \in X$ .

- (i)  $S(x, y, z) \geq 0$ ,
- (ii)  $S(x, y, z) = 0$  iff  $x = y = z$ ,
- (iii)  $S(x, y, z) \leq S(x, x, a) + S(y, y, a) + S(z, z, a)$ .

The pair  $(X, S)$  is called a S-metric space.

**Example 2.1:** [21] Let  $X=R$  the distance function  $S: X^3 \rightarrow [0, \infty)$  defined by  $S(x, y, z) = |x - z| + |y - z|$  for all  $x, y, z, \in X$  is a S-metric on  $X$ .

**Definition 2.2:**[21] Let  $(X, S)$  be a S-metric space for  $r > 0$  and  $x \in X$ , we define the open ball  $B_S(x, r)$  and the closed ball  $B_S[x, r]$  with centre  $x$  and radius  $r$  as follows:

$$B_S(x, r) = \{y \in X: S(y, y, x) < r\},$$

$$B_S[x, r] = \{y \in X: S(y, y, x) \leq r\}.$$

The topology induced by the S-metric is the topology generated by the base of all open ball in  $X$ .

**Definition 2.3:**[14] Let  $(X, S)$  and  $(X', S')$  be two S-metric space. A function  $f: (X, S) \rightarrow (X', S')$  is said to be continuous at point  $a \in X$  if for every sequence  $\{x_n\}$  in  $X$  with  $S(x_n, x_n, a) \rightarrow 0$ ,  $S'(f(x_n), f(x_n), f(a)) \rightarrow 0$ . We say that  $f$  is continuous on  $X$  if  $f$  is continuous at every point  $a \in X$ .

### III SOFT S-METRIC SPACES

In this section, we introduce soft S-metric spaces and also we give some important results.

Let  $\tilde{X}$  be the absolute soft set,  $A$  be a non-empty set of parameters and  $\mathbb{SE}(\tilde{X})$  be the collection of all soft points of  $\tilde{X}$ . Let  $\mathbb{R}(A)^*$  denote the set of all non-negative soft real numbers.

**(a) Definition 3.1:** Let  $X$  be a non-empty set and  $\tilde{X}$  be absolute soft set. A mapping  $S: \mathbb{SE}(\tilde{X}) \times \mathbb{SE}(\tilde{X}) \times \mathbb{SE}(\tilde{X}) \rightarrow [0, \infty)$  is said to be a soft S-metric on  $\tilde{X}$  if  $S$  satisfies the following axioms holds for all  $\tilde{x}, \tilde{y}, \tilde{z}, \tilde{a} \in \tilde{X}$ ,

- (S<sub>1</sub>)  $\Theta \lesssim S(\tilde{x}, \tilde{y}, \tilde{z})$ ,
- (S<sub>2</sub>)  $S(\tilde{x}, \tilde{y}, \tilde{z}) = \Theta$  iff  $\tilde{x} = \tilde{y} = \tilde{z}$
- (S<sub>3</sub>)  $S(\tilde{x}, \tilde{y}, \tilde{z}) \lesssim S(\tilde{x}, \tilde{x}, \tilde{a}) + S(\tilde{y}, \tilde{y}, \tilde{a}) + S(\tilde{z}, \tilde{z}, \tilde{a})$

Then, the soft set  $\tilde{X}$  with a soft S-metric  $S$  on  $\tilde{X}$  is called a soft S-metric space and is denoted by  $(\tilde{X}, S, A)$  or  $(\tilde{X}, S)$ .

Then  $S$  is called soft S-metric on  $\tilde{X}$  and  $(\tilde{X}, S)$  is called soft S-metric space.

**Example 3.1:** Let  $A$  be a finite set of parameters, Let  $\tilde{X} = \mathbb{R}^3(A)$ ,

$(S, A) = \mathbb{SS}\{(\tilde{x}, \tilde{y}, \tilde{z}) \in \tilde{X}: \tilde{x}, \tilde{y}, \tilde{z} \geq \tilde{0}\}$ , the function  $S: \tilde{X}^3 \rightarrow [0, \infty)$  such that,

$$S(\tilde{x}, \tilde{y}, \tilde{z}) = |\tilde{x} - \tilde{z}| + |\tilde{y} - \tilde{z}| \text{ for all } \tilde{x}, \tilde{y}, \tilde{z} \in \tilde{X}.$$

The  $(\tilde{X}, S, A)$  is a soft S-metric spaces.

**(b) Definition 3.2:** Let  $(\tilde{X}, S)$  be soft S-metric space. Let  $\{\tilde{x}_n\}$  be a sequence of soft elements in  $\tilde{X}$  and  $\tilde{x} \in \tilde{X}$ .  $\{\tilde{x}_n\}$  converges to  $\tilde{x}$  if  $S(\tilde{x}_n, \tilde{x}_n, \tilde{x}) \rightarrow 0$  as  $n \rightarrow \infty$ . That is, for each  $\tilde{\varepsilon} \succ \tilde{0}$ , there exists  $n_0 \in \mathbb{N}$ , such that for all  $n \geq n_0$ , we have,  $S(\tilde{x}_n, \tilde{x}_n, \tilde{x}) \prec \tilde{\varepsilon}$ . We denote this  $\lim_{n \rightarrow \infty} \tilde{x}_n \rightarrow \tilde{x}$ .

**(c) Definition 3.3:** Let  $(\tilde{X}, S)$  be soft S-metric space. Let  $\{\tilde{x}_n\}$  be a sequence of soft elements in  $\tilde{X}$ . A sequence  $\{x_n\}$  Cauchy sequence if  $S(\tilde{x}_n, \tilde{x}_n, \tilde{x}_m) \rightarrow 0$  as  $n, m \rightarrow \infty$ . That is, for each  $\tilde{\varepsilon} \succ \tilde{0}$ , there exists  $n_0 \in \mathbb{N}$  (there is natural number  $\mathbb{N}$ ), such that for all  $n, m \geq n_0$ , we have,  $S(\tilde{x}_n, \tilde{x}_n, \tilde{x}_m) \prec \tilde{\varepsilon}$ .

**(d) Definition 3.4:** Let  $(\tilde{X}, S)$  be soft S-metric space. If every Cauchy sequence of soft elements in  $\tilde{X}$  is convergent in  $\tilde{X}$ , then  $(\tilde{X}, S)$  is called complete soft S-metric space.

(e) **Definition 3.5:** Let  $\tau$  be the soft set of all  $A \tilde{\subset} \tilde{X}$  with  $\tilde{x} \in A$  and there exists  $r \succ 0$  such that  $B_S(\tilde{x}, r) \tilde{\subset} A$ . Then  $\tau$  is a topology on  $\tilde{X}$ .

(f) **Definition 3.6:** Let  $(\tilde{X}, S)$  be soft S-metric space. A mapping  $T: \tilde{X} \rightarrow \tilde{X}$  is called contraction if  $S(T\tilde{x}, T\tilde{x}, T\tilde{y}) \tilde{\leq} \alpha \cdot S(\tilde{x}, \tilde{x}, \tilde{y})$  for all  $\tilde{x}, \tilde{y} \in \tilde{X}$  with  $\alpha \in [0, 1)$ .

Some basic results which is generalized form of S-metric space[21]:

(i) **Basic result 3.1:** Let  $(\tilde{X}, S)$  be soft S-metric space. Limit of the convergent sequence  $\{\tilde{x}_n\}$  in soft S-metric space  $(\tilde{X}, S)$  is unique.

(ii) **Basic result 3.2:** Soft S-metric  $(\tilde{X}, S)$  is jointly continuous on all three variables.

(iii) **Basic result 3.3:** In soft S-metric space we have,  $S(\tilde{x}, \tilde{x}, \tilde{y}) = S(\tilde{y}, \tilde{y}, \tilde{x})$  for all  $\tilde{x}, \tilde{y} \in \tilde{X}$ .

(iv) **Basic result 3.4:** Let  $(\tilde{X}, S)$  be soft S-metric space. If there exists sequence  $\{\tilde{x}_n\}$  and  $\{\tilde{y}_n\}$  be the soft elements in  $\tilde{X}$ , such that  $\lim_{n \rightarrow \infty} \tilde{x}_n \rightarrow \tilde{x}$  and  $\lim_{n \rightarrow \infty} \tilde{y}_n \rightarrow \tilde{y}$ , then

$$\lim_{n \rightarrow \infty} S(\tilde{x}_n, \tilde{x}_n, \tilde{y}_n) = S(\tilde{x}, \tilde{x}, \tilde{y}).$$

(v) **Basic result 3.5:** Let  $(\tilde{X}, S)$  be soft S-metric space and suppose that sequence  $\{\tilde{x}_n\}$  and  $\{\tilde{y}_n\}$  are S-convergent to  $\tilde{x}, \tilde{y}$  respectively. Then we have

$$\limsup_{n \rightarrow \infty} S(\tilde{x}_n, \tilde{z}, \tilde{y}_n) \leq S(\tilde{z}, \tilde{z}, \tilde{x}) + S(\tilde{x}, \tilde{x}, \tilde{y}).$$

In particular, if  $\tilde{x} = \tilde{y}$ , then we have  $\limsup_{n \rightarrow \infty} S(\tilde{x}_n, \tilde{z}, \tilde{y}_n) \leq S(\tilde{z}, \tilde{z}, \tilde{x})$ .

Proof: Let  $\lim_{n \rightarrow \infty} \tilde{x}_n \rightarrow \tilde{x}$  and  $\lim_{n \rightarrow \infty} \tilde{y}_n \rightarrow \tilde{y}$ . Then for each  $\tilde{\epsilon} > 0$  there exists  $n_1, n_2 \in \mathbb{N}$  such that for all  $n \geq n_1$ ,

$$S(\tilde{x}_n, \tilde{x}_n, \tilde{x}) < \frac{\tilde{\epsilon}}{2}$$

for all  $n \geq n_2$ ,

$$S(\tilde{y}_n, \tilde{y}_n, \tilde{y}) < \frac{\tilde{\epsilon}}{4}.$$

If set  $n_0 = \max\{n_1, n_2\}$ , then for every  $n \geq n_0$  by condition (3) of soft S-metric space, we have

$$\begin{aligned} S(\tilde{x}_n, \tilde{z}, \tilde{y}_n) &\leq S(\tilde{x}_n, \tilde{x}_n, \tilde{x}) + S(\tilde{z}, \tilde{z}, \tilde{x}) + S(\tilde{y}_n, \tilde{y}_n, \tilde{x}) \\ &\leq S(\tilde{x}_n, \tilde{x}_n, \tilde{x}) + S(\tilde{z}, \tilde{z}, \tilde{x}) + 2S(\tilde{y}_n, \tilde{y}_n, \tilde{y}) + S(\tilde{x}, \tilde{x}, \tilde{y}) \end{aligned}$$

On taking the upper limit as  $n \rightarrow \infty$  in the above inequality, we get the first desired result.

The second result is obvious.

This result is generalized form of S-metric space [13].

Invariant points on soft S-metric space:

(vi) **Definition 3.7:** Let  $(\tilde{X}, S)$  be soft S-metric space and  $T: (\tilde{X}, S) \rightarrow (\tilde{X}, S)$  be mapping. If there exists soft elements  $\tilde{x}_0 \in \tilde{X}$  such that  $T\tilde{x}_0 = \tilde{x}_0$ , then the  $\tilde{x}_0$  is called fixed element in  $T$ .

(vii) **Definition 3.8:** Let  $(\tilde{X}, S)$  be soft S-metric space and  $T: (\tilde{X}, S) \rightarrow (\tilde{X}, S)$  be mapping. For every  $\tilde{x}_0 \in \tilde{X}$ , we can construct the sequence  $\{\tilde{x}_n\}$  of soft elements by choosing  $\tilde{x}_0$  and continuing by;

$$\tilde{x}_1 = T\tilde{x}_0, \tilde{x}_2 = T\tilde{x}_1 = T^2\tilde{x}_0, \dots, \tilde{x}_n = T^n\tilde{x}_0, \dots$$

We say that the sequence  $\{\tilde{x}_n\}$  is constructed by iteration method.

## IV MAIN RESULTS

Let  $\psi$  denote the class of all functions  $\psi: R^+ \rightarrow R^+$  such that  $\psi$  is non-decreasing, continuous and  $\sum_{n=1}^{\infty} \psi^n(t) < \infty$  for all  $t > 0$ . It is clear that  $\psi^n(t) \rightarrow 0$  as  $n \rightarrow \infty$  for all  $t > 0$  and therefore we have  $\psi(t) < t \forall t > 0$ .

**Theorem 4.1:**  $\tilde{X}$  be a soft set. Let the metric space  $(\tilde{X}, S)$  be complete soft S-metric space and consider the map  $P, Q: \tilde{X} \rightarrow \tilde{X}$  be mappings satisfies the following condition :

- 1)  $P(\tilde{X}) \tilde{\subseteq} Q(\tilde{X})$  and either  $P(\tilde{X})$  or  $Q(\tilde{X})$  is closed subset of  $\tilde{X}$ ,
- 2) The pair  $(P, Q)$  is weakly compatible ;
- 3)  $S(P\tilde{x}, P\tilde{y}, P\tilde{z}) \leq \psi(\max\{S(Q\tilde{x}, Q\tilde{y}, Q\tilde{z}), h_1S(Q\tilde{z}, P\tilde{x}, P\tilde{z}), h_2S(Q\tilde{z}, P\tilde{y}, P\tilde{z}), h_3S(Q\tilde{z}, P\tilde{y}, P\tilde{z})\})$

[4.1.1]

For all  $\tilde{x}, \tilde{y}, \tilde{z} \in \tilde{X}$  and  $0 < h_1, h_2, h_3 < 1$  where  $\psi \tilde{\in} \phi$ .

Then the map  $P$  and  $Q$  have unique common fixed point. If  $Q$  is continuous at the fixed point  $\tilde{r}$ , then  $P$  is also continuous at  $\tilde{r}$ .

**Proof:** Let  $\tilde{x}_0 \in \tilde{X}$ . We define a sequence  $\{\tilde{y}_n\}$  in  $\tilde{X}$  such that

$$\tilde{y}_n = P\tilde{x}_n = Q\tilde{x}_{n+1} \quad \text{for } n = 0, 1, 2, \dots$$

And let  $\tilde{d}_{n+1} = S(\tilde{y}_n, \tilde{y}_n, \tilde{y}_{n+1})$ . Then we have

$$\tilde{d}_{n+1} = S(\tilde{y}_n, \tilde{y}_n, \tilde{y}_{n+1})$$

$$= S(P\tilde{x}_n, P\tilde{x}_n, P\tilde{x}_{n+1})$$

$$S(P\tilde{x}_n, P\tilde{x}_n, P\tilde{x}_{n+1}) \leq \psi(\max\{S(Q\tilde{x}_n, Q\tilde{x}_n, Q\tilde{x}_{n+1}), h_1S(Q\tilde{x}_{n+1}, P\tilde{x}_n, P\tilde{x}_{n+1}),$$

$$h_2 S(Q\overline{x_{n+1}}, P\overline{x_n}, P\overline{x_{n+1}}), h_3 S(Q\overline{x_{n+1}}, P\overline{x_n}, P\overline{x_n})) \\ = \psi(\max \{S(\overline{y_{n-1}}, \overline{y_{n-1}}, \overline{y_n}), h_1 S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}), h_2 S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}) \\ h_3 S(\overline{y_n}, \overline{y_n}, \overline{y_n})\})$$

$$\leq \psi(\max \{\overline{d_n}, h_1 \overline{d_{n+1}}, h_2 \overline{d_{n+1}}\})$$

Thus  $\overline{d_{n+1}} \leq \psi(\overline{d_n})$ ,  $n = 1, 2, \dots$ . Hence we have

$$S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}) \leq \psi(S(\overline{y_{n-1}}, \overline{y_{n-1}}, \overline{y_n}))$$

$$\leq \psi^2.S(\overline{y_{n-2}}, \overline{y_{n-2}}, \overline{y_{n-1}})$$

Continuing this process, we get

$$S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}) \leq \psi^n S(\overline{y_0}, \overline{y_0}, \overline{y_1}) \quad (4.1.2)$$

Hence for every  $m > n$  by using (S<sub>3</sub>), we have,

$$S(\overline{y_n}, \overline{y_n}, \overline{y_m}) \leq S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}) + S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}) + S(\overline{y_{n+1}}, \overline{y_{n+1}}, \overline{y_{n+2}}) \\ \leq 2 S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}) + S(\overline{y_{n+1}}, \overline{y_{n+1}}, \overline{y_{n+2}}) \\ \leq 2 [S(\overline{y_n}, \overline{y_n}, \overline{y_{n+1}}) + S(\overline{y_{n+1}}, \overline{y_{n+1}}, \overline{y_{n+2}})] + S(\overline{y_{n+2}}, \overline{y_{n+2}}, \overline{y_{n+3}}) \\ \vdots$$

$$\leq 2 \sum_{i=n}^{m-2} S(\overline{y_i}, \overline{y_i}, \overline{y_{i+1}}) + (\overline{y_{m-1}}, \overline{y_{m-1}}, \overline{y_m}) \\ \leq 2 [\psi^n (S(\overline{y_0}, \overline{y_0}, \overline{y_1})) + \psi^{n+1} (S(\overline{y_0}, \overline{y_0}, \overline{y_1})) + \dots + \psi^{m-1} (S(\overline{y_0}, \overline{y_0}, \overline{y_1}))] \\ = 2 \sum_{i=n}^{m-1} \psi^i (S(\overline{y_0}, \overline{y_0}, \overline{y_1})).$$

Since  $\sum_{n=1}^{\infty} \psi^n(t) < \infty$  for all  $t > 0$ ,  $S(\overline{y_n}, \overline{y_n}, \overline{y_m}) \rightarrow 0$  as  $n \rightarrow \infty$ . So, for each  $\tilde{\epsilon} > 0$ , there exists  $n_0 \in \mathbb{N}$  such that for each  $n, m \geq n_0$

$$S(\overline{y_n}, \overline{y_n}, \overline{y_m}) < \tilde{\epsilon}.$$

This shows that  $\{\overline{y_n}\}$  is Cauchy sequence in  $\tilde{X}$ . Since  $\tilde{X}$  is complete, there exists  $\tilde{r} \in \tilde{X}$  such that  $\lim_{n \rightarrow \infty} \overline{y_n} = \tilde{r}$  and

$$\tilde{r} = \lim_{n \rightarrow \infty} \overline{y_n} = \lim_{n \rightarrow \infty} P\overline{x_n} = \lim_{n \rightarrow \infty} Q\overline{x_{n+1}}.$$

Let  $Q(\tilde{X})$  be a closed subset of  $\tilde{X}$ . Then there exists  $\tilde{v} \in \tilde{X}$  such that  $Q\tilde{v} = \tilde{r}$ .

We prove that  $P\tilde{v} = \tilde{r}$ . Since,

$$S(P\tilde{v}, P\tilde{v}, P\overline{x_n}) \leq \psi(\max \{S(Q\tilde{v}, Q\tilde{v}, Q\overline{x_n}), h_1 S(Q\overline{x_n}, P\tilde{v}, P\overline{x_n}), \\ h_2 S(Q\overline{x_n}, P\tilde{v}, P\overline{x_n}), h_3 S(Q\overline{x_n}, P\tilde{v}, P\tilde{v})\}) \\ = \psi(\max \{S(\tilde{r}, \tilde{r}, \overline{y_{n-1}}), h_1 S(\overline{y_{n-1}}, P\tilde{v}, \overline{y_n}), h_2 S(\overline{y_{n-1}}, P\tilde{v}, \overline{y_n}) \\ h_3 S(\overline{y_{n-1}}, P\tilde{v}, P\tilde{v})\})$$

On taking upper limit as  $n \rightarrow \infty$  in the above inequality, by basic result 3.5, we get

$$S(P\tilde{v}, P\tilde{v}, P\overline{x_n}) \\ \leq \psi(\max \{0, h_1 \lim_{n \rightarrow \infty} (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}), \\ h_2 \lim_{n \rightarrow \infty} (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}), h_3(0)\}) \\ \leq (\max \{0, h_1 (\tilde{r}, \tilde{v}, \tilde{r}), h_2 (\tilde{r}, \tilde{v}, \tilde{r}), 0\}) \\ \leq \max \{h_1, h_2\} (\tilde{r}, \tilde{v}, \tilde{r}).$$

$$\leq \max \{h_1, h_2\} (\tilde{r}, \tilde{v}, \tilde{r}).$$

This implies that  $1 \leq \max \{h_1, h_2\}$ , which is contradiction. Hence, from ( )  $< \forall > 0$ ,

We have  $\tilde{v} = \tilde{r}$ .

By the weak compatibility of the pair  $(\tilde{v}, \tilde{r})$ , we have  $\tilde{v} = \tilde{r}$  and hence  $\tilde{v} = \tilde{r}$ . Now, we have to prove that  $\tilde{v} = \tilde{r}$ . Consider  $\tilde{v} \neq \tilde{r}$ . Then

$$h_2 (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}), h_3 (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}) \\ = (\max \{ (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}), h_1 (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}), h_2 (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}) \\ h_3 (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}) \})$$

On taking upper limit as  $n \rightarrow \infty$  in the above inequality, we get

$$\leq (\max \{ (\tilde{r}, \tilde{v}, \tilde{r}), h_1 \lim_{n \rightarrow \infty} (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}), \\ h_2 \lim_{n \rightarrow \infty} (\overline{y_{n-1}}, \tilde{v}, \overline{y_n}), h_3 (\tilde{r}, \tilde{v}, \tilde{r}) \}) \\ \leq (\max \{0, h_1 (\tilde{r}, \tilde{v}, \tilde{r}), h_2 (\tilde{r}, \tilde{v}, \tilde{r}), 0\}) \\ \leq \max \{h_1, h_2\} (\tilde{r}, \tilde{v}, \tilde{r}).$$

$$\leq \max \{h_1, h_2\} (\tilde{r}, \tilde{v}, \tilde{r}).$$

Since, ( )  $< \forall > 0$ , we have  $\tilde{v} = \tilde{r} = \tilde{r}$ . Hence  $\tilde{v}$  is common fixed point of

Let  $\tilde{v}'$  is another common fixed point of . Then,

$$(\tilde{v}', \tilde{v}') = (\tilde{v}', \tilde{v}, \tilde{v}') \\ \leq (\max \{ (\tilde{v}', \tilde{v}, \tilde{v}'), h_1 (\tilde{v}', \tilde{v}, \tilde{v}'), h_2 (\tilde{v}', \tilde{v}, \tilde{v}'), h_3 (\tilde{v}', \tilde{v}, \tilde{v}') \})$$

If  $(\tilde{v}', \tilde{v}, \tilde{v}') \leq (\tilde{v}', \tilde{v}, \tilde{v}')$ , then  $(\tilde{v}', \tilde{v}, \tilde{v}') \leq (\tilde{v}', \tilde{v}, \tilde{v}') < (\tilde{v}', \tilde{v}, \tilde{v}')$  which is contradiction.

Therefore, we have  $\tilde{v} = \tilde{v}'$ . If  $(\tilde{v}', \tilde{v}, \tilde{v}') < h (\tilde{v}', \tilde{v}, \tilde{v}')$ , then

$$(\tilde{v}', \tilde{v}, \tilde{v}') < h (\tilde{v}', \tilde{v}, \tilde{v}') \\ \leq (2 (\tilde{v}', \tilde{v}, \tilde{v}') + (\tilde{v}', \tilde{v}, \tilde{v}')) \\ = (\tilde{v}', \tilde{v}, \tilde{v}'),$$

Where  $\alpha = \max \{ \alpha_1, \alpha_2 \}$ , this is also contradiction. Therefore, we have  $\tilde{u} = \tilde{v}$ . Hence  $\tilde{u}$  is unique common fixed point of  $\mathcal{T}$ .

Now, we prove continuity of the mapping in soft S-metric space.

Consider sequence  $\{\tilde{u}_n\}$  in  $\tilde{X}$  such that  $\{\tilde{u}_n\}$  is convergent to  $\tilde{u}$ . Then we have

$${}_2 ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \leq ( \max \{ ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_1 ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_3 ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \} )$$

On taking upper limit as  $n \rightarrow \infty$  in the above inequality, from the continuity of  $\mathcal{T}$  at a point  $\tilde{u}$ , we get

$$\begin{aligned} \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) &= \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \\ &\leq ( \max \{ \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_1 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_2 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \} ) \\ &\leq ( \max \{ 0, {}_1 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_2 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), 0 \} ) \\ &\leq \max \{ \alpha_1, \alpha_2 \} ( \tilde{u}, \tilde{u}, \tilde{u} ). \end{aligned}$$

Since,

$${}_1 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \leq {}_1 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) + {}_1 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} )$$

And

$${}_2 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \leq {}_2 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) + {}_2 \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} )$$

We have,

$$\lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \leq \max \{ \alpha_1, \alpha_2 \} \lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ).$$

Which implies that  $\lim_{n \rightarrow \infty} ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) = 0$ . Then, we conclude that  $\mathcal{T}$  is continuous at  $\tilde{u}$ .

**Theorem 4.2:**  $\tilde{X}$  be a soft set. Let the complete soft S-metric space  $(\tilde{X}, \mathcal{T})$  and consider the map  $\mathcal{T}, \mathcal{S} : \tilde{X} \rightarrow \tilde{X}$  be continuous and  $\mathcal{T}, \mathcal{S}$  be commutative with  $\mathcal{T}$ . If for every  $\tilde{\epsilon} \in \tilde{E}$ , the following conditions satisfying:

- 1)  $(\tilde{X}, \mathcal{T}) \subseteq (\tilde{X}, \mathcal{S})$
  - 2) The pair  $(\mathcal{T}, \mathcal{S})$  is weakly compatible ;
  - 3)  $( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \leq ( \max \{ ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_1 ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_2 ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ), {}_3 ( \tilde{u}_n, \tilde{u}_n, \tilde{u} ) \} )$
- [4.1.1]

For all  $\tilde{u}, \tilde{v}, \tilde{w} \in \tilde{X}$  and  $0 < \alpha_1, \alpha_2, \alpha_3 < 1$  where  $\tilde{\epsilon} \in \tilde{E}$ . Then the map  $\mathcal{T}, \mathcal{S}$  have unique common fixed point  $\tilde{u} \in \tilde{X}$ . Further, if  $\mathcal{T}$  is continuous at the fixed point  $\tilde{u}$ , then  $\mathcal{S}$  is also continuous at  $\tilde{u}$ .

**Proof:** The proof is similar to the proof of theorem 4.1.

## V CONCLUSION

In this paper the concept of soft S-metric space via soft elements. Some fixed point theorems for two mapping on complete soft S-metric space was also discussed. There are ample scopes for further research on soft S-metric space.

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# Synthesis and Antibacterial Activity Screening of Pyrazole-Pyridine Derivatives

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## ABSTRACT

Fused heterocyclic compounds, 6-(5-(4-alkyl phenyl)furan-2-yl)-3-methyl-1-phenyl-1H-pyrazolo[3,4-b]pyridine-5-carbonitrile 3(a-e) were synthesized by the reaction of 3-Methyl-1-phenyl-1H-pyrazol-5-amine(1) with 5-(4-alkylphenyl)furan-2-carbaldehyde (2a-e) in presence of Acetoacetonitrile. The structures of all the compounds series (3a-e) were characterized by elemental and spectral studies. The compounds were also screened for antibacterial activity.

**Keywords:** 3-Methyl-1-phenyl-1H-pyrazol-5-amine, 5-(4-alkylphenyl)furan-2-carbaldehyde, antibacterial activity and spectral studies.

## I INTRODUCTION

Heterocyclic compounds shows number of pharmaceutical activity as well antibacterial activity. [1] Among the all the heterocyclic compounds, the Nitrogen containing are important and applied in chemistry and biology. They have vital role in the all the bio-chemical reaction (i.e. metabolism) [2, 4]. Pyrazole moiety containing heterocyclic compounds shows various biological activities such as anti-inflammatory, antimicrobial, analgesic, antifungal, antitumor and anxiolytic activities [5-9]. Pyrazolo[3,4-b]pyridine Skeleton have proven to be interesting classes of heterocycles due to diverse biological properties including antitubercular, antibacterial and antioxidant activities [10-14]. Recently, many authors [15-17] synthesized pyrazolo[3,4-b]pyridine by novel methods. Hence, pyrazole-pyridine containing compounds into one molecule have good medicinal property. Thus it was thought to synthesize this type of fuse molecules. The present communication deals with the synthetic approach shown in scheme-1.

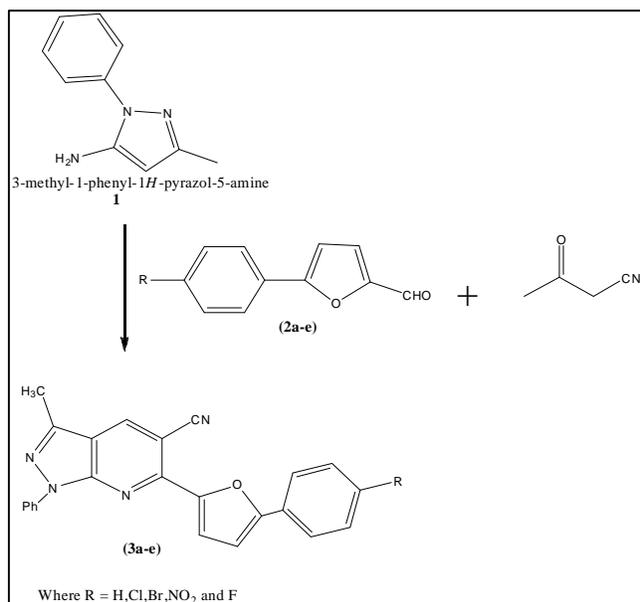
All the chemicals were used laboratory grade. The methods in [16] and [17] were followed for the synthesis of 3-Methyl-1-phenyl-1H-pyrazol-5-amine(1) and 5-(4-alkylphenyl)furan-2-carbaldehyde 2(a-e), respectively.

<sup>1</sup>HNMR spectra were recorded on a Bruker (400 MHz) spectrometer. Deuterated DMSO was used as a solvent. The FTIR spectra produced substances were scanned in KBr disc by using on a NICOLET-400D spectrophotometer. LC-MS spectra of two samples of series were recorded by LC-MSD-Trap-SL-01046 instrument. All the compounds were checked for their purity by TLC. The characterization data of all these compounds are given in Table.1.

The antibacterial activities of the series of compounds (3a-e) were studied against gram +Ve and -Ve bacteria shown in Table-2. The activity was measured at a conc., 50µg/ml by agar-cup plate method [18]. The percentage inhibition of growth of bacteria by the compounds is shown in Table-2.

## II EXPERIMENTAL

scheme-1



### Synthesis of 6-(5-(4-alkyl phenyl)furan-2-yl)-3-methyl-1-phenyl-1H-pyrazolo[3,4-b]pyridine-5-carbonitrile 3(a-e)

A mixture of 3-Methyl-1-phenyl-1H-pyrazol-5-amine(1) (2 mmol), Acetoacetonitrile (2 mmol) and 5-(4-alkyl phenyl) furan-2-carbaldehyde 2(a-e) (2 mmol) in acetic acid (25 ml) and in the presence of TEA (1.5 ml) was refluxed for 6-7 hours. The resultant viscous mass was added slowly in ice cold water (50 ml). The solid mass was resulted which was collected by filtration, washed with water and recrystallized from Ethyl alcohol give pure 3(a-e). The details are presented in Table-1.

**Table-1**  
**Characterization of the Produced Compounds (3a-e)**

Com p. No.	M. F. (Mol. Wt)	M.P. @ °C	Analysis of C, H, N in %age		
			C	H	N
			Calc ulate d (Fou nd)	Calc ulate d (Fou nd)	Calcul ated (Foun d)
<b>3a</b>	C <sub>24</sub> H <sub>16</sub> N <sub>4</sub> O (376)	162- 163	76.58 (76.5)	4.28 (4.2)	14.88 (14.8)
<b>3b</b>	C <sub>24</sub> H <sub>15</sub> N <sub>4</sub> OCl (410.5)	168- 169	70.16 (70.1)	3.68 (3.6)	13.64 (13.6)
<b>3c</b>	C <sub>24</sub> H <sub>15</sub> N <sub>4</sub> OBr (454)	174- 175	63.31 (63.3)	3.32 (3.3)	12.3 (12.3)
<b>3d</b>	C <sub>24</sub> H <sub>15</sub> N <sub>5</sub> O <sub>3</sub> (421)	166- 167	68.40 (68.3)	3.59 (3.5)	16.62 (16.6)
<b>3e</b>	C <sub>24</sub> H <sub>15</sub> N <sub>4</sub> OF (394)	179- 180	73.09 (73.0)	3.83 (3.8)	14.21 (14.2)

@Uncorrected LC-MS data for 3b:412, 3e: 397

### III RESULTS AND DISCUSSIONS

Here we accomplished synthesis of pyrazolo[3,4-b]pyridine derivatives **3(a-e)** in which the multi component reactions of Acetoacetonitrile, 5-aminopyrazole (**1**) and 5-(4-alkyl phenyl) furan-2-carbaldehyde **2(a-e)** were carried out in acetic acid (as shown in scheme).

The molecular structures of series (**3a-e**) were assigned by C, H, N contents and IR spectral features. The IR spectral bands at 3032 cm<sup>-1</sup> (aromatic C-H), 2215 cm<sup>-1</sup> (C≡N), 1585, 1375(NO<sub>2</sub>), 2960, 1370 cm<sup>-1</sup> (-CH<sub>3</sub>), 690(C-Br), 1080 (-Cl), 1180-1200 cm<sup>-1</sup>(C-O bond). NMR signals: at  $\delta$  ppm: 8.51(m, 1H, of pyridine ring), 2.08(s, 3H, from methyl group), 7.12(d, 2H of furan ring), (**3a**):8.25-7.42 (m,10H, of two phenyl rings); (**3b**)-(3d):8.25-7.40 (m,9H,of two phenyl rings); (**3e**): 8.32-7.42 (m, 9H, of two phenyl rings ). The C, H, N content of all synthesized heterocycles are illustrated in Table-1.

**Table-2**  
**Antibacterial Activity of Compounds (3a-e)**

Comp. No.	Zone of Inhibition(mm)			
	Gram +ve		Gram -ve	
	Bacillus subtilis	Staphylo coccus aureus	Kllebsiella promioe	E.coli
<b>3a</b>	59	42	67	64
<b>3b</b>	65	46	71	69
<b>3c</b>	62	44	69	67
<b>3d</b>	64	45	72	66
<b>3e</b>	60	41	68	63
<b>Tetracycline</b>	79	55	87	72

All the elemental and spectral features suggest that the values are agreed with the molecular structure presented in Scheme-1 are matching with the proposed molecular structural frame scanned in Scheme-1. The LC-MS of selected compounds shows the peak of M<sup>+</sup> ion which is consistent of their molecular weight. All these facts confirm the structures **3(a-e)**.

The examination of antibacterial activity data reveals that all compounds toxic against microbes and the compounds **3b** and **3e** found more active against the gram-positive and gram-negative bacteria. The results show that the compounds are good toxic for microbes.

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# Human Resource Management Roles converted into Green Human Resources Management (GHRM) Roles

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## ABSTRACT

*Human resource management is a precious resource of every company and this is the only one living resources available. This study of HRM includes changing environment factors that make roles of the employees more competitive and interdependent. Resources crisis, increasing demand and the most de-globalization and the crunching globalization are the conditions with suggestions required on finding based on various reorganized and innovative practices of HRM. Practices of involving green effects with existed human resource management is Green Human Resource Management (G-HRM), these all are the integrated practice with existing practices which provide modest solution and upgrade the HRM practices. This study is based on the HRM practices and special reference to Recruitment and selection with the impact of Green Human Resource practices of various R as Reduce, Replenish, Reuse, Restore, and Recycle). Core objective of this paper is to uncover the greening activities towards sustainability. An initiative with the spreading awareness of Green HR and its effect on environment sustainability, resources availability and utilization This paper is more on preparing policies of recruitment and selection which could be initiated with Green factors integrated which could increase employee outcome by this way organizations & firms are motivating to employees to improve activities of Green. Second most aim of the study is to work on understanding profit and cost analysis of green practices implementation.*

**Keywords:** Human Resource Management Practices, Recruitment and Selection, Green HR, Green Recruiting, Sustainability, Human Resource Utilization

## I INTRODUCTION

A great tinkle condition to think and take action about the situation of drastically to think on over utilization of resources and sustain the resources. One side of the coin as world is moving from underdeveloped to developed economy and least utilization to most utilise technological state. Now most important time to think over to become aware about consumption, rest resources, fast growing population and over usage of resources

Paper usage in bulk and heavy consumption is the second to think on, make some habits of using less paper and wood products. Also find another replacement of trees and raw sources. To make it effective we have two options available as: **One-** Less use or optimum use of all resources this will more related to behaviour, habits and psychological pattern of Humans

**Second-** To discover new substitute By Human Resources Management means the basic concern of all the firms related with human, their proficiencies, competence, utilization of skills and all Human dimensions

As per stated by **Dale Yoder** "HRM is the provision of leadership and direction of people in their working or employment relationship." Also stated by the **M. J. Jucious** is more on functional values of HRM that involves started from planning, organization, directing and controlling functions of procuring, developing, maintaining and utilizing a labour force. HR starts with planning of HR availability and proper utilization to fulfil the objective of individual to company. The basic need of management is to make alignment between all these factors. Planning involves all major HR Policies, procedures and practices to be executed and implemented. If we can elaborate terms define as Planning is giving right path to fulfilling all

responsibilities of the company, Policies and procedures are the basic framed rules/ directions to move on whereas practices are more connected with leadership qualities. When all three Ps like policies, practices and procedures work together towards sustainability it will provide new direction to the company for getting better outcome with less incurred cost

One more important view has given by Founder & MD of Spreadhead InterSearch Mr. Jyorden T Misra that Eco-consciousness or colour of green is rapidly emerging in every dimension of our lives and workplaces focusing on Green HRM which worked with awareness about climate change, various environmental issues due to emerging changes, Energy utilization Trainings, Optimum resource utilization, Promotion about eco and environment oriented HR practices. Prevention, preservation, secure and invention are the basic practices which would be included in HRM practices. Need to focus more about the importance and concern about environment and sustainability rather just finishing the functions

## II LITERATURE REVIEW

To understand the study view it needs to understand the meaning of HRM stated by Lado and Wilson (2014) about HRM system as a set of distinct but interrelated activities, role, and process like attracting, developing, and maintaining (or disposing of) a firm's HR. In a broader way Greening should be included into the HRM. As per the Cambridge dictionary greening means the process of becoming more vigorous about protecting the environment

To prepare the Green model the complete meaning should include all the components of HRM and environmental factors while preparing the process.

Green human resource management is considered to be a broader and holistic approach to align employees with a company's environmental strategy. It is frequently argued that companies that take up environmental management system are particularly dependent on elaborated Green HR policies.

Authors like Viola Muster and Ulf Schrader stated more added with sustainability that Green Human Resource Management focuses on employee environmental behaviour in the company, which in turn, employees carry prototype of consumption in their private life. The included concept of an ecological of sustainability development is invented with the Brundtland Report in 1987 that describes as kind of development that gratifies the necessities of the present without unfavourably affecting the capability of future generation to make happy their needs

Whereas some of the other authors are putting more focus on policies. In reality the best result may be find after incorporated of both these concepts as stated by Deshwal (2015) 'Green Human Resources Management (Green HRM) is the use of HRM policies to carry the sustainable employ of resources within organizations'.

### III GREEN HUMAN RESOURCE MANAGEMENT

GHRM engage into an incorporation of organizational environmental management objectives to the HRM process of recruitment and selection, training & development, Performance Management and Reward system for environment sustainability (Renwick et al. 2008, and Muller-Carmen et al. 2010) further defined by Renwick et al. (2008) highlights that the implementation of rigorous recruitment and selection of employee, performance-based appraisal system and introduction of developmental programmes aim at increasing the employee's awareness about the environmental sustainability. Introduction of E-recruitment start from recruitment cycle to HR audit have a crucial role in establishing environment improvement programmes for any business. Organisation initiates such initiatives which include on regular basis in the Human Resource processes. HR factors are involved in environment management and are embracing the organizational and environmental sustainability

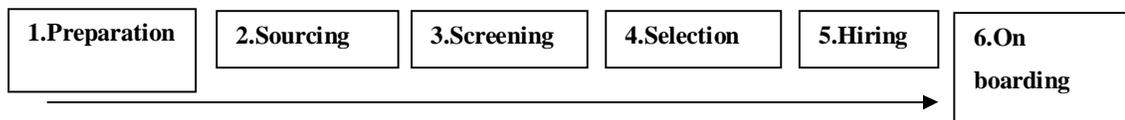
aspect of HRM. Callenbach et al. (1993) stated that 'in order to carry out green human resource management, employee must be inspired, empowered and environmentally aware of greening to be successful'. One more study of Callenbach et al. (1993) stated more about 'the need for both technical and management skill among employees for implementation of the green initiatives for the preservation and conservation of the natural resources for the organisational sustainability'. Environment friendly HR initiative create results into greater efficiencies, lower cost, better employee engagement and retention which in turn help to build competitive advantages and organisational sustainability by reducing carbon footprints well stated by Nijhawan Geetu, (2014 )

By using as approach of high responsibility of Green Sense and work objective mixed together is become an innovative approach which would be adopted in GHRM. HR policies are critical to add on more green factors into existing HR policies for execution. Let's take an example as we are considering paper less recruitment but all documentation work will shift immediately become difficult, also a big challenge is to train the employee

HR persons in the industries can play an emergent role to plan and execution to make green objective in the industry. Being as people oriented HR employee may communicate through Induction, socialization and philosophical conditions in most of the organizations are implementing an integrated systematic approach to proceed with Environmental Management programs but they have to facade various challenges and problems. The term Sustainability can be distinct as per dictionary as 'the development that meet the present without compromising the capability of future generations to gather their needs.' It defined three components for sustainability developments that are environmental protection, economic growth, and social equity. When organization are working more for profit maximization and for completing this purpose it should go with cost cutting and begin eliminating the facilities, cutting salaries instead of these practice if we start Green practice it provides profit enhancement as well as employee satisfaction the three Ps (Profit, People and Planet) would be the base pillar for fundamental factors of Green HRM.

### IV GREEN RECRUITMENT & SELECTION (R&S)

Recruitment Cycle: from start to finish of all activity included is called Full Recruitment Cycle as:



- (a) **Preparation:** First step of preparation of recruitment in which every individual task should identify attached resource and environmental factors that must include at the timing of planning stages of the recruitment. In the first step evaluate that people are ready to accept but lack of awareness is major reason to create hurdles for adopting greening techniques.
- (b) **Sourcing:** Through hard advertisement, newspaper, agencies, boarding also the candidate are applying through soft methods as email, search sites, Internet; cloud system etc these candidates should get extra marks.
- (c) **Screening:** If total selection is shift on soft method, electronic or technological method and only final document will print or use paper form this would save tons and tons of paper every day and indirectly affect to an environment.
- (d) **Selection:** The final result or information could be shared telephonically; e- methods of communication like email, cloud or same, instead of any form of post will save cost on transportation along with paper and manpower.
- (e) **Hiring:** New technological method should be the base for selection test and techniques which enhance the quality as well as time and money.
- (f) **On Boarding:** In geographically distance area person could work jointly instead to send and back the employee to different locations till it is not necessary. It will accumulate huge cost on To-and fro, fuel, time, energy, efficiency of people, and psychological safety too. Documentation should shift on software or ERP pattern to save cost as well as ease to get information from anywhere. It creates crystal clear and ethical environment inside the companies too.
- (g) **Survey:** Green Recruiting starts with deciding Grades or Weight-age or percentage on each and different recruitment system. When recruiter planned in detail that what environmental factors should be covered, at what level then that will be the responsible to understand and complete the entire task. Also how they can create positive reaction of candidate to take it on serious concern. After getting all information based on need, then distribute accordingly as per weight-age method of each Job with green components.
- (iii) Ready to change the habits as per the need
- (iv) Thinking about Save water and similar resources
- (v) Ready to adopt new resolution
- (b) **Role Conversion -** While converting the roles of Human Resource into Green Human Resource some basic questions should be asked. Findings should include these challenges into:
  - (i) Is employee being ready, self-enthusiastic, adoptable and flexible to accept the changes?
  - (ii) How does HR communicate properly to show the positive result that influences the employees?
  - (iii) How can Human Resource create constructive attitude towards environment and Greening?
- (c) Integration of components of Green HRM - After finding the responses of the above questions the core HR functions of the human resources department would frame with integration of components to prepare Green HRM as:
  - (i) **Green Employee recruitment-** this is the most crucial responsibility of HR if it does not right decision it can trouble the whole organization culture, Departmental environment, work efficiency or personnel get affected and completion of work would diverge and overall it creates huge cost to the company. Selected candidate become newly recruit employee where they learn about the organization culture, behaviour, value system, work purpose and psychological patterns related with individual, task, company and relation with others.
  - (ii) **Changing factors Concern and Serious approach:** when recruitment and selection includes all factors of Greening starting from Interview till selection pattern, in this case employee will concern and attached with all environmental practices running into the company.
  - (iii) **Green Scheduling-** This should be done by the technological and cloud storage which will save number of papers and other stationary resources, also provide valid evidence for future.
  - (iv) **Green Performance & Payroll-** Majority of the employees are working for monetary factors. In rare cases non monetary would be motive of the employees. To follow the greening process perfectly performance should be attached with greening Indicators and components as less paper use, less electricity usage, sharing transportation, reuse of used plastic in the firms, colleges can use the techniques of crushing the copies and paper material to recycle the paper, less or NO utilization of disposable in the premises,

## V CONVERTING HR ROLE INTO GREEN HR ROLE

- (a) **Preparation of Job description -** While creating the HR roles many challenges and problems should be facing by the recruiter. To find out the solution recruiter should includes these points while preparing Job Description:
  - (i) Awareness about the Greening or Environmental factors
  - (ii) Candidates' interest for using less paper or other resources

When payroll is directly related with performance with Green Components this could give better result to the organization in some cases or situation organization make this compulsorily. This is the direct approached area where all necessary components would be added to reduce usage of extra resources.

- (v) **Green administration-** Standard of environmental as ISO14001, Six-Sigma, process of production and manufacturing, operation & services will provide benefits to both the associated parties employer as well as employee while running it will be a win-win situation that provides positive impact to society.
- (vi) **Internal relations-** it works with motivation and leadership and convincing. With the hard leadership Green practices will flow smoothly in the organization it could initiate with the power and authority and then converted as a behaviour which could create Green Behaviour inside the organization.
- (vii) **Green employee Training & Development-** Green indicators should involve in Training and through green training it develops Green behaviour, green environment and Green habits of all employees smoothly.
- (viii) **Green Compliance-** HR and strategic department can finalize the rules also the punishment- in case of not following the rules, penalties- in case not filled by the people voluntarily then by the use of Law and legislation Green Task would be completed.
- (ix) **Safety-** if we go with much Green and environmental standards procedures inside the firms many chances of accidents become low, also safety parameters should include in Green Indicators.
- (x) **Involvement of Social trends as Status Symbols-** when Green Components become the Status Symbols then it will automatically adopt by large number of people and chances that majority of people affected by the overall result positively.
- (xi) **Carbon Footprint Knowledge:** By particular individual, organization, or group of people, animal and all other living organism for completing various activities the amount of carbon dioxide released into the atmosphere which raise the Carbon dioxide level in the environment. With few practices of the HR in the company that apply new processes and practices can create healthy atmosphere. Example: A Bengaluru, India-based startup has created a Graphene-Lime Paint .The Graphene-Lime paint absorbs Carbon Dioxide in a similar fashion as a tree does.
- (xii) **Green Innovation:** In Russia the residential society painted their street walls with the paints that absorb the carbon dioxide from the atmosphere. Another

could be in Bulgaria for road construction they don't cut the trees laying in their map instead they shift the trees with the help of crane and replant in other area to save old and green trees. One example done at Bangalore that through waste plastic, plastic bottle waste and little stone and ashes created flexible and most durable Roads.

## VI CONCLUSION

As we detoxify our body time to time for healthy and fit life, same way we need to work on detoxification form of all policies, procedure, technology, environment, values, concern, utilization of resources to utilize proper resources that can lessen wastage. In a circular way in most of the practices should include all Green Factors, environmental sustainability factors and with the help of HR department and people made this compulsorily. Because in combine form it is not only create Greenhouse effect, it also create Global warming, known and unknown diseases, frustration and many adverse conditions. We should again remember 'prevention is better than cure'. So this is the right and peak time to work on environmental prevention with Green weapons

Somewhere we have to take the first step to save our mother till the time mother took responsibility to take care of their all kids that's us, but now this situation when earth become sick and wants our hand to save, think Green take initiative, and motivates others so it works for betterment collectively.

'Let's take one single step towards the Greening'

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# Farmer Producer Organization (FPO): An Integrated Review

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## ABSTRACT

*The Producer Organization (PO) is a legitimate component that involved interesting creators, specifically farmers, dairy producers, fishermen, weavers, local skilled workers, specialists. PO can be an advantageous association, co-employable society, or another overall arrangement of laws that offers the sharing of focal points and favorable circumstances between people. It is one kind of PO where people are farmers. The Small Farmers Agribusiness Consortium (SFAC) offers assistance for the headway of FPOs. PO is the fundamental name for a relationship of creators of anything, for instance, Agribusiness, non-farm things, crafted works, etc. The amount of farmers' relationship in India has extended definitely yet the challenges they face are many. The Indian government has announced \$ 34 million to manufacture a "PRODUCE" under NABARD. This paper included the probable occupation of the Farmers' Association concerning the quick plant advancement of emerging farmers in India. We are scrutinizing various POs appearing over time with the assistance of NABARD to show how PRODUCE can fill openings toward the start of producer bunches in India. Finally, we give an advancing model of how those resources can best be used, similarly as rules for setting up financially reasonable and broadening POs.*

**Keywords:** - NABARD, POs, FPOs, collective bargaining, sustainable development

## I INTRODUCTION

The Producer Organization (PO) is a genuine substance outlined by the primary creators, for instance, farmers, dairy creators, fishers, weavers, home specialists, skilled workers. A Producer Company can be a creator association, a co-usable neighborhood, another overall arrangement of laws that offer advantage sharing/benefits between people. In various brands, for instance, maker associations, driving creator spots can similarly be a person from the PO.

It is one kind of PO where people are farmers. The Small Farmers 'Agribusiness Consortium (SFAC) offers assistance to actuate FPOs. PO is a normal name for a relationship of creators of anything, e.g., Agriculture, non-farm things, craftsmanship things, etc.

Starting now and into the foreseeable future, the corporate government has been obliged by foundations like NABARD and the Small Farmers 'Agribusiness Consortium (SFAC), under the sponsorship of the Department of Agriculture and Cooperation (DAC), the Department of Agriculture. For example, NABARD has, as far back a few years, maintaining the plan and headway of POs through the Producer Organization Development Fund (PODF) and various activities. SFAC is moreover endeavoring to progress existing POs every single through Indium, or the year 2014 has been broadcasted "The Year of Farmer Producer Organizations" by DAC. Lately, India's Union Budget, the first in an as of late picked NDA-drove government, pronounced R3. 200 crores (\$ 34 million) to help the establishment and progression of POs by NABARD in 2014. The resource is known as

the Producers Development and Upliftment Corpus (PRODUCE).

NABARD has been supporting producer relationships since 2011 under PODF, which was started through the chief corpus of Rs. 50 crore (\$ 11.1 million) for 2010-11. Before the establishment of PODF, NABARD had commonly sponsored creators under the Umbrella Program for Natural Resources Management (UPNRM) and offered money-related assistance to various POs, called Second-Level Institutions (SLI). Lately, NABARD reconsidered the choice to develop the degree of exercises of Primary Agricultural Credit Societies (PACS), changing over some into Multi-Service Centers (MSCs). A couple of POs are upheld (and continue to be financed) through these channels.

Along these lines, NABARD has had wide, yet mixed, data on building POs since the incorporating techniques have made. An incredible rustic refiner has rich and grouped knowledge (likewise a strong association of nation credit foundations) in ensuring that current POSs are fiscally plausible and various affiliations (like SFAC, see underneath) can ensure that PRODUCE is throughout supervised. Dependent upon the specific necessities set out by NABARD, POPIs ought to be financially maintained under PRODUCE to ensure that their development helps and preferences the establishment of new FPOs. In any case, POPIs should ensure producer arrangement by perceiving existing bundles like Joint Liability Groups, Self-Help Groups, and Farmer's Clubs and transforming them with sensible perception of what issues need outside assistance. At that point, the cutoff building will consolidate homeroom planning, common social events, receptiveness visits, maintain for thing improvement, showing objections, displaying method, etc Also, organizing as of late

molded POs through the establishment and time of enlistment can be critical imagined by these workplaces. By setting up a fitting system to repay progress from POs under PRODUCE, POPIs can in like manner ensure that new creator affiliations are on track for better financial execution. Finally, similarly, like other exclusive organizations, setting incredible checking techniques can go far in ensuring that as of late outlined FPOs are financially appropriate.

## II OBJECTIVE & METHODOLOGY

### (a) Objectives

- (i) Analyzing the potential role of Farmers' Organizations.
- (ii) To analyze the sustainable development model of FPO.

**(b) Research Methodology** - The research is based on secondary sources of data or information. Various online news reports, strategic government agencies in government publications are aimed at creating a superior approach.

## III LITERATURE REVIEW

Document survey is a significant piece of any examination as it not just gives an outline of the work done previously yet additionally gives a premise to deciphering and talking about the discoveries. Different examinations were directed every once in a while in various areas of India with various parts of FPOs. Numerous examinations are identified with ranchers' support in agrarian augmentation exercises, the present status of maker organizations, farming obligation in the legitimate area including business banks, RRBs, and neighborhood cooperatives, the rebuilding of the Indian Agricultural Marketing System, and the nearby economy. An audit of the submitted courses is introduced underneath:

- (a) Government of India** in their examination in 2013 presumed that to incorporate the little farmers with rural market at more profitable costs with low exchange cost and support them for the offer of their excess creation, Government of India presented a pilot conspire, Farmer Producer Organizations (hence, FPOs) during 2011-12 through Small Farmers' Agribusiness Consortium (SFAC). The reason for the development of FPOs is to collectivize ranchers, particularly little makers, at different levels across a few states to encourage innovation entrance, improve efficiency, empower improved admittance to sources of info and administrations and increment rancher earnings, in this manner reinforcing their feasible horticulture based occupations.
- (b) Rondot and Collions** in 2001 in their investigation found that the producers in the worth organizations are minimized because of expanding significance of retailing specialists.

There can be choices which can upgrade the exchange force of this gathering of farmers, for example, co-employable or Producer Companies based models. One such model is Farmer Producer Organizations (from now on, FPOs) which can coordinate the little ranchers with agrarian market at gainful costs with low exchange costs. With this agreement, this investigation investigates the current worth organizations and draws examination between the FPO-drove advertising framework and the regular models. It likewise makes an endeavor to examine the adequacy and sustainability of a particularly model in the Indian setting. Along these lines, the investigation centers around the FPO models existing in two conditions of India specifically, Punjab and Gujarat. The subsequent segment momentarily clarifies the current promoting channels for agrarian produce and the third area talks about the FPO model in India. Sustainability and feasibility of FPO program has been dissected from the field perceptions and has been talked about in the fourth area while the last segment presents the ends.

- (c) Kamal Vatta, Parisha Budhiraja and Gurpreet Singh** in his examination on Sustainability on Farmer Producer Organization under Agricultural Value Network in India in 2018 explored that The sustainability of FPOs post end of the award given by SFAC (which last just two years post foundation of this framework), offers a conversation starter to work as an autonomous association. There are some vital difficulties regarding admittance to credit to meet their infrastructural and working capital requirements which have accepted the centrestage. The greater part of the FPOs are coordinated by little and minimal ranchers and their commitment to value base association is frequently lacking to take care of even the operational expense. Albeit these associations are possessed, and oversaw by ranchers, yet the compensation to staff like directorate, CEOs, nearby asset people, sanctioned bookkeepers should be covered by the net revenues made by FPOs. Another issue is getting advance from banks, hesitance in loaning credits to associations like FPOs with little turnover and nonappearance of insurance makes it troublesome. In this manner, an ideal environment is an absolute necessity for advancement of these worth organizations since they manage the weakest piece of agri-esteem networks what begins from the homestead and goes on till handling and the removed business sectors.
- (d) Dr Amar KJR Nayak (2017)** has contemplated the present status of Indian assembling organizations through hierarchical construction and the arrangement of possession and operational execution of existing organizations in different business areas and to improve

productivity and market power. for small and medium scale farmers.

- (e) **Neha Christie and C. Shambu Prasad (2017)** in their paper investigate information creating studies and assembles fortitude among accomplices working for the government assistance of gainful ranchers through their organizations. Focus on sharing accomplishments as well as problem areas in the development and the executives of FPOs.

#### **IV PROPOSED SUSTAINABLE DEVELOPMENT MODEL**

- (a) **Research Gap** - As most of the peripheral and small farmers are confronting extraordinary concealment by the brokers/commission agents for gainful cost and beneficial pay, and the investigation was done on farmer producer organization has not done by taking the perception of farmers because of which they are not getting the reasonable advantages from the farmer producer organization, which is a significant issue for concern. Increasingly more commitment from the advancing foundations is of the most extreme requirement for training, business arranging, and market linkage with different public and worldwide organizations. Backing from the arrangement producers in running the FPO will be an extraordinary shelter to the cultivating local area.
- (b) **Sustainable Development Model** - The round model proposed here shows the means from the interior administration of an FPO to its outer administration. It begins with building the limit of FPO board individuals and other institutional pioneers to learn great administration practices and practices. Learning all alone is a stage towards the development of FPO, which is vital for self-assurance. Estimating and recording information focuses is another progression in making FPO noticeable and prepared to convey, this additionally assumes a significant part in molding future methodologies. The organization is another significant advance in making FPOs practical over the long haul, reaching purchasers, providers, monetary establishments, carriers, stockrooms encourages take FPOs to the following level. The planning step will assist with changing the methodology of the FPO from the main phase of development to the following stage, etc, on the whole stages, the requirement for FPOs will change. Here are a few stages (in view of the said model) that should be taken by various partners in making FPOs a superior future.
- (i) **Step 1 - Regular capacity building of FPO board members and other key appointments to Management Practices-** FPO board members as a rule come from agrarian history, head of region panels, or stand firm on other initiative footholds in the

town or at the Gram Panchayat level. Different zones where the arrangement of board individuals is more significant incorporate; towns where nearby administration is powerless, an enormous number of smallholder ranchers exist, towns are excessively far separated, the working class is excessively solid, openings for blending are accessible, and so forth Effective FPOs are those, where authority is solid and ready to play out their obligations with most extreme trustworthiness and respectability. By and large, it has been discovered that horticultural alumni from provincial and nearby networks are recruited to play out the obligations of the CEO of FPO, a technique that is useful for institutional structure, yet the board should comprehend that the part of CEO and holding this position is outside the extent of neighborhood governmental issues. Board individuals need steady limited working in great administration practices and assist them with improving their business and MIS abilities.

- (ii) **Step 2 - Exit the FPO goal scoring system; including financial, administrative, social and environmental-** Today there is no standard arrangement in the entire field for getting FPOs, change practices or backing associations. It has become evident that monetary establishments don't have a different interaction for assessing FPOs, which is viewed as a delicate issue. Policymakers need to comprehend the basic issues related to FPOs; requires an exceptional testing measure as it is a mix of business and social foundations. The test school can change and regard the FPO as a business association after specific years. At present, monetary foundations center more around balance size, yet leaving social and ecological limits isn't right. A standard arrangement of objective scoring models for FPOs in an alternate classification is needed to help monetary establishments, private offices, CSR organizations, and different partners to comprehend the significant picture of the foundation prior to giving assets to work.
- (iii) **Step 3 - Changing rural, agricultural and farmer development policies and FPOs -** In India, we cause an approach of numerous issues and afterward neglect to incorporate those at the undertaking level. There is the clearness of program/plot level according to FPOs in New Delhi, however, the equivalent ought to be decreased at the town level. There are numerous approaches that can be changed for FPOs to help them initially and help these organizations make the following stride later on. Establishments, for example,

NABCONS, SFAC, the Department of Agriculture can meet up on FPO-related issues and assist each other with distinguishing assets, chances, hindrances, and so on.

(iv) **Step 4 - Improving risk management systems in FPO** - FPOs urgently need to design their information the executive's frameworks, all that occurs in the field, market, vault, and gatherings ought to be very much reported. This will be useful in deciding the pattern of exercises that happen in any FPO, which will be the way to future achievement. The standard MIS arrangement should be forced by the public authority and different offices. A few stages have been taken by different organizations, yet require a logical and easy-to-use approach. Inspectors and senior administration of FPOs need direction in their MIS-related exercises, with solid blunders and mistakes.

(v) **Step 5 - Propose the formation of FPO funds in a separate category, and support it in financial communication** - The monetary design and tasks of an FPO can't stay adjusted for the duration of its life cycle, likewise, with some other association, the FPO additionally needs an underlying change to address the development way. Zeroing in on the essential construction of FPO has a spot for new nearby advancements, however, strategies don't uphold new developments. The FPO's life cycle requires the foundation of various neighborhood levels and associations to support manageability over the long haul. The proposed FPO monetary design functions admirably now and again, however much of the time, it has been discovered that the FPO returns as an establishment when the suspension of financing from the public authority or some other association is suspended. The venture is likewise in the possession of monetary foundations, as there is consistently the chance of loaning because of political pressing factors. The formation of an FPO center pledge drive requires certain adaptability, incorporated monetary arrangement, and expanded responsibility for utilizing the office and the executive's board.

(vi) **Step 6 - Intra FPO learning and development platform to be launched** - There is a need to assemble a stage for gaining from the errors and accomplishments of one another, right now, FPOs are gaining from other FPOs distantly or can collaborate in another circumstance, which is less significant. The public authority through eNAM anticipates a major change, yet neighborhood structures need to

approach and begin utilizing them to share nearby information. A state or territorial level data discussion should be created for FPOs, which should be coordinated by the Department of Agriculture or significant government offices.

(vii) **Step 7 - Increase the role of FPOs in community development activities** - FPOs are framed in the nearby local area in the town, where one job is vital; be it farming, fishing, cultivation, and so forth All maker bunches meet up and structure an FPO. To remember this area, we likewise need to recognize normal social issues in the public eye. All in all, in my experience, I have seen that all ranchers, anglers, and different makers deal with similar social issues, really a similar spot. To upgrade the responsiveness of FPO, there is a need to characterize its social job. This activity can help FPOs become socially focused, making them more straightforward and responsible to the local area. FPOs come up short since individuals don't think past their item, coordination, and productivity. It is exceptionally essential that public reaction ought to be joined to these establishments from the development stage.

(viii) **Step 8 - Consolidating the role of FPOs in strengthening the business environment** - We ought not to regard the FPO as a solitary substance, it could prompt the development of other little and medium-sized foundations. The whole provincial climate should be rebuilt, which fills in as a key and changes the new environment of rustic organizations to develop more country business people. FPOs can assume a vital part in the provincial turn of events, which is imagined in this idea. Policymakers, government divisions, DMs, BDOs, agrarian laborers, common society associations, and so on all need to comprehend the incredible texture of provincial advancement before they can comprehend the FPO.

(ix) **Step 9 - Link the FPO to the nearest agricultural center** - FPOs need customary initiative and limit building, best practices, elective environment-related information sources, hereditarily changed seeds, and so on; the entirety of this and significantly more is past the force of the executing offices, the FPO itself, and other government offices. It is acceptable to interface with rural colleges, regulatory organizations, government horticulture offices, and other data places with the public authority. This ought to be viewed as two arrangements, the data communities are resolved to explore contemplates, better investigation of achievements and disappointments, data from ranchers can

help them and policymakers over the long haul. While, ranchers need consistent limit working in business the board, MIS, creation strategies, and creation advances. FPO is a coordinated improvement place for rustic individuals, particularly makers. These estimates will build their capacity to go through more cash and help them in assuming a significant part in the monetary turn of events.

## V CONCLUSION

NABARD can possibly advance (and set up) POs for the following a few years. By effectively zeroing in on existing rancher gatherings like ranchers' gatherings, SHGs, and JLGs and POPI ID, NABARD can utilize PRODUCE to forcefully advance new POs (both on and off the homestead). A vital necessity for the achievement of POs is to fabricate viable limit building and to support organizations that permit new POs to perform business capacities. A portion of the critical components of the arrangement under the NABARD PRODUCE are featured as follows:

- (a) Continued utilization of different types of monetary help and backing will encourage an assortment of PO advancement procedures. PRODUCE will fill in as a significant motivation for the work previously attempted under these projects.
- (b) Examining existing associations and gatherings (like PACS) to evaluate how POs can be upheld through different channels.
- (c) The NBFC is focused on dealing with the PRODUCE organization and giving fundamental credit prerequisites to recently framed FPOs.
- (d) Capacity working, inside and outside NABARD (in a joint effort with SFAC) to comprehend (and eventually give) the various necessities of POs will guarantee that their tasks are reasonable and monetarily practical. From various perspectives, POs structure a fundamental piece of the

vocations of smallholder and native ranchers because of destitution and improve their seriousness in agrarian business sectors. In the event that we accept this as an issue of 'Green Transformation', it must be reasonable if measures that advance supportable and comprehensive rural improvement are taken inside the accessible assets. Maker Organizations can contribute diversely to this, and ought to be created and upheld adequately.

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# How Phytoremediation Technology Protecting Soil, Water & Environment from Heavy Metal Stress

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## ABSTRACT

Heavy metals like Pb, Cd, Cr, As, Cu are a serious threat for plants, animals, food chain and living beings causes illness or damage to human beings, animals and plants, water becomes unfit for drinking, changing PH of Soil and water. Phytoremediation technology is the use of green plants and Hyper accumulator's to clean soil, water, air and environment. Hyper accumulator's like *Lycopersicon esculentum* (Tomato), *Brassica juncea* (Mustard), *Helianthus annuus* (Sunflower), *Eichhornia crassipes* (Water Hyacinth) clean soil and water when grown in it. The mechanism involved in Phytoremediation technology is Phytoextraction, Phytoaccumulation, Phytostabilization by reducing mobility, Rhizofiltration, Phytodegradation, Reduction in root, shoot length and  $TF = \frac{C_p}{C_s}$ ,  $BCF = \frac{C_r}{C_s}$  shows heavy metal transferred from root, shoot and potential of Phytoremediation plants for Phytoremediation.

## I INTRODUCTION

Phytoremediation is the use of green plants to remediate the contaminants present in soil, water, air, land etc. Phytoremediation Greek words Phyto means "plant", and remediation means "recovery, "removal". Hyper accumulators like *Lycopersicon esculentum* (Tomato), *Brassica juncea* (Mustard), *Helianthus annuus* (Sunflower), *Eichhornia crassipes* (Water Hyacinth) clean soil and water when grown in it. When heavy metals enter the soil and water sequestration or reduction of heavy metals takes place in rhizosphere through roots and xylem vessels in shoots by metal complexation, precipitation etc. concentration of heavy metals decreases and soil, water becomes free from heavy metal. Reduction in root, shoot length is observed when heavy metal transfer takes place from soil to aerial parts of plant for removal of heavy metals. Phytoremediation technology checks soil erosion. The translocation factor TF greater than one and BCF greater than one is found which shows greater potential for Phytoremediation. In this way Phytoremediation technology clean soil, water, air and environment.

## II LITERATURE REVIEW

Phytoremediation is the use of green plants to remediate the contaminants present in soil water, air, land etc. Checks soil erosion in soil, water, air, land etc. Phytoremediation Greek words Phyto means "plant", and remediation means "recovery" or "removal". With the development of industrialization and urbanization, the abundance of heavy metals in the environment has increased enormously during the past decades, which raised significant concerns throughout the world (1). (1-7). Heavy metals are a group of metallic chemical elements that have relatively high densities, atomic weights, and atomic numbers. The common heavy metals/metalloids include cadmium (Cd), mercury (Hg), lead (Pb), (Cd), mercury (Hg), lead (Pb), arsenic (As), zinc (Zn), copper (Cu), nickel (Ni), and chromium (Cr). These heavy metals/metalloids originate from either

natural or anthropogenic sources such as produced water generated in oil and gas industries (Neff et al., 2011; Pichtel, 2016), use of phosphate fertilizers in agriculture (Hamzah et al., 2016; Rafique and Tariq, 2016), sewage sludge (Farahat and Linderholm, 2015), metal mining and smelting (Chen et al., 2016), pesticide application (Iqbal et al., 2016), electroplating, and fossil fuel burning (Muradoglu et al., 2015). Phytoremediation is the use of plants and associated soil microbes to reduce the concentrations of contaminants in the environments. It is a relatively recent technology and is perceived as cost effective, efficient, novel, eco-friendly and solar driven technology with good public acceptance. Phytoremediation is an area of active current research. New efficient metal hyper accumulator's are being explored for applications in phytoremediation and phytomining-. Molecular tools are being used to better understand the mechanisms of metal uptake, translocation, sequestration and tolerance in plants.

Phytoremediation a green technology consists of process phytoextraction, phytostabilization, phytodegradation, Phytovolatilization, Rhizofiltration, Phytostabilization(1). With increasing industrialization mining, pesticides sewage disposal, heavy metal deposition and other contaminants are added in water and soil through human activities. These interfere with the metabolic functions of plants, inhibition photosynthesis, respiration, crop yield, sometimes intracellular compartments of cell. Mining include crushing, grinding, washing, smelting. (Subodh kumar Maiti)(2010). Phytoremediation is a group of technologies that use plants to reduce degrade or immobilized environmental toxins. Phyto extractions also known as phytoaccumulation, phytoabsorption, and Phytosequestration (7). This process reduces soil metal concentration by cultivating plants with a high capacity for metal accumulation in shoots. Plants extract large concentrations of heavy metals into their roots, translocate the heavy metals to above ground shoots or leaves and produce large quantity of plant biomass that can easily be harvested. Rhizofiltration technique is used in cleaning contaminated waste

water or contaminated waste water or acid mine drainage by absorption or precipitation. Phytostabilization is phytoimmobilization, holding of contaminated soil and sediments in place of vegetation and to immobilized toxic contaminants in soils. It occurs through the sorption, precipitation, complexation or metal valence reduction. For eggrasses, sedges, forage and reeds. Phytovolatalization involves the use of plants to take up contaminants from the soil transforming them into volatile form and transporting them into the atmosphere.eg selenium. Phytodegradation also known as Phyto trans formation, involves uptake, metabolization degradation of contaminants within the plant or in the soil sediments, sludges, groundwater or surface water by enzymes produced and released by the plant.(Hazrat Ali a\*,Ezzat Khan et al(2013). Heavy metals refers to any metallic chemical element that has relatively high density and is toxic or poisonous at low concentrations eg of heavy metals like Cadmium (Cd), Chromium (Cr), Lead (Pb), Arsenic (As),Ti etc. Heavy metals are naturally found in earth. They are used in Many modern day applications such as agriculture, medicine, industries etc. Heavy metals when dumped by anthropogenic activities in soil through food chain affect the plants animals and human beings.

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

TF greater than one, BCF greater than 1 suggest heavy metal transfer from root to shoot and to roots and shoots with maximum Phytoremediation.

### III OBJECTIVES & HYPOTHESIS

- (a) **Objectives-** To study how Phytoremediator technology is cleaning soil and water and checks soil erosion maintaining pH of soil. To study the processes and mechanism of cleaning the soil, water and environment. To prevent soil, water and environment by this technology. To study TF and BCF for remediation of heavy metals from soil and water.
- (b) **Hypothesis -** Phytoremediation processes clean soil and water by shortening root, shoot length, increase in biomass of root means heavy metal is transferred to root and shoot and remediation is taking place. TF greater than one, BCF greater

than 1 suggest heavy metal transfer from root to shoot and to roots and shoots with maximum Phytoremediation processes and greater remediation of heavy metals from soil and water , checking soil erosion and greater Phytoextraction capacity of Phytoremediator's.

### IV EXPERIMENTAL STUDY

- (a) **Methodology-**Plants of Lycopersicon esculentum ie Tomato, Helianthus annus, Eicchornea crassipes, Brassica juncea grown in pots and water pots,pots are treated with heavy metals of different concentrations. Root, shoot lengths is observed. Root, shoot is washed and solution is observed in atomic absorption Spectrophotometer (AAS). 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.
- (b) **Application-** Helpful in cleaning soil, water, air, land and also remediation of heavy metals and other contaminants.

### V RESULTS AND DISCUSSION

Results are tabulated at Table 1 and shown in Fig. 1 to increase in root biomass suggest that heavy metal transferred to root, TF greater than one, BCF greater than one suggest that heavy metal transferred to aerial parts of plant. Decrease in root, shoot length suggest that heavy metal transferred with greater Phytoremediation.

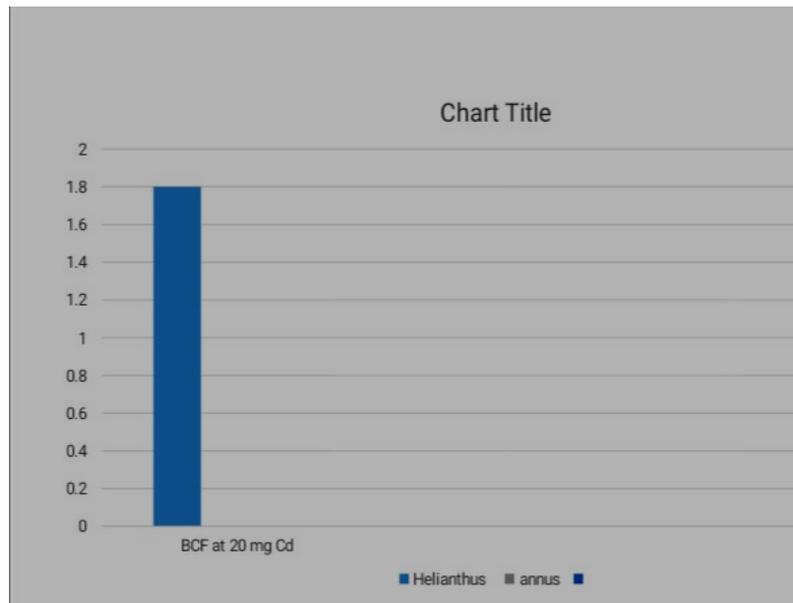
### VI CONCLUSION

Phytoremediation processes clean soil and water by shortening root, shoot length, increase in biomass of root means heavy metal is transferred to root and shoot and remediation is taking place. TF greater than one, BCF greater than 1 suggest heavy metal transfer from root to shoot and to roots and shoots with maximum Phytoremediation processes and greater remediation of heavy metals from soil and water , checking soil erosion and greater Phytoextraction capacity of Phytoremediator's.

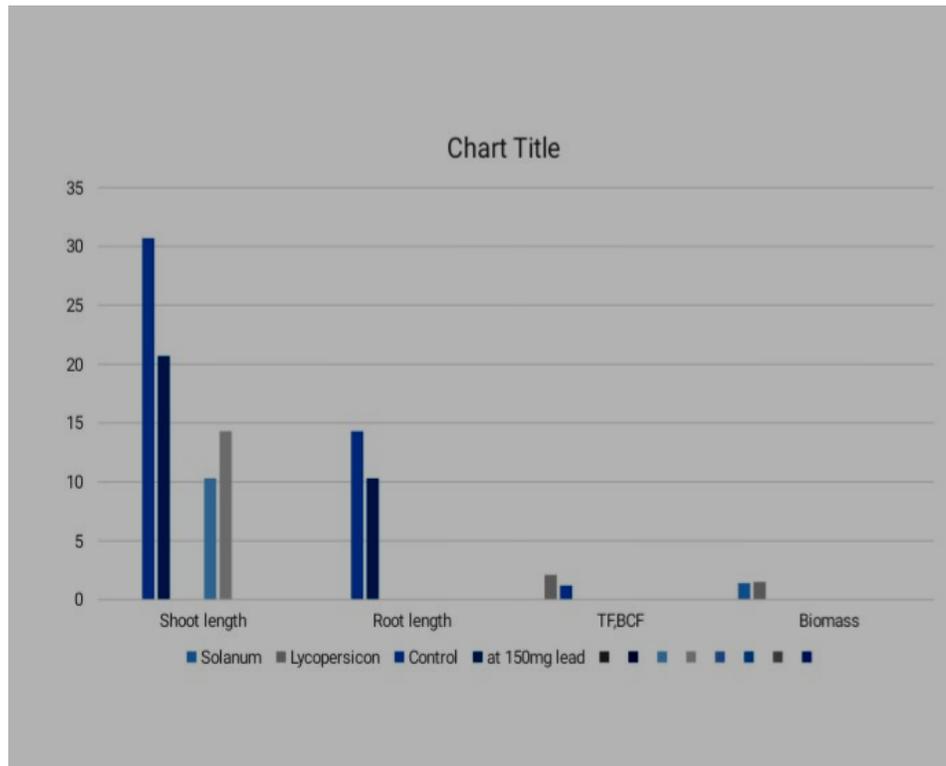
## VII BRASSICA JUNCEA

**Table 1**

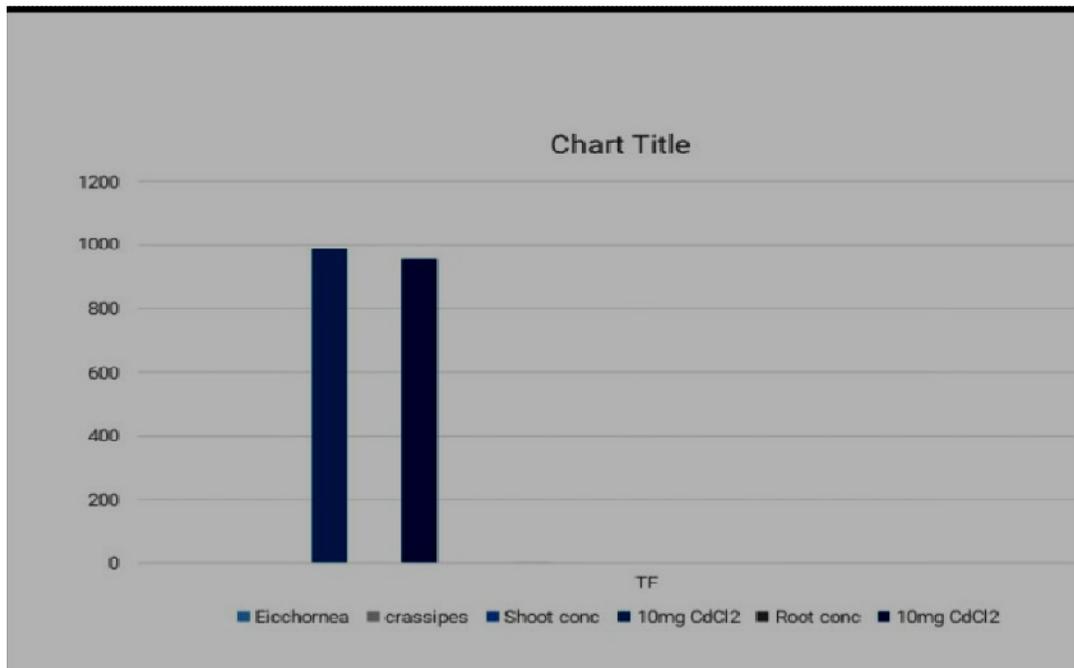
Table of conc,TF,bcf biomass etc. 25mg/kg Cr ,Cd conc. Root 10 mg,100mg Cd conc.	TF=1.61,1.43 18.78,175ug/g
Solanum Lycopersicon Shoot length-control 30.7 at 150mg lead 20.7 Root length control-14.3,10.3 at 150 mg lead. Root biomass at 10ug Cd conc	BCF-1.2,TF-2.1 Control1.4, increases to 1.5
Helianthus annus 20 mg Cd conc. BCF-1.8	BCF-1.8
Eicchornea crassipes 10mg CdCl2	Shoot conc-986 Root conc-956ug/g dry wt TF-1.03 TF =1.03



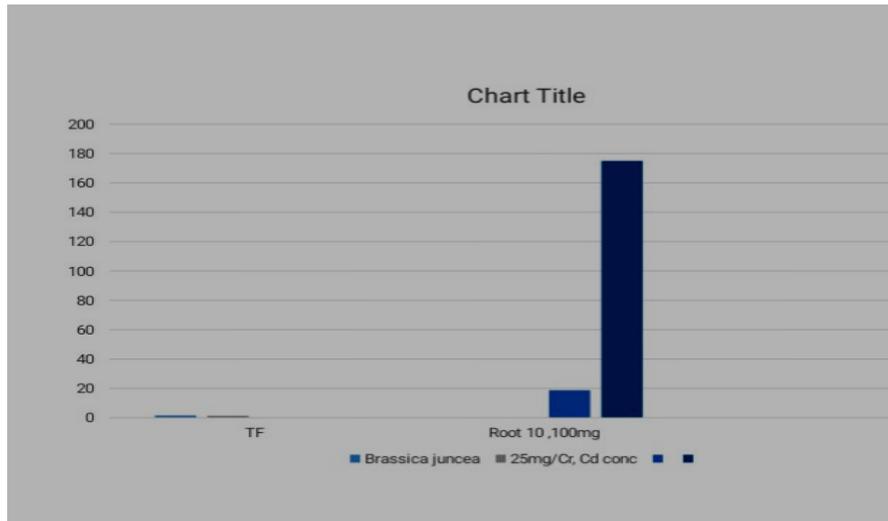
**Fig. 1 Graphs BCF of Helianthus Annus**



**Fig. 2 Shoot length, Root length, TF, BCF, Biomass of Solanum Lycopersicon (Tomato).**



**Fig. 3 Shoot, Root conc of Eicchornea crassipes at 10 mg CdCl2 crassipes at 10 mg cdCl2**



**Fig. 4 Brassica juncea root at 10,100mg Cd conc.**

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# Performance Analysis of DVR and UPQC for Mitigating Voltage Sag in a Distribution System

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## ABSTRACT

*In this paper Power Quality (PQ) improvement for a distribution system is presented using Dynamic Voltage Restorer (DVR) and Unified Power Quality Conditioner (UPQC) controllers. DVR and UPQC are widely adopted custom devices that are reported for mitigation of voltage sag. Voltage sag is a result of the faults in the power system. The designed UPQC and DVR systems help in obtaining regulated and balanced output voltages with reduced harmonics across the load terminals. Also, they suppress the source harmonics generated by the loads. The Matlab simulation model is presented for both the types of controllers using synchronous reference frame. Their performances have been analyzed under 3-phase fault condition and the results are compared to assess the improvement achieved in power quality by DVR and UPQC devices.*

**Keywords**— Power Quality, Photo Voltaic, Unified Power Quality Conditioner (UPQC), Dynamic Voltage Restorer (DVR).

## I INTRODUCTION

Power quality (PQ) is a serious concern for system operators. Poor PQ directly affects the end-users or consumers. Power quality phenomena or power quality disturbance may be defined as the deviation of the voltage and the current from their ideal waveform i.e. sinusoidal in power systems [2-4]. If the PQ issues are not rectified at source, then they may threaten the connected equipment [1]. These PQ problems are classified by five main events; sags, swells, harmonics, interruptions, and transients. These events can cause degradation in service which may cost monetary losses to utility as well as consumers.

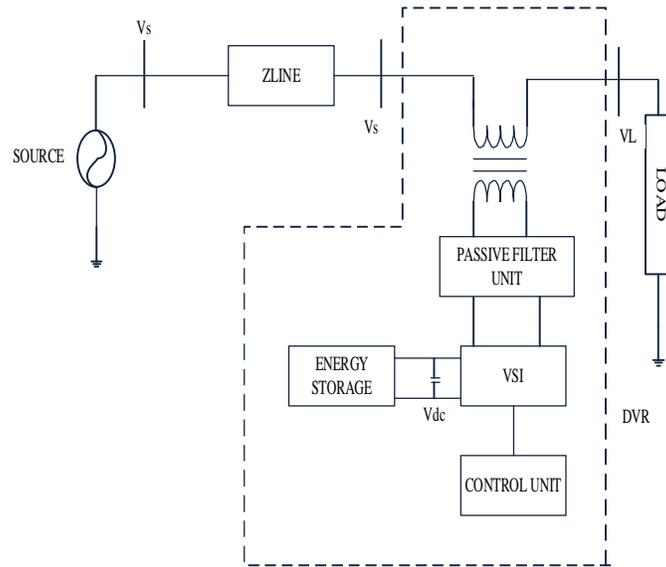
Most of the PQ problems are related to voltage sag. Voltage sag refers to a condition when, magnitude drops lower than 90% of the nominal voltage. There may be lot of reasons for the occurrence of voltage sag. Mainly it occurs due to fault in the load connected to the feeder [5].

In this paper, grid connected DVR and UPQC controllers are presented to minimize the voltage sag which could be the result of system faults [6]. The basic function of the DVR is to inject a dynamically

controlled voltage  $V_{DVR}$  generated by a forced commutated converter in series with the bus voltage [7-10]. On the other hand, UPQC has been reported for simultaneous mitigation of both the current and voltage related power quality impacts [11]. The simulation model for both the devices is presented with comparative analysis to assess improvement in PQ. The results mainly focus on the voltage sag. The criteria for comparison of about voltage sag are the percentage of voltage restoration and THD during the fault.

## II DYNAMIC VLTAGE RESTORER

The DVR is a custom power device that is connected in series with the distribution system as shown in Fig 1 [12]. It protects the sensitive electric load against PQ problems such as voltage sags, swells, unbalances, and distortion through power electronic controllers that use voltage source converters (VSC) [13]. It regulates the load voltage near to set reference value. The voltage is regulated by the injection of reactive power into the sensitive load or the distribution network by the DVR. The main components of the DVR consist of a coupling transformer, passive filter, series VSC, and energy storage and control system [14, 15].

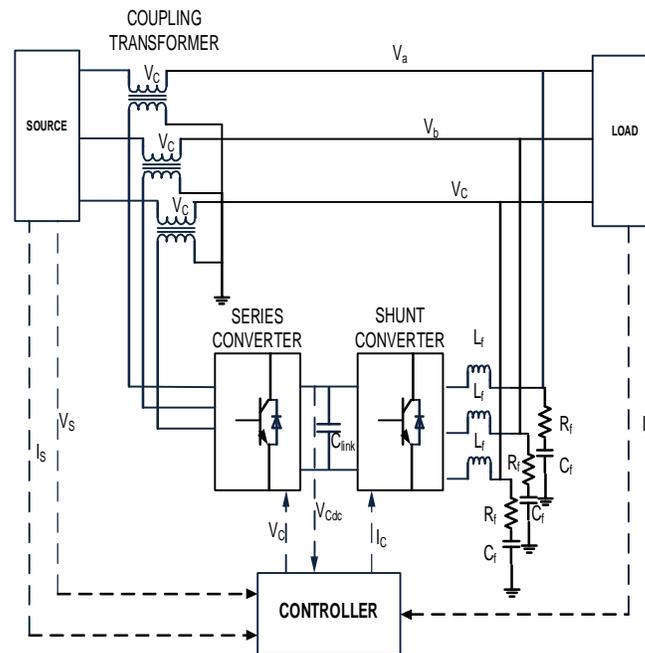


**Fig. 1 Schematic of DVR connected to a distribution network**

### III UNIFIED POWER QUALITY CONDITIONER

The UPQC can be represented as the combination of series-shunt converters. The series converter is connected between the source and load via isolation-transformer and behaves as an ideal current source [16]. The shunt converter is connected in parallel to the load which behaves as an ideal voltage-source converter [17]. The circuit topology of the UPQC is given in Fig. 2. In UPQC, shunt converter helps in maintaining the balanced sinusoidal voltage via the shunt capacitor of the filter element. The series converter is connected on

a source side via coupling transformer and helps in draining sinusoidal balanced current from source. The filter elements LCR help in suppressing harmonics of the system. The series-shunt converters of UPQC ensure no injection or absorption of real power from the system but only compensates for reactive power [18-20]. In conventional UPQC topology, the DC-link capacitor is energized with storage devices like batteries, switch mode supply, flywheel, etc. [21, 22]. UPQC offers numerous benefits, mainly the improvement in PQ by its ability to minimize the distortion in voltage and current waveforms. [23].



**Fig.2 Detailed configuration of the UPQC**



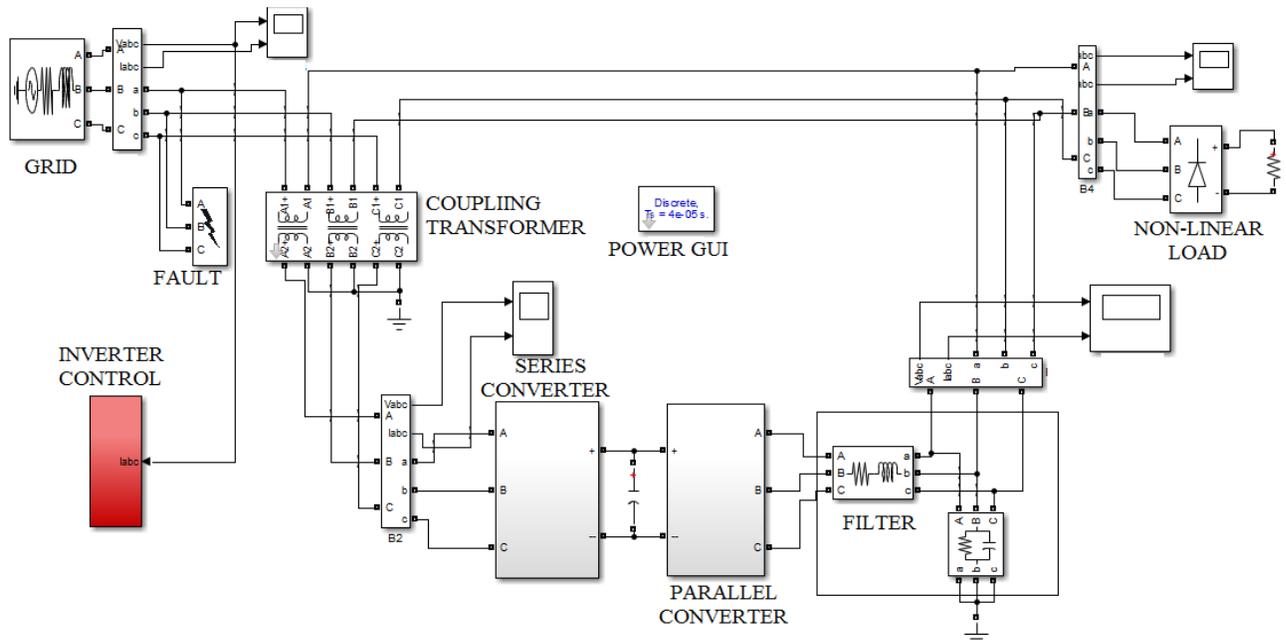


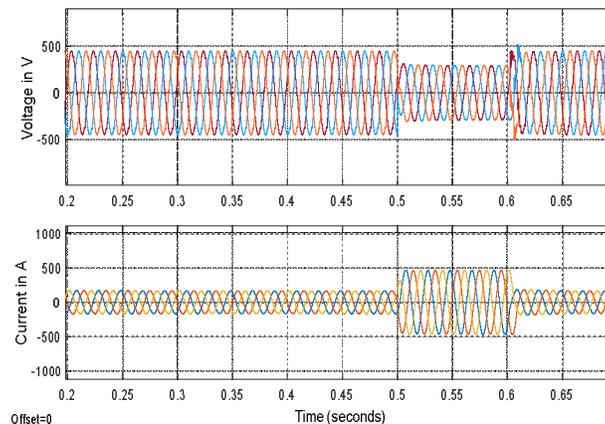
Fig. 4 Simulation model of

## V RESULTS AND DISCUSSION

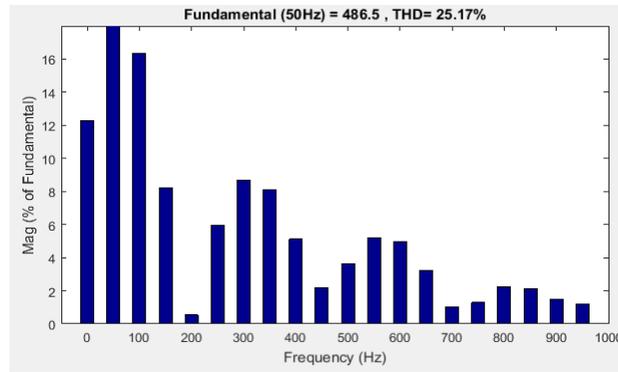
Among the various PQ problems, voltage sags are the most severe disturbances, which are caused by the fault in power systems. If a fault occurs due to the short circuit at the source side in a power network, it results in the voltage sag in the load connected to the power network. The distortion in voltage waveforms load side due to sag is analysed. Both DVR and UPQC successfully mitigate the voltage sag, by injecting the required amount of reactive power at the time of fault to restore the load voltage.

The fault occurs at grid side and its effect is analysed on grid as well as load side. Fig. 5 presents the grid side voltage and current when a three phase to ground fault occurs at 0.5 sec. and cleared at 0.6 sec.

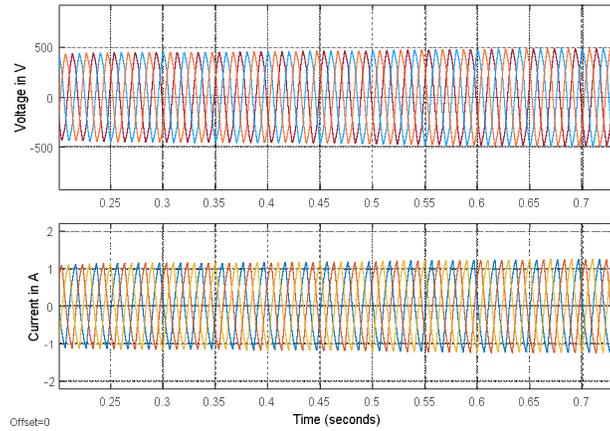
But it results in the 50% voltage sag. This dip in voltage propagates to the load bus and may cause severe damage to the sensitive loads connected. Also, it will increase the grid current upto 50% which results in over current. The distortion in grid voltage will also be increased as shown in Fig. 6, the THD due to the fault is 25% which is very high. Fig. 7 shows the load voltage and current profile with DVR connected in series with the source using a coupling transformer. From the figure, it can be seen that DVR mitigates the voltage sag successfully by restoring about 90% system voltage when the sag occurs. Also, it reduces the THD of the load voltage to 3.08% which is well within the permissible limit (IEEE 519-1992) allowing THD of 5% in voltage. Fig. 8. presents the THD graph of load voltage at fundamental frequency.



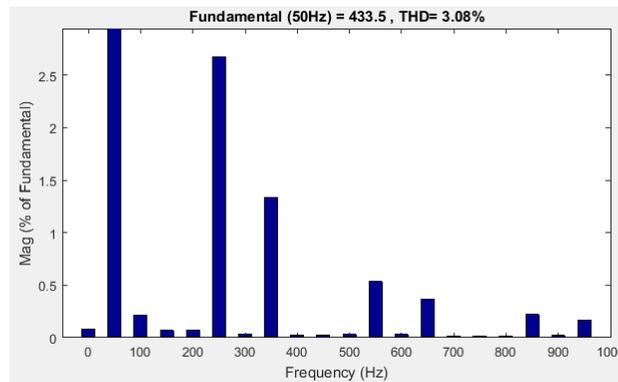
**Fig. 5 Grid side voltage and current waveforms under three phase fault**



**Fig. 6 THD of grid voltage**

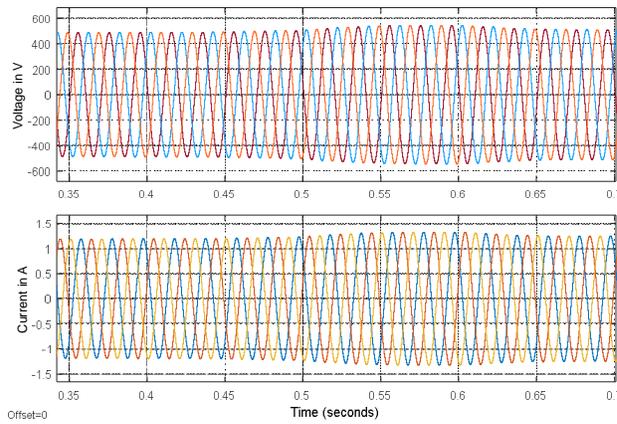


**Fig. 7 Load side voltage and current under three phase fault load side with DVR**

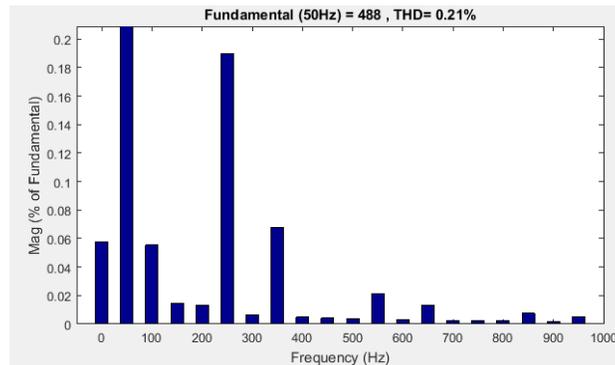


**Fig. 8 THD of load voltage with DVR**

Fig. 9 presents the load voltage and current profile with UPQC. From the figure it can be seen that UPQC mitigates the voltage sag successfully. And restores the 100% system voltage. Also, it reduces the THD of the load voltage to 0.21% which is very nominal. Fig. 10. presents the THD graph of load voltage at fundamental frequency.



**Fig. 9 Load side voltage and current waveforms under the condition of three phase fault with UPQC**



**Fig. 10 THD of load voltage with UPQC**

## VI CONCLUSION

The modeling and simulation of a DVR and UPQC are presented using MATLAB/SIMULINK toolkit. A control system based on the synchronous reference frame technique is used. The simulation results show that the DVR and UPQC performance are satisfactory in mitigating voltage sags as well as improving the power quality by reducing harmonics in the voltage profile. From the result, it can be seen that, though both DVR and UPQC are capable of mitigating the voltage sag. With the designed controller, DVR restores about 90% of voltage after the occurrence of fault whereas UPQC restores 100%. Further, THD is lower in case of UPQC in comparison to DVR. The authors have also noted from the research papers that the performance of UPQC is superior to that of DVR. The authors have also concluded the same.

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# Conserving Electricity to Save the Mother Earth

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## ABSTRACT

*Electricity is the basic need in every aspect of our daily life. It is the most convenient form of energy. Hence, various other forms of energy are being transformed into electrical energy in final application. Transport sector is the glaring example where it may be railways, roadways, water ways or even space mission. Its consumption has become a measure of the growth of a nation. In view of the challenges imposed by the climate change, it has become all the more to minimize/avoid the burning of fossil fuels to obtain electricity. The best way out is to conserve the energy by demand side management and energy efficiency and maximize the use of environment friendly renewable energy. The scientific approach to conserve energy is to monitor the consumption and take corrective measures to minimize the wastage.*

**Keywords:** Energy conservation, energy consumption, energy efficiency, best practices in energy saving, star rating

## I INTRODUCTION

Electricity is a flexible and most convenient form of secondary energy which is generated from primary sources of energy like fossil fuels, Hydro, Nuclear or Renewable Energy like Solar, wind, hydro, Biomass, etc. The energy is needed to cook food, light and cool/heat our homes, run appliances in our homes. Electricity is also needed for transport, industry, commercial, institutional, recreational, medical and governmental activities. Electricity is the costliest but the cleanest and highest quality energy and can be

used to do all types of works which no other forms of energy can do. It is said that in future all the works will be performed using electrical energy. Hence, it is necessary to understand and follow the best practices in the intelligent and smart use of electricity with the objective to minimize/avoid wastage of electricity. [1]

Figure 1 shows a changing scenario of mother earth from green and environment friendly to present polluting environment resulting in global warming which is harming the health of mother earth.



**Fig. 1 Save our Mother Earth [2]**

## II BENEFITS OF CONSERVING ELECTRICITY

Electricity is directly linked with the following **3-dimensions of sustainable development.**

Economic, Social and Environmental.

Thus, it is important to use electricity efficiently and judiciously. Saving electricity not only helps us in reducing our bills but also results in several fringe benefits to the society, nation and the planet. Some of the benefits are listed below:

- (a) **Economic Benefits** - Electricity is produced in power plants which require huge capital investments by the public and private sectors. Further, there are recurring expenses for fuel, maintenance, salaries etc. The losses in generation, transmission, distribution add to the cost. The country is spending more than Rs. 11 Lakh Cr. per year on electricity. It costs 2 times more to generate than to conserve same amount of electricity due to losses taking place in power transmission, distribution and utilization. The electricity cannot be stored also (except in batteries; which again adds to costs) it is

therefore economically more prudent to use electricity smartly and intelligently.

- (b) **Social Benefits** - All the villages in India have been electrified. However, still all the homes are not having electric supply connections which may be 10-15% of our population; mostly in rural areas due to which they are dependent on polluting fuel Kerosene to light their homes. By saving electricity, we can share the same with the underprivileged population. The availability of electricity will help in social benefits to the rural population. Their children can get better education and health facilities. With the availability of the electricity, their economy also improves as their active hours are increased.
- (c) **Environmental Benefits** - The efficient use of electricity minimises the emission of CO<sub>2</sub> and other Green house gases and particulate matters. With more emphasis and adoption on electric vehicles, the pollution in cities will substantially reduce which will reduce expending on import of crude oil.

From the above, one can understand how important it is to conserve electricity. It is very much possible by using electricity intelligently and smartly without sacrificing on comfort.

### III METHOD OF CONSERVING ELECTRICITY

Basically, electricity can be conserved by following 3-measures, namely energy conservation, efficiency and renewable.[1]

- (a) **Conservation Measures**- These measures require understanding of how each electricity consuming item needs to be used. There are Dos and Don'ts and certain techniques which must be explained to all family members and followed strictly.
- (b) **Efficiency Measures**- These measures require retrofitting of existing inefficient gadgets/appliances with the highest efficiency ones available in the market. These measures are implemented with external help and still need to be monitored.

Bureau of Energy efficiency, Ministry of Power sets the standards and labels for marking star-rating of appliances. The star ratings are provided to the appliances in the form of 5-stars. Higher the number of stars, lower is the energy consumption. The star label shows at a glance a basic sense of energy efficiency to facilitate the consumer. The power saving guide is with explanation is shown in Figure 2.

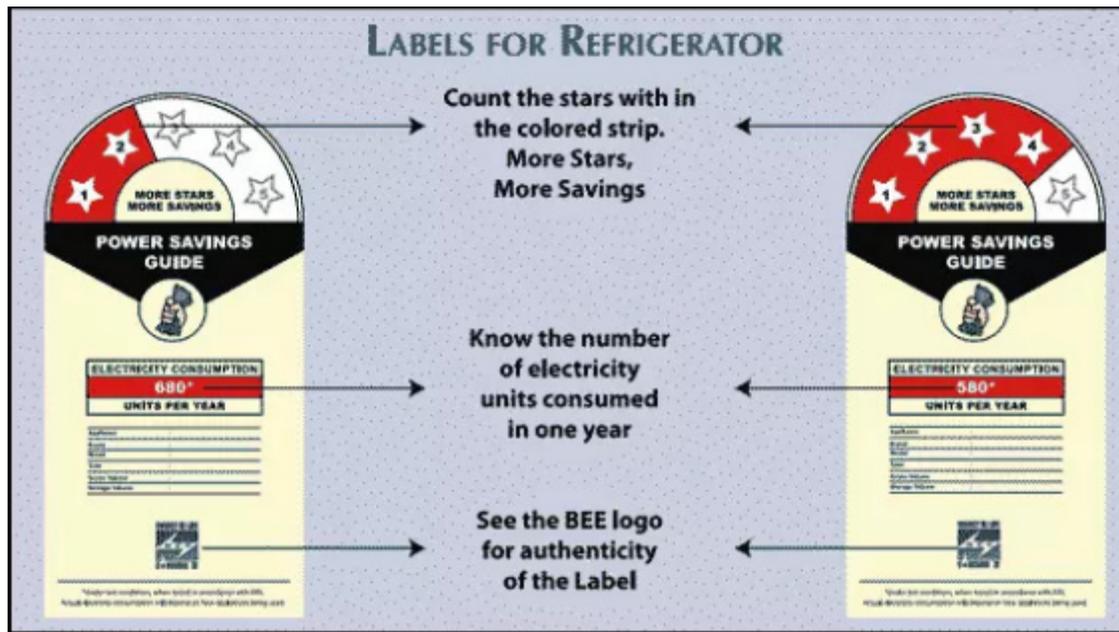


Fig. 2 Power saving guide [3]

- (c) **Renewable Energy Measures**- These measures require replacing electricity consuming gadgets with solar energy based gadgets and also need external help and expert advice.

The above -approaches have been depicted in the form of a pyramid shown in Figure 3.

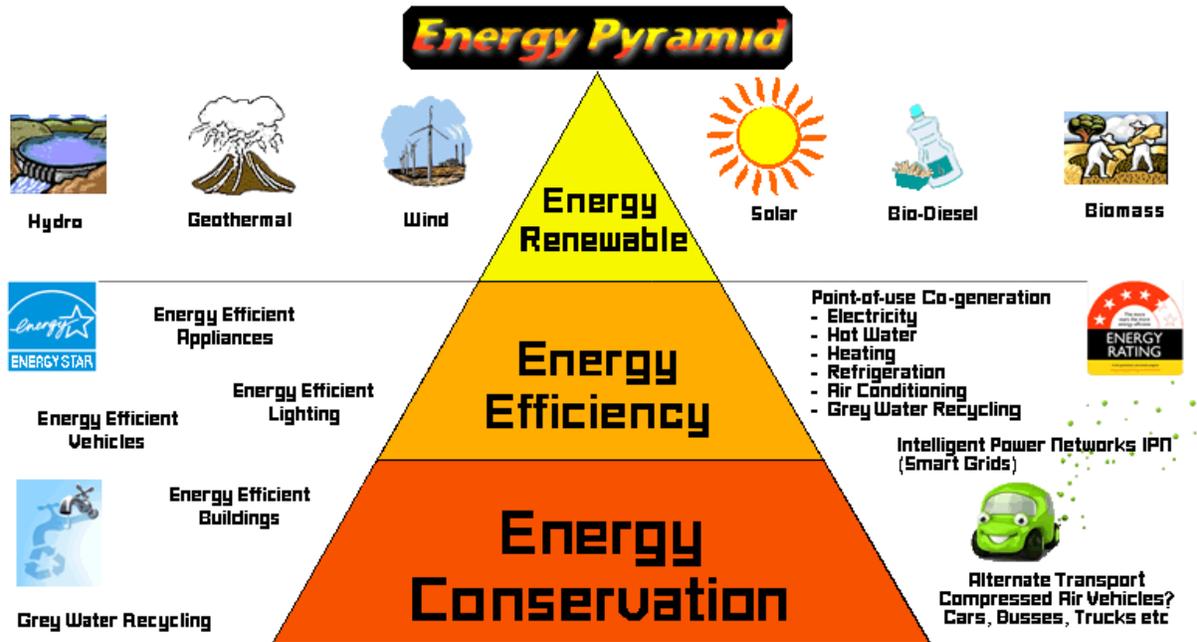


Fig. 3 Energy Conservation pyramid [4]

(d) **ABC approach to conserve electricity-** It is recommended to adopt ABC approach i.e. Accounting, Budgeting (Best Practices) and Controlling for maximum benefits.

#### IV ACCOUNTING OF ELECTRICITY CONSUMPTION

One should start with understanding how the billing is done and how much electricity is consumed by which item or appliance. Basic understanding of what is the meaning of a unit of electricity (kWh) and how it is calculated is very important. The billing is in two parts i.e Fixed Charges and Energy Charges. Fixed charges depend on the connected load and Energy charges are levied on actual consumption as per gradually increasing slab tariff. The step by step guide on how to account electricity consumption is given below: [1]

#### (a) Recording Framework

- (i) Open a file to keep records of electricity bills
- (ii) Safety First-Understand all electricity safety measures before starting. Do not attempt anything which requires services of a qualified electrician.
- (iii) Understand how the electricity meter works and start taking meter readings twice a day i.e. at 7 AM and at 7 PM to see the consumption pattern in day time and night time.
- (iv) Make a list of all electricity consuming items in the home with their rated power in watts
- (v) Estimate the approximate hours of use.
- (vi) Enter the data in an Excel sheet in the format given in Table 1.

**Table 1**  
**Monitoring the electricity consumption**

Sl. No	Item Description	Rated Power (W)	Estimated Hours of Use (Hr) per day	Consumption per day (3 X4)	Consumption per month 5 X No. of days
1	2	3	4	5	6

**(b) Activity Framework** - It may be noted that the items like Refrigerators, ACs, Geysers are provided with thermostats which switches off the compressor/ heating element once the set temperatures have been achieved. Further, Ceiling fans are provided with regulators and as such consumption depends on the regulator setting. Such appliances need more analysis to account their consumption. The following steps may be adopted to estimate approximate consumption of such appliances:

- (i) Switch off everything – check the meter to ensure that it is not working.
- (ii) Note down the initial meter reading
- (iii) Set the thermostat / regulator Fridge / AC / Fans etc. at middle point
- (iv) Start the appliance and keep it running for minimum of 2 hours
- (v) Note down the meter reading again
- (vi) The difference is the approximate consumption by the appliance for 2 hours. Multiply it by the no of hours it is used to get the daily consumption.

One may repeat the exercise in the night hours and at different settings of thermostat for better results. Similar calculations shall also be carried in different seasons.

The estimated monthly electricity consumption thus arrived should be compared with the bill to ensure that the meter is working properly and to identify the potential electricity saving measures.

## **V BEST PRACTICES FOR ELECTRICITY SAVINGS**

As explained earlier, the electricity savings can be realized by the adoption of conservation, efficiency and renewable energy measures. Understanding the best practices in the adoption of such measures helps in maximizing gains. Some of the best practices are listed below:[1]

### **(a) Conservation Measures**

- (i) Basic rules to ensures switching off lights/fans/ACs etc. when not in use should be kept in mind and practiced
- (ii) Educate the family members about the losses due to ‘Standby consumers’ (Ghost Consumers) and instruct them to switch off electronic gadgets from main Switch instead of Remote.

- (iii) Set computers on power saving mode.
- (iv) Clean Lighting Fixtures, Ceiling Fans, and Filters & Coils of ACs regularly.
- (v) Make use of day lighting and ‘free cooling’ (opening the windows) as much as possible.
- (vi) Ensure that appliances are used smartly and intelligently e.g.- set thermostat of Fridge as per weather conditions / load. Read the user’s instruction manuals and follow the guidelines given. Sometimes the manufacturers will give insufficient/ wrong information. Double check the instructions and adopt them to suit your usage.
- (vii) Avoid using appliances during peak load hours (morning and evenings). Use during late night (after 10 pm) or early morning (before 6 am) to reduce peak demand. This will also keep your electric wiring in healthy condition.
- (viii) Use ACs at a higher thermostat setting along with a Ceiling Fan i.e. 27-28 Deg.C.
- (ix) Make use of Timer Sleep Mode settings for ACs and Fans (Super energy efficient fans with remote come with this facility)
- (x) Adopt ‘Task-Lighting & Cooling’ wherever possible.
- (xi) Use hand operated tools as much as possible instead of Mixer/Grinder

### **(b) Efficiency Measures**

- (i) Discontinue the use of Incandescent Lamps and Compact Fluorescent Lamps (CFLs)-replace them with Light Emitting Diode (LED) Lamps.
- (ii) The so-called ‘zero watt’ bulbs actually consume 10-15 watts -replace it with 0.5 watt LED lamp.
- (iii) Provide 2-3 watt LED Lamps for areas where low illumination will suffice.
- (iv) Provide 5 watt LED lamps for small rooms, bath rooms, toilets etc
- (v) Replace all T8 and T12 Fluorescent tube lights with LED tube lights.
- (vi) Replace old ceiling fans with 28 watt super energy efficient fans.
- (vii) Provide Sensors to automatically switch off lights/Fans etc when not in use.
- (viii) Replace Electric Geyser with Solar Water Heater
- (ix) Make it a policy to always buy highest efficiency latest gadgets. For example- whenever AC is to be purchased buy latest

Inverter type AC or the ones coming with highest star rating.

**(c) Renewable Energy Measures**

- (i) Replace Electric Geyser with Solar Water Heater
- (ii) Use Solar Lanterns and Torches regularly
- (iii) Use Solar DC fan for cooling requirements during power cuts instead of providing an Inverter.
- (iv) Make use of solar passive techniques to minimize the use of electrical appliances for cooling/heating etc.

**(d) Controlling Measures-**Once a system is in place to introduce all measures to conserve electricity, it becomes important to ensure that this is followed religiously by all members of the family. This part can be made interesting and rewarding by introducing an Incentive and penalty scheme. A piggy bank may be kept for this purpose and any member found wasting electricity may be fined a sum equal to potential loss in a month and asked to deposit that much money in the piggy bank. The money thus collected may be used partly to fund purchase of new energy efficient gadget and partly to have an outing for the family.

## VI CONCLUSION

Electricity is most important but its source has become critically more important in last few decades. It is directly linked with the 3-dimensions of sustainability, viz. economic, social and

environmental. In order to fight against the climate change, 3-dimensional measures are necessary. These are electricity conservation measures by demand side management. The use of energy efficient appliances play important role in energy conservation. The third measure is the adoption of energy based on renewable sources i.e. which either do not emit green house gases such as solar, wind, hydro etc. The most important tool for energy conservation is the monitoring of energy consumption and carrying our energy audit and implementing its outcome. All such measures have become all the more necessary for sustainable development and saving the mother earth.

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# Protection of Grid Connected Hydro Power Generating Units – Practical Insight with Reference to some Case Studies

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## ABSTRACT

*The paper attempts to present a unified approach to the vast field of protections for hydro power generating sets. Typically, there are a number of agencies involved in the formation of protection logics viz the main turbine-generator manufacturer, the protection relay supply company, the customer (Electricity boards or private producers) and may be a consultant also. The integration of views of these agencies is a task in itself. The typical inter-tripping logic diagram given in the paper fulfils this requirement to a great extent. Also, some case studies of actual fault incidents at hydro power stations have been included.*

**Keywords:** Inter-tripping diagram, fault detection and action devices, categorization of faults, master tripping relays, generator circuit breaker (GCB), generator field breaker (GFB), penstock gate, main inlet valve, electro-mechanical and micro-processor based relays.

## I INTRODUCTION

It is well known fact that availability factor of generating units for Power Generation in Power Stations is of paramount concern of all stake holders. It is also known that in spite of advanced manufacturing technologies together with good erection techniques at sites, faults do occur in the Generators and connected Transformer, Bus duct, Feeder Lines etc. up to switchyard for various reasons. In addition to these so called internal faults of the unit, there are faults originating in the grid system which affect the normal operation of the units connected to it. Obviously, faults need to be detected and acted upon quickly to avoid major damages and in-turn minimize the downtime and cost. Hence, proper protections have to be provided for the twin objectives of timely detection and isolation of the unit in case of external system faults and stopping it on internal faults to prevent aggravation of damage.

## II FAULTS CATEGORIZATION AND DETECTION

- (a) **Categorization of Faults-** There are various ways of categorization. One broad way of it is location based that is internal or external as already clarified above. Internal, faults can be categorized either as hydro mechanical or electrical in nature which again can be either normal type where one can wait for a little while or emergency type requiring immediate action for stopping of the turbine after detection and that too by two stopping devices namely motorized limiter mechanism of governor and ESV (Emergency Slide Valve) both acting in parallel and independently.
- (b) **Detection Devices/Circuits-** Normally, fault detection is done at two stages. In the first, only annunciation is given out for warning and in the second when fault level reaches the threshold, tripping is initiated with annunciation. List of fault types and their detection devices as well as corresponding action taking devices are given in Table-1.

**Table 1**  
**Faults and their Detection and action devices**

S. No	Fault Type	Detection Devices	Action Devices	Remarks	Abbreviations used
1.	Over Temperature	DTT/Thermostat/RTD	Motorized limiter of Governor for Normal Stopping of Unit	For Generator Bearings, Main Transformer etc.	DTT = Dial type thermometer
2.	Low Pressure	Pressure Switch	ESV + motorized limiter for stopping of the unit	For OPU Accumulator oil Pressure for Governor	ESV- Emergency Slide Valve OPU = Oil Pressure Unit
3.	Low level	Level Switch	ESV + motorized limiter for stopping of the unit	For OPU Accumulator oil Level	
4.	Over Speed	Centrifugal Force Operated Switch and		Additionally MIV/PS gate also	MIV = Main Inlet valve

		Speed Relays		close	PS = Penstock
5.	Over Voltage	PT	GCB	For generator Stator WDG and other voltage based faults	GCB = Generator circuit breaker WDG = Winding
6.	Over Current	CT	ESV + motorized limiter for Stopping of the Unit	For Differential Protections (and other current based Protections)	CT = Current transformer
7.	Fire	Fire/Smoke detectors	Motorized limiter of Governor for Normal Stopping of the Unit	For Generator Barrel Fire	

### III INTER TRIPPING DIAGRAM

popularly known class A, class B and class C categories, is shown in Figure 1 which is quite self explanatory.

A Generally accepted Inter Tripping Diagram which shows classification of various faults into

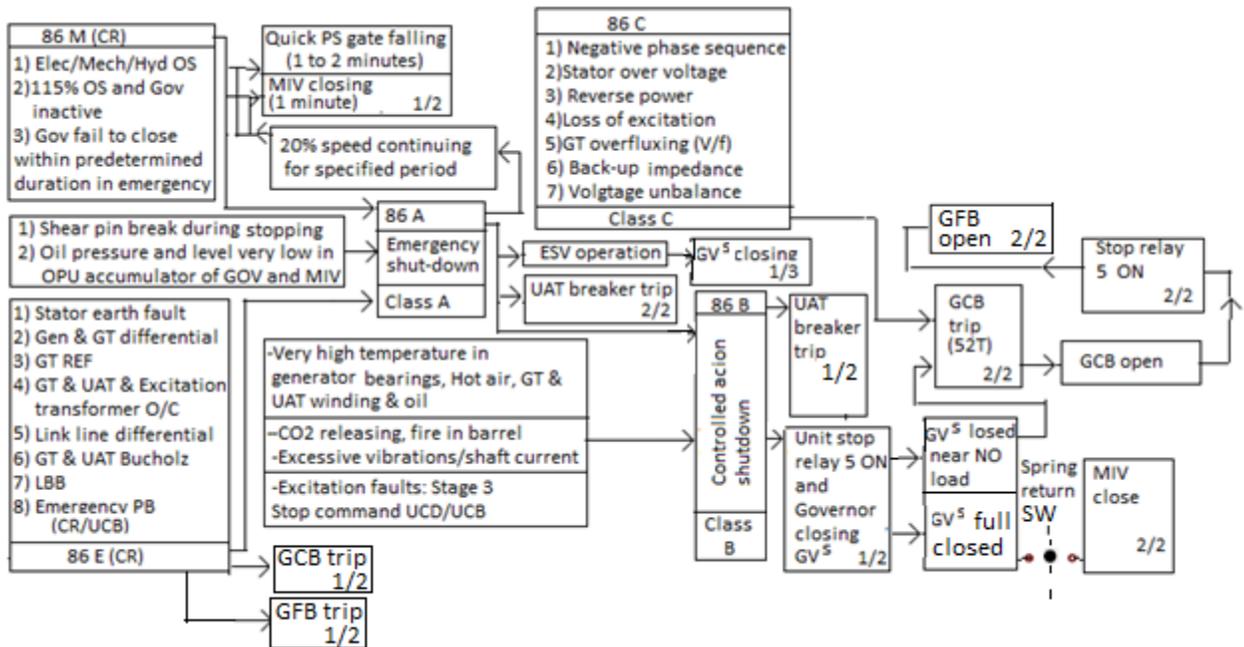


Fig.1 Inter-tripping diagram

- (a) **Class C Faults (Acting Through Master Trip Relay 86C)** - These require only the isolation of the unit from the grid by opening of GCB. This is a load throw condition in which unit continues to run on NO load excited under auto governing and excitation, with UAT remaining charged to continue power supply for power house load as in normal operation.
- (b) **Class B Faults (Acting Through Master Trip Relay 86B)**

These are non urgent types where some time is available to follow the normal sequence of stopping as shown in Figure 1 and elaborated below.

- (i) Stop relay 5 of unit automation scheme is energized for start of GV<sup>S</sup> closing through motorized limiter mechanism of governor.
- (ii) At near no load position of GA as sensed by a master switch, operated by its

movement for closing, GCB is tripped followed by tripping of GFB. Here, almost no over speed occurs.

- (iii) After GV<sup>S</sup> full close (FC), MIV may be closed from its control switch if desired, which will be happening in still water.

- (c) **Class a Faults (Acting Through Master Trip Relay 86A):** These are the severest type, requiring immediate action for stopping not only from motorized limiter but also from ESV acting at same time independently. GCB and GFB too open out immediately resulting in over speed like it happens in load throw, while stopping is in progress. Over speeds being more critical, back up of MIV OR penstock gate closing is additionally provided which would close in flowing water of turbine which may be noted.



## **V CONCLUSION**

The subject of protections is very exhaustive. Given their role of 'silent sentinels' against various faults which may occur at any time during the operation of generating units this paper underline their importance and need for the plant engineers to ensure that they are always in ready state for action. Starting from electro-mechanical protection relays in the beginning, now-a-days, it is the time for microprocessor based

relays- also known as numerical relays which use software based protection algorithm for detection of various electrical faults and housed just in a unit, requiring only CT/PT inputs from the field. One a disadvantage of these systems is also worth mentioning. With these sophisticated system the site engineers normally not get it to understand of underlying principles of fault detection as in the case of basic electromechanical protection relays.

# X- Rays in the Service of Mankind – A Review

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## ABSTRACT

*This paper gives a brief account of the invention of X-rays and their first medical application. The evolution of the X-ray machines, the features in the modern machines and the emerging trends are chronologically presented. Other applications mainly in the industries are also discussed. The role of artificial intelligence and machine learning are also mentioned which are likely to play important role in the field of X-rays applications.*

**Keywords** –X-ray, medical x-ray, x-ray device, innovations in X-ray technology, emerging trends in X-rays

## I INTRODUCTION

The X-ray is a familiar term which normally relates to illness diagnostic procedure recommended by doctors. X-rays, also termed as X-radiation, were discovered on November 8, 1895 by German physics

Professor Wilhelm Roentgen. Roentgen called it "X" to indicate that it was an unknown type of radiation. The photograph of the Wilhelm Rontgen's first "medical" X-ray, of his wife's hand, taken on 22 December 1895 is shown in Figure 1.

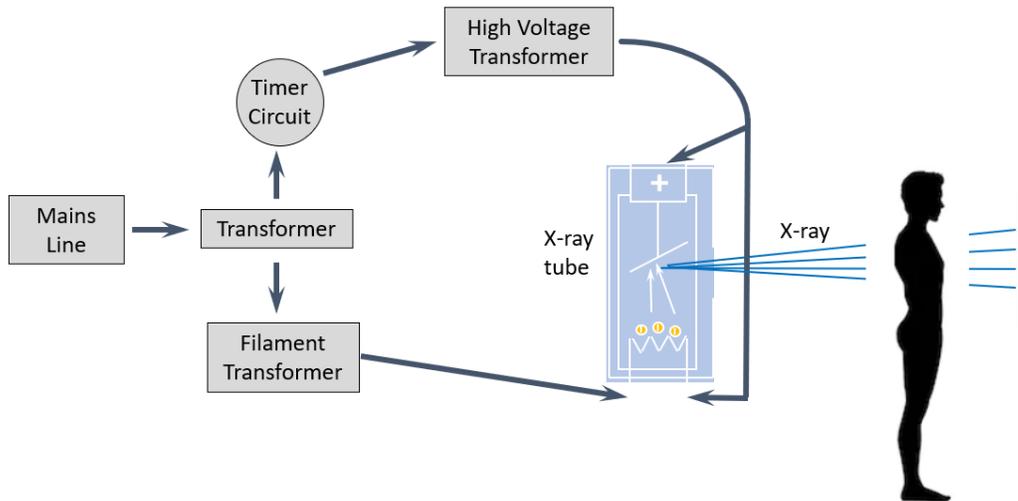


**Fig. 1: Photo of Wilhelm Rontgen's first "medical" X-ray[1]**

This X-radiation has been proved as a blessing in the medical industry for diagnostics and treatment over the years. Although X-rays are harmful to the human body as they affect tissues of the body, they are needed for medical diagnosis for many diseases.

## II EVOLUTION OF X-RAYS TECHNOLOGY IN MEDICAL FIELD

- (a) **The Basics of X-ray Machine** -The X-rays are produced by an X-ray machine which penetrates into the body and falls on the X-ray acquisition plate or detector. The basic X-ray machine generally consists of a timing controlling circuit, filament circuit, high voltage generator, X-ray vacuum tube which produces X-rays and of course the X-ray capturing device.



**Fig. 2: Basic block diagram of X-ray machine**

The X-rays are generated by supplying high voltage to X-ray tube before which the electron creation happened inside the tube by a filament. This filament current matters for electron generation, which is important for X-ray intensity, this provides appropriate contrast to the X-rays, whereas the high voltage matters for penetration of body, like higher voltage is produced for penetration in thicker objects.

Here the timer circuit is also very important to contain the X-ray generation timing so that right amount of x-rays pass through body to produce the x-ray image needed for diagnosis. Otherwise, if time is not controlled properly, then the X-ray image will be overexposed or underexposed and may not be of any use for diagnosis.

The combination of time and current to filament is also important to obtain contrast /in X-ray image.

**(b) Basic X-ray machine:** In the basic machines, X-ray film generation technique used to be a dark room technique similar to one where our earlier photos were created in dark room. In this dark room technique, the X-rays are taken on X-ray sensitive film which is then developed in a special liquid solution in a room which is complexly dark, only very low red light is a part of dark room so that the developer technician may work inside the dark room to carry out this process.

**(c) Cassette Reader based Machines** -A cassette reader-based technology came up as next improvement which reduced X-ray film generation time. In this technology, a cassette

containing imaging receptors and its processing device exists which is connected to a computer to display the image on monitor.

**(d) Digital Machines** - Subsequently, a digital flat detector technology was invented in which a device captures X-ray signals, converts them into electrical signals and transmits to a computer to further process based on specific software algorithm. The image is instantly displayed on monitor in the technology. This reduces the total workflow time of X-rays process significantly.

**(e) Advancements in X-Ray Machines** -Now a days, X-ray machines possessare having various features like motorized movements, mobile X-ray machine, fast image generation, faster workflow, easy and accurate positioning on patient's intended areaand so on. The minimum X-ray dose(exposure) to patient is a pressing need from hospitals and national regulations. Hence, the X-ray machine manufacturers are constantly working on innovating newer technologies with a focus on making the radiographer's life safer, faster workflow, minimum X-ray exposure etc. The technology is developed and getting enhanced which aims at minimizing the exposure of X-rays to minimize the harmful effects to the human body. In this technology, a device called Amplimat senses the X-rays which falls into it before reaching to detector, then a signal will be generated by amplimatto trip the X-ray circuit to stop the radiation.



**Fig. 3: Modern X-ray machines from Philips**

- (f) **Computed Tomography or CT scan** – CT scan machine uses ionizing X-ray radiation in conjunction with a computing machine to create images of both soft and hard tissues. Tomo means slice because the images look as if the patient was sliced like bread. Newer versions of these machines operate with much reduced dose of radiation.
- (g) **Dual Energy X-Ray Absorptiometry (DEXA)**- It is a bone densitometry. X- rays are emitted in two narrow beams at  $90^0$  to each other to calculate the quantity of calcium in bones (bone density)
- (h) **C-Arm:** C-Arm machines produce live X-rays which are used in orthopedics related procedures like fracture treatment, joint replacement etc.
- (i) **CATH lab machines:** The CATH lab machines are used in diagnostics and treatment of cardiovascular diseases in which continuous or live X-rays are used to observe blood flow in veins and arteries.
- (j) **Fluoroscopy Machines:** Fluoroscopy machines are being used for study of gastrointestinal tract and esophagus flows with live and continuous X-

rays. Figure 3 shows a few of the photographs of such machines.

### **III X-RAY MACHINES - APPLICATIONS IN NON MEDICAL FIELD**

X-ray machines are also being used in fields other than medical diagnostics. In recent years, several countries have introduced ionizing radiation in non-destructive mode for various industrial applications:-

- (a) **Industrial Radiography** – It is sub specialty of non destructive testing using X-ray imaging to evaluate properties of material without its destruction. This is extensively used in Forensics, Aerospace, Structural safety, shipping, Airport Security, and cargo screening etc.
- (b) **3D Imaging** – Large number of images can be aligned to reconstruct 3-D images by TXM. It can reveal non scale structural details and may be useful in research. X- Ray can be used to kill bacterial grow, to delay fruit ripening process as

per will. In geology mineral deposits can be found out.

- (c) **X-ray Astronomy** – It began when astronomers created crude sun spot image in 1963. NASA's latest X-ray observatory, Chandra, can observe X-ray from immense clouds of so large gases that they would take light 5 million year to travel from one end to other. A classic example of combination of man produced X-rays to detect the X-rays produced by nature.

#### IV EMERGING TRENDS

The new and emerging trend observed now a day is more towards dose reduction and easy workflow in medical X-ray field. Several manufacturers are working on new and innovative design which will help medical professionals to have quicker workflow of X-ray procedure right from patient entry for X-ray to provide final reporting. Also same focus is there for X-ray dose reduction like how the machine can obtain good and diagnosable quality X-ray image with the minimum dose. This is becoming possible by improving the image construction algorithms in the backend software as well which is being improved day by day.

A multimillion dollar machine at SLAC Natural Accelerator Laboratory in Stanford University, California can combine X-rays in to a laser beam similar to visible light laser. Unlike regular laser, laser bursts made from X-rays can be so bright and so brief that they allow researchers to create ultra fast stop motion movies of natural phenomenon with clarity that was never possible otherwise. Scientists are also combining X-rays with microscopy to pioneer newer ways of visualizing cellular structure and micro organism.

#### V CONCLUSION

In x-ray field, the safety of the patients and operator are very crucial for which medical equipment manufacturers are not only solely responsible party but hospital is also equally responsible while processing x-ray workflow along with patient for example, covering the area of patient which is not intended for x-ray image like if hand x-ray is requested then patient's rest of the body should be positioned away at best possible distance from X-ray source. The X – Ray machines combined with the computational power of present days is new emerging area which find applications in medical and industrial field. Application of Artificial Intelligence and machine learning in X-ray machines are becoming now most emerging field to watch.

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<https://www.philips.co.in/healthcare/product/HC706100/proxidiagnost-n90>

# Financial Data Management and Innovations – New Trends in Corporate

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## ABSTRACT

Financial data management is a set of processes and policies — usually assisted by specialized software — that enable an organization to consolidate its financial information, maintain compliance with accounting rules and laws, and produce detailed financial reports. This paper presents the chronological development of the database management system, role of artificial intelligence and machine learning in near future and the challenges in database management. The emerging trends in database management system covered mainly the focus of the corporate world on developing the systems to face forthcoming challenges of competition and security.

**Keywords:** Data management, financial data management, innovations in data management, trends in data management.

## I INTRODUCTION

The data are a set of values of qualitative or quantitative variables about one or more persons or objects. In the present context, Database is any collection of electronic records that can be processed to produce useful information. The data can be accessed, modified, managed, controlled and organized to perform various data-processing operations. The data is typically indexed across rows, columns and tables that make workload processing and data querying efficient.

The user organizations require technology solutions to maintain, secure, manage, and process the data stored in databases. Here comes the role of Database Management Systems (DBMS) which refers to the technology solution to optimize and manage the storage and retrieval of data from databases. It offers a systematic approach to manage databases via an interface for users as well as workloads accessing the databases via apps. Figure 1 shows the basic elements of a database management system.

## Database Management System

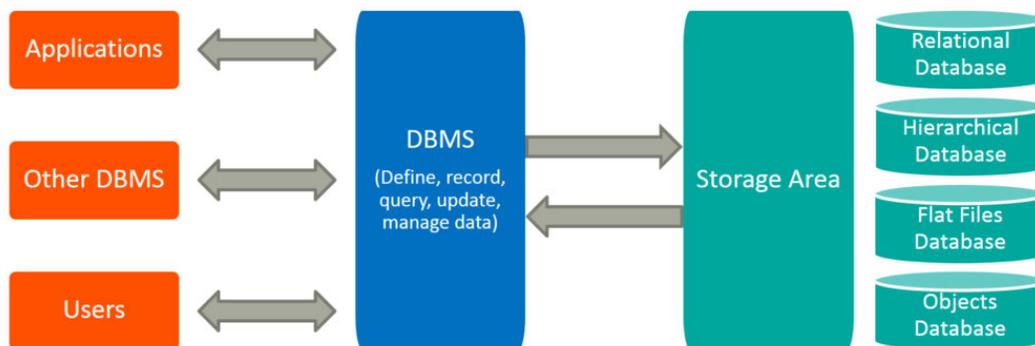


Fig. 1 Database management system [1]

This paper deals with the development of the DBMS since the inception of the large memory based fast computing systems.

## II A TIMELINE OF DATABASE HISTORY

- (a) **Overview** -Human began to store the information long ago. Even during mid-1950s, data used to be maintained by government offices, libraries, hospitals, and business organizations and some of the basic principles of these systems are still in used. Table 1 presents an overview of the chronological development of database management system.

**Table 1**  
**Development of database management [2]**

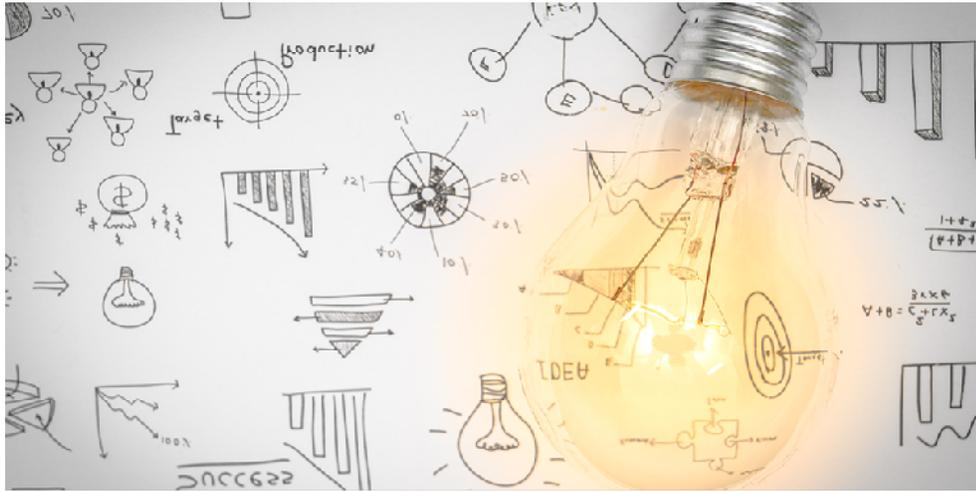
<b>Duration</b>	<b>Developments</b>
1960s	The database first started computerization in the private sector when the use of computers offered a cost-effective option. In the beginning, data models were namely, a network model CODASYL and a hierarchical model IMS. However, commercially success was the SABRE system owned by Sabre Corporation to help American Airlines in first online reservations system.
1970 to 72	E.F. Codd proposed the relational database model in which the database's schema, or logical organization, is disconnected from physical information storage. Gradually it became the standard basic principle for database systems.
1970s	Two major relational database system prototypes were developed during 1974 to 1977. The Ingres was developed at UBC whereas System R. was created at IBM San Jose. Ingres used a query language, QUEL which led to the development of systems such as Ingres Corp., MS SQL Server, Sybase, Wang's PACE, and Britton-Lee. System R used the SEQUEL query language which led the development of SQL/DS, DB2, Allbase, Oracle, and Non-Stop SQL. The term RDBMS (Relational Database Management System) became popular during the decade.
1976	P. Chen proposed a new database model, Entity-Relationship (ER). It was made feasible by this model for the designers to concentrate on data application in place of logical table structure.
1980s	The adoption of Structured Query Language (SQL) and Relational database systems resulted in rapid growth in the database market. The database product DB2 of IBM and the introduction of the IBM PC resulted in induction of new database companies and development of products such as PARADOX, RBASE 5000, RIM, Dbase III and IV, OS/2 Database Manager, and Watcom SQL etc.
<b>Early 1990s</b>	New client tools for application development were released, and these included the Oracle Developer, PowerBuilder, VB, and others. A number of tools developed included ODBC and Excel/Access. Prototypes for Object Database Management Systems (ODBMS) were created.
<b>Mid 1990s</b>	The advent of the Internet led to exponential growth of the database market. The use client-server database systems to access computer systems started that contained legacy data.
<b>Late 1990s</b>	The demand for Internet database connectors, such as Front Page, Active Server Pages, Java Servlets, Dream Weaver, ColdFusion, Enterprise Java Beans, and Oracle Developer 2000 increased rapidly. The open source solution to the intrnet was offered by the use of cgi, gcc, MySQL, Apache etc. The online transaction processing and online analytic processing witnessed the drastic change with the increased use of point-of-sale technology.
<b>2000s</b>	The database applications, mainly the interactive type, continue to grow. In the western world, the leading database companies are Microsoft, IBM, and Oracle.

**(b) Present Scenario** - Today, databases are used in our routine life mainly due to databases. Many companies offer the non-relational database space based tailor-made specific solutions. The giant relational databases include Oracle, MySQL, and DB2. The emerging trends focus on developing user friendly technology with accessibility to everyone. There is an online database platform namely **Quickbase** which is built on a relational database which is very simple and user friendly and has ability to create custom applications.

### **III AI AND MACHINE LEARNING IN DATABASE MANAGEMENT**

**(a) Use of AI** – Traditionally speaking, Artificial Intelligence (AI) is an artificial creation of human-like intelligence that can learn, reason, plan, perceive, or process natural language. AI is a rapidly expanding technology that may substantially affect our daily life.

One of the most important applications of AI is in the field of data management. AI-based data management possess out of the box thinking which offers more intelligent ways to manage business needs. AI can drive efficient search and discovery of data to help extract value from it more efficiently, even at today's massive scale of data.



**Fig. 2 AI and Machine learning [3]**

**(b) Machine Learning** - Practically all of the achievements mentioned so far stemmed from machine learning, a subset of AI that accounts for the vast majority of achievements in the field in recent years. When people talk about AI today they are generally talking about machine learning.

In simple terms, machine learning is where a computer system learns how to perform a task, rather than being programmed how to do so. The term machine learning was coined in 1959 by Arthur Samuel, a pioneer who developed the world's first self-learning systems known as the Samuel Checkers-playing Program.

To learn, these systems are fed huge amount of data, which are used to learn as to how to carry out a specific task, such as understanding speech or captioning a photograph. The quality and size of this dataset is important for building a system able to accurately carry out its designated task. For example, if you were building a machine-learning system to predict house prices, the training data should include more than just the property size, but other salient factors such as the number of bedrooms or the size of the garden.

**(c) Neural Networks in Data Management-** Key to success in machine learning depends on neural networks. These mathematical models are able to tweak internal parameters to change what they output. During training, a neural network is fed datasets that teach it what it should spit out when presented with certain data. In concrete terms, the network might be fed greyscale images of the numbers between zero and 9, alongside a string of binary digits – zeroes and ones – that indicate which number is shown in each greyscale image. The network would then be trained, adjusting its internal parameters, until it classifies the number shown in each image with a high degree of accuracy. This trained neural network could then be used to classify other greyscale images of

numbers between zero and 9. Such a network has been used by the US Postal Service to recognise handwritten zip codes.

The structure and functioning of neural networks is very loosely based on the connections between neurons in the brain. Neural networks are made up of interconnected layers of algorithms, which feed data into each other, and which can be trained to carry out specific tasks by modifying the importance attributed to data as it passes between these layers. During training of these neural networks, the weights attached to data as it passes between layers will continue to be varied until the output from the neural network is very close to what is desired, at which point the network will have 'learned' how to carry out a particular task. The desired output could be anything from correctly labelling fruit in an image to predicting when an elevator might fail based on its sensor data.

A subset of machine learning is deep learning, where neural networks are expanded into sprawling networks with a large number of sizeable layers that are trained using massive amounts of data. It is these deep neural networks that have fuelled the current leap forward in the ability of computers to carry out tasks like speech recognition and computer vision.

## **IV CHALLENGES IN CORPORATE WORLD DATABASE MANAGEMENT**

In this wonderful world of technology where everything is done online, e.g. we shop, bank, and even find dates through the Internet. Whereas once upon a time, businesses had rows upon rows of client files, the brilliant minds of software experts have made our lives easier by coming-up with facilities like cloud. The information can be accessed from anywhere through internet.

However, these innovative wonders are not foolproof as some important data may be lost. In the spirit of making database management as efficient as possible. Some of the most common challenges are discussed next.

- (a) **Scalability** - With the growing business, the database has to be scaled-up accordingly. The scaling-up may be vertically or horizontally depending on specific business needs of the business.
- (b) **Cyber security** - There is always room for improvement in security measures. Only allow access to employees who have an actual need to view the data. *Always* encrypt your information. Update your cyber security software on a regular basis. Do regular database health checks to see if you have to patch any vulnerability. There should be occasional surprise checks.
- (c) **Back-up the database** - The giants like Equifax and Yahoo have suffered major security breaches. Even small business may land into a similar situation. It results not only in the financial loss but also the loss of reputation or may even compel to close down your business. It necessitates back-up the data. Have duplicate copies of documents for storing at separate places which will help in smooth running of business.
- (d) **Speed** - The computer systems should be optimized with proper indexing. If required, the bandwidth should be increased. The regular database health checks should be treated mandatory.
- (e) **Integration** - Maybe a fortnight and some time ago, your database management was pretty simple, but as you scaled your databases, new complexities emerged, and now you're stumped as to how to modify your DBM accordingly. If you provide omni-channel services, now you also have to integrate data from all of your many sources. You can do so with software specifically designed for this purpose.

## V DATABASE MANAGEMENT IN BANKS: EMERGING TRENDS

Banks and financial services institutions are the engine of 21<sup>st</sup> century economies and data is undoubtedly the fuel of this engine. With the revolution of digital transformation over the past decade, banks have been generating more and more diverse data than ever before. Businesses of every shape and size are being impacted by the forces of an ongoing global digital transformation. According to the April 2017 *McKinsey & Company* report, Analytics in banking: Time to realize the value, "by 2020, about 1.7 megabytes a second of new information will be created for every human being on the planet."

With this explosion of data availability, there are several challenges that banks must address e.g. rising data volumes, data pervasiveness and user demands for data- in order to become the data-driven enterprises they need to be. Banks are swamped with data on customers, from financial transactions, customer purchase histories, marketing campaigns, social media streams, third-party sources, text messages and more. As data continues to explode, several data management technologies are developed to help companies achieve improved organizational consistency, increased productivity, greater collaboration & communication and lastly but not the least, applicability of data in faster, more knowledgeable business decisions.

Some of the technologies which are shaping the way we handle the data onslaught are given next:

- (a) **Big Data [5, 6]** - Big data in finance refers to the petabytes of structured and unstructured data that can be used to anticipate customer behaviors and create strategies for banks and financial institutions. Data is generated from various sources and gets categorized as structured and unstructured. Structured data is information managed within an organization in order to provide key decision-making insights. Unstructured data exists in multiple sources in increasing volumes and offers significant analytical opportunities. Big data analytics can help companies take very informed decisions, no matter how big or small the decision is. Banks and financial institutions today are making the best use of the data they possess so that they can improve their levels of services to their customers. They are taking steps in this direction so that fraud can be detected and prevented. Some of the salient benefits of using big data by financial and banking institutions are given below (**Sources:**

- (i) **Optimized and Enhanced Risk**

**Management:** Big Data can effectively improve the ways companies' use predictive modeling in the field of risk management. Banks utilize business intelligence tools to identify potential risks related to lending money and proactively detect fraud. Big data analytics also assists banks in evaluating market trends and position them to take informed decision of offering competitive interest rates to their clients.

- (ii) **Personalization of Banking Solutions:**

Clients today do not appreciate the traditional one-size-fits-all approach to banking. Banks needs to understand their needs and present sensible solutions. Insights from big data analytics can help marketers to identify the type of products customers already have and what they would possibly want. Based on this information, they can provide tailored services and products to their clients and stop losing them to their competitors.

**(iii) Employees Engagement:** One of the biggest benefits of employing big data in banking is employee engagement. Big data solutions if implemented properly can help them track analyze and share metrics that relate to employee performance. Big Data tools enable company to measure team spirit, collaborations, morale, and individual performance enabling them to streamline the work process.

**(b) Autonomous Databases** - Emerging technologies and automation permeate every aspect of our work and lives. The opportunity of these technologies which include Artificial Intelligence (AI), Machine Learning (ML), Internet of Things and human interfaces – is to enable us to embrace innovation on a scale never seen before. From self-driven cars to personalized medicine to precision agriculture and smart cities, technologies are changing the way we experience our world. Autonomous opens a new world of opportunities for enterprises. It allows them to move from operations to innovation. It enables new ways to develop and deliver apps and services. Enterprise can harness the abundance of data to gain predictive insights into their businesses and ultimately drive better outcomes for their customers.

Relational databases have made tremendous improvements in performance, availability and security over the past couple of decades. They can run up to 100 times faster, can be configured for zero data loss and have hardened security capabilities that can protect against malicious internal and external threats. So, what's missing? The degree of manual intervention required to manage today's cloud databases and all these attributes inhibits true "Database as a Service (DbaaS)". As a result, enterprises are unable to truly realize the full operational and financial benefits of the cloud.

Autonomous databases leverages AI and machine learning to provide full, end-to-end automation for provisioning, security, updates, availability, performance, change management, and error prevention for a database offering and covers mainly these characteristics: self-driving, self-securing and self – repairing.

**(c) AI-enabled Data Management [8]** - In today's data guzzling world, data management systems and AI technologies have become synergistic in nature and go hand in hand. Data management systems when coupled with AI capabilities has enormous potential to impact an entire data value chain. **AI-enabled data management** helps in automating repetitive and complex tasks. It improves the performance, accuracy, and productivity in an enterprise.

More than 80% of time is spent by data scientist on manual data preparation, feature engineering, and model selection. Large amount of time spent on manual data management task can be saved by augmenting data management system with AI/ML capabilities. AI processes when implemented across the whole data value chain enables organizations to automate data preparation process, key aspects of data science and implement ML/AI modelling techniques and narrate relevant insights for customers using NLP and conversational analytics. As data continues to grow, there is more than ever need to collect, index and analyze as much data in real-time. Hence, leveraging continuous data streams from disparate sources using AI driven solution allows the companies to continuously gather insightful information for their businesses and helps widen their revenue and bottom line.

## VI CONCLUSION

Data Management Systems have emerged as very important tool for banking sector and financial institutions. The chronological development of DMS is presented. The challenges associated with DMS and future trends have been discussed. The economic impact of COVID-19 may have some similarities to the 2007–09 financial crises. However, the implications for financial firms' performance are likely to be different and hence its impact needs to be analyzed in banking sector for corrective measures, as required.

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# An Overview of Wind Power Development in India

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## ABSTRACT

Climate change has become one of the biggest challenges of the global environment which is primarily caused by the emission of green house gases due to the burning of fossil fuels. It has compelled the world to explore renewable sources of energy for power generation which are environment friendly. Wind resource is one of the major renewable energy resources besides solar resource. The paper gives an overview of the wind power development in India including basic principle and technology. The policy and service supports are briefly explained. The trend for optimum use of location specific wind resource in the form of repowering, wind-solar hybrid and off-shore projects is also discussed.

**Keywords:** Wind resource, power curve, wind power consultancy, wind power directory, repowering, wind-solar hybrid power, offshore wind power

## I INTRODUCTION

Due to rapid depletion of fossil fuel and the challenge of climate change, whole world is looking for environment friendly clean sources of Renewable Energy. Among various renewable energy sources, wind energy has been emerged as one of the most promising option for generation of electricity. For many centuries, globally, wind energy has been used for water lifting and grinding purposes but for its utilization towards generation of electricity started somewhere in the mid-20<sup>th</sup> century.

$$P \text{ (Watts)} = \frac{1}{2} \rho A V^3$$

where,

$\rho$  = air density, 1.225/m<sup>3</sup>

A = swept area of turbine rotor, m<sup>2</sup>

V = wind speed, m/s

## II WIND POWER DEVELOPMENT

Air in motion is wind. Kinetic energy available in wind is converted in to mechanical energy and then electrical energy using a wind machine which is called wind turbine generator or wind electric generator or wind energy conversion device.

(a) **Wind turbine output** - The kinetic energy of wind is utilized rotating the turbine shaft. The output of wind turbine (P) is given by the following equation.

... (1)

A German physicist Albert Betz mathematically proved that no wind turbine can convert more than 59.3% of the kinetic energy of the wind into mechanical energy for turning a rotor.

(b) **Main parts of wind turbine** - The main parts of a turbine are shown in Figure 1.

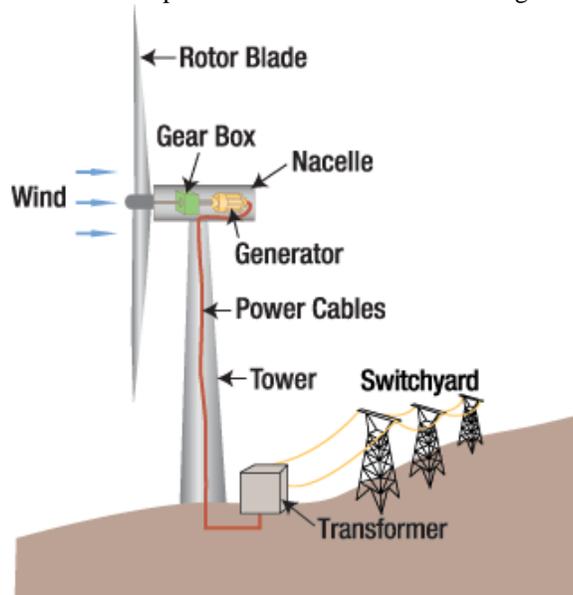
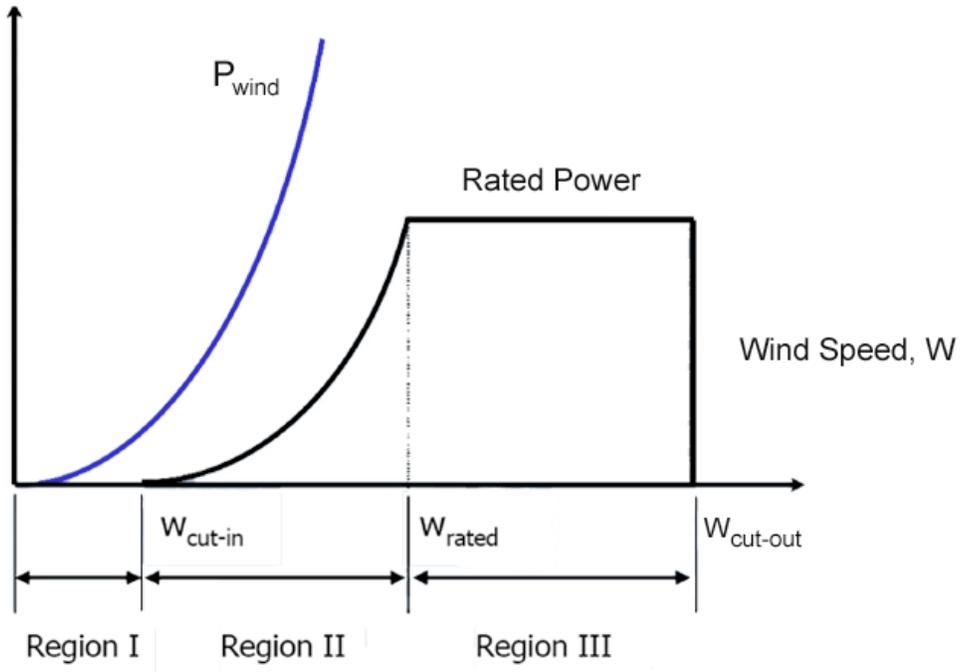


Fig. 1 Main parts of the horizontal axis wind turbine [1]

(c) **Power curve** - The power curve of a wind turbine drawn between wind speed (X-axis) and turbine output (Y-axis) is shown in Figure 2 along with wind power curve. In the region-I up to cut-in speed there is no power generation. With the increase in wind speed, turbine power

also increases up to rated turbine output in region II. However, the turbine output is maintained constant in region III by regulating the pitch of the turbine blades. In case of stall regulated turbine, the output is restricted by the profile of the rotor blades.



**Fig. 2 Power curve of a wind turbine [2]**

The wind turbines, access road, internal roads, crane platform can be seen in a wind farm located in CQ Australia. Refer Figure 3.



**Fig. 3 Wind farm view [3]**

**(d) Advantages of the Wind Power Project -**

Following are the major advantages of wind power projects :

- (i) The technology of electricity generation from wind has been developed fully for smooth and trouble-free operation as well as for its economic viability.
- (ii) It is pollution free and eco-friendly.
- (iii) Low gestation period—less than six months from concept to commissioning, enabling fast bridging of power gap even in remote areas.
- (iv) With no fuel consumption, power generation becomes almost free after recovery of capital cost. O&M, cost is nominal.
- (v) It can be developed in modular form with facilities for extension at a later date.

**(e) Limitations of the Wind Power Project -**

Following are the major limitations of wind power projects :

- (i) Adequate wind is not available at all the places. It is very much site specific
- (ii) Wind is variable in nature and so is the output from wind electric generator
- (iii) Wind alone cannot give firm power

- (i) Availability of adequate wind resources for viability
- (ii) Availability of land
- (iii) Availability of strong grid in view of the variable power evacuation
- (iv) Availability of appropriate logistics

**(b) Policy initiatives by the Government -** An independent ministry named New and Renewable Energy, dedicated to the wind power development was formed. Government of India has formed an independent ministry for renewable energy called Ministry of New & Renewable Energy (MNRE). MNRE has been formulating policies/guidelines for development of wind power projects in India. MNRE created a financing wing for renewable energy projects named Indian Renewable Energy Development Agency (IREDA).

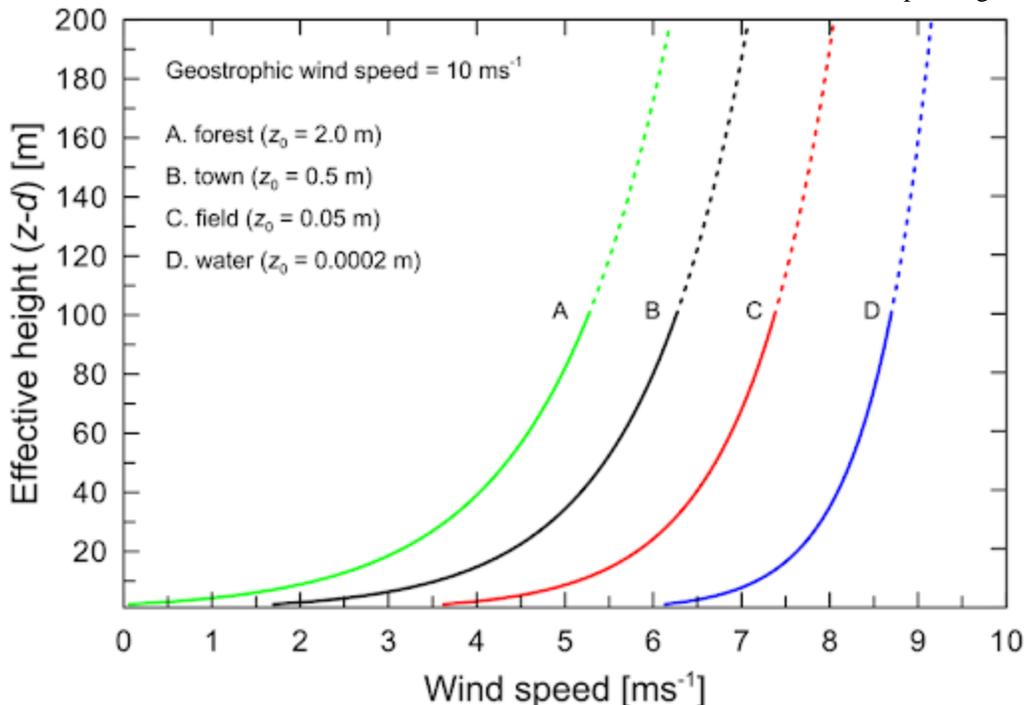
MNRE has also formed a research & Development organization for wind power projects named National Institute for Wind Energy (NIWE) formerly known as Centre for Wind Energy Technology (C-WET) as technical arm of MNRE for Wind Power. There are State Nodal Agencies to promote renewable energy program in their states through state governments working in coordination with MNRE.

### III WIND POWER DEVELOPMENT

**(a) Essentials for Establishment -** Following are the essential requirements of establishment of wind power projects:

**(c) Wind Resource and Wind Power Potential -**

It is seen from equation (1) that wind turbine output varies as a cube of the wind speed. The wind speed increases with the height above ground as can be seen in Figure 4. Hence, the trend has been to install the turbine at a higher elevation to maximize the power generation.



**Fig. 4 Variation in wind speed with height [4]**

The wind resource is variable by nature as it varies from place to place and time to time. Hence, selection of site is governed by the available wind resource. Thus, wind resource assessment at probable site becomes the starting point for installation of wind turbines in a wind farm. Wind resource assessment is the process of estimation of power generation which provides the basis to the wind farm developers to take appropriate decision.

To estimate the energy yield of a wind farm, the wind resource measurement at probable site is the first step. The data at 10 minutes interval are recorded for minimum period of 1 year and to work out an annually representative wind speed frequency distribution.

In India wind monitoring at government level has been done initially by the Indian Institute of Tropical Meteorology, Bangalore and subsequently by the

National Institute of Wind Energy (NIWE). Some private developers have also started wind resource measurement on their own. As on 31<sup>st</sup> March 2020, wind masts were erected at 914 locations, out of which 249 locations have shown minimum wind power density of 200 W/m<sup>2</sup> at 50 m height. In order to maximise the generation, the trend is for higher rating, higher rotor diameter and higher hub height based on advanced technology. In view of this, the wind mast heights have also been increasing. Accordingly, the tallest wind mast installed in India is 150 m high.

Generally for flat terrain, an area within 10 km radius of the wind mast is considered under the influence zone of the mast. However, for complex terrain, this may get reduced.

The estimated wind power potential at different heights above ground level is given in Table 1.

**Table 1**  
**Estimated wind power potential in India [5]**

Height (magl)	Estimated Wind Power Potential
50 m	49,130 MW
80 m	1,02,788 MW
100 m	3,02,252 MW
120 m	6,95,509 MW

**(d) Installed Wind Power Capacity** - The installed wind power capacity of wind power projects in India as on 31.1.2021 is 38,684 MW. The

installed wind power capacity in the leading states in India as on 31<sup>st</sup> January 2021 is given in Table 2.

**Table 2**  
**Installed wind power capacity in India [6]**

Rank	Country	Capacity (MW)
1.	Tamil Nadu	9428 MW
2.	Gujarat	8245 MW
3.	Maharashtra	5000 MW
4.	Karnataka	4872 MW
5.	Rajasthan	4327 MW

**(e) Manufacturing and Services** - In India Wind power development started by installation of the demonstration projects by the Government of India. The wind turbines ranging from 55 kW to 3000 kW of different makes have been installed.

National Institute of wind Energy (NIWE) under MNRE updates and issues the revised list of Models and Manufacturers (RLMM) of WEGs having valid Type Certificates from recognized international testing agency. However, now RLMM list is issued directly by MNRE. In India WEG manufacturers have established manufacturing plants. Currently there are more than 15 WEG Manufacturers with manufacturing capacity of about 8000 MW of wind

turbines and associated equipment/systems. They have established technology to manufacture from units 225 kW to 3000 kW rating. There are ancillaries and component/spares suppliers for the WEGs. There are also service providers like WEG transportation, erection, civil works, electrical works, wind resource assessment, operation & maintenance, repairs, liaisoning, scheduling & forecasting, consultants etc.

As per the available information there are more than 35,000 WEGs belonging to more than 5300 parties of different make ranging from 55 kW to 3000 kW.

## IV OPTIMUM UTILIZATION OF WIND RESOURCE

MNRE has taken initiatives for making optimum use of wind resource by issuing the policies for repowering of the existing old wind farms, wind-solar hybrid power projects and offshore wind power development. These are discussed next.

**(a) Repowering of Wind Farms** - Repowering means replacing old turbines with fewer, larger and taller modern turbines which are more efficient and can generate more energy. MNRE issued a new policy for repowering of wind farms in August 2016.

The objective of the Repowering policy is to endeavour for optimum utilization of wind energy resources. Most of the wind-turbines installed up to the year 2000 have capacity up to 500 kW and are installed at sites which have high wind resource. It is estimated that over 3,000 MW capacity installations are eligible for repowering.

For repowering, Indian Renewable Energy Development Agency (IREDA) provides an additional rebate of 0.25% on interest applicable for the new wind power projects.

In Coimbatore, Tamil Nadu a repowering project Phase-I was completed in which 10 turbines totalling 3.4 MW were replaced by 4 large turbines of the same total capacity. However, due to advanced technology and higher CUF, the generation is estimated to increase by over 1.5 times.

**(b) Wind-solar Hybrid Power Projects** - In order to optimize the wind and solar resources, MNRE issued policy in May 2018 for not only the new wind-solar hybrid plants but also for encouraging hybridization of existing wind and solar plants.

The solar and wind power being variable in nature which poses challenges on grid stability. The solar and wind resources are complementary to each other and their hybridization would minimize the variability apart from optimal utilization of the infrastructure including land and transmission system and also O&M man power. The existing wind farms generally have possibility of installing solar PV plants and similarly there may be wind power potential in the existing solar PV power plants.

The energy storage may also be provided to the project to reduce the variability of output power from wind solar hybrid power project and also ensuring supply of the firm power for a committed period.

Some hybrid power projects are under execution in India. A hybridisation of existing 50 MW wind (existing) and 28.8 MW solar PV project was

commissioned in Raichur District in Karnataka in 2018.

**(c) Offshore Wind Power** - India has a 7,600 km of coastline. The coasts of Gujarat and Tamil Nadu have potential to be exploited for the development of offshore wind power.

The National Institute of Wind Energy (NIWE) invited leading offshore wind technology suppliers for technical discussion. After this, knowledge building and activities related to offshore wind development and advance investigations initiated through two projects viz. FOWIND (2013-18) and FOWPI (2016-19). The national offshore wind policy was issued in 2015 to create interest in developers and investors.

More studies and analysis will be required to identify bankable offshore wind sites. It is learnt that India has established inter-governmental cooperation and bilateral agreements with the European countries to share their experiences in the development of offshore wind forms. A bilateral agreement signed with Denmark.

The Indian government is looking into setting up structures for power purchase agreements as well as offshore wind auctions. The cost will be high for the first offshore project hence, in order to lower the cost, it would be necessary to provide some Viability Gap Funding.

## V CONSULTANCY SERVICES

There are several wind energy consultancy organizations in India such as National Institute of Wind Energy, TERI, CECL, DNV, MITCON etc. The services offered include site Identification, Wind Resource Assessment, Micro-siting, Energy estimation, Validation, Feasibility studies, Detailed Project Report preparation, Design and Engineering, etc.

**(a) National Institute of Wind Energy** - The NIWE was established in Chennai in 1998 as an R&D institution by the MNRE then MNES. It was converted into an autonomous institution. A Wind Turbine Test Station with technical and partial financial support from Danish International Development Agency (DANIDA), Government of Denmark, was established at Kayathar, Thoothukudi District, Tamil Nadu, as an integral part of NIWE. Main functions are: [7]

- (i) Assesses and analyses wind resources and preparation wind maps/atlas
- (ii) Develops standards, guidelines, procedures, protocols for design, testing and certification
- (iii) Accords type approval/type certification
- (iv) Consultancy services to the customers.

- (v) Wind Turbine Testing including Power performance/load/power quality measurements,
- (vi) Safety and functional tests yaw efficiency test and also the user defined measurements.
- (vii) Standards and certification
- (viii) Wind Power Forecasting Services
- (ix) Training to National, international participants, customised training

- (b) **Consolidated Energy Consultants Limited - CECL, Bhopal** needs special mention. CECL has been offering the concept to commissioning consultancy services in wind energy for 35 years. However, there are certain unique features associated with CECL as given below: [5]
- (i) Pioneer: One of the pioneer consultants in Wind Energy Sector in the country.
  - (ii) CECL is the first and so far only company to take initiative of making a joint sector

company - MP Wind farms Ltd. (MPWL) along with state government and central government for acting as single window agency for development, operation and maintenance of wind farm on behalf of many small investors. MPWL established a wind farm project at Jamgodrani, Dewas, Madhya Pradesh.

- (iii) CECL has been annually publishing Directory Indian Wind Power ever since 2001. It is the only document which provides comprehensive and authentic information and data bank pertaining to wind power in India. It is very useful not only for the investors, developers, planners, consultants etc. but also to the researchers.
- (iv) Besides having internationally acclaimed softwares, CECL has developed on its own a number of softwares to ensure grid compatibility and financial viability.

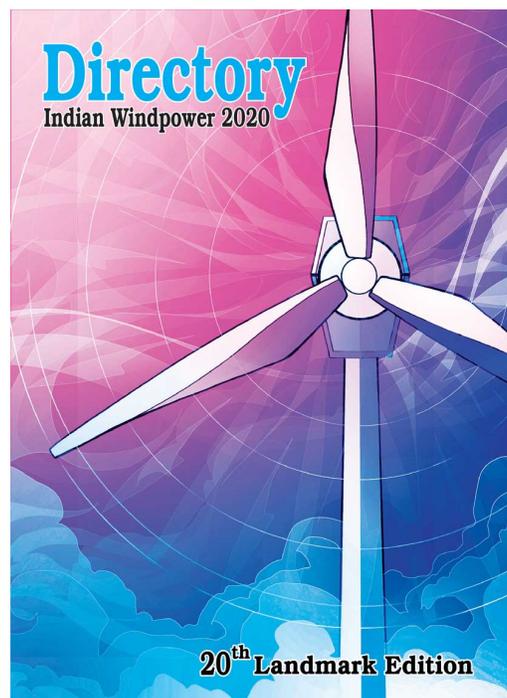


Fig. 5 Directory Indian Wind power [5]

## VI CONCLUSION

The renewable sources of energy, mainly solar and wind have emerged as the leaders in fighting against the challenges imposed by the climate change. The conversion of wind energy into electrical energy, wind resource assessment, installed wind power capacity; various services from concept to commissioning have been discussed. An overview of the initiatives taken to make optimum utilization of wind resources in the form of repowering, wind-solar hybrid and offshore wind power development have been covered.

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# BHEL Overcame Unprecedented Challenges in Hydropower Project in Azerbaijan

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## ABSTRACT

*Mingeaur Hydro Project was the first export order in CIS (Commonwealth of Independent States) Countries won by BHEL in October 1999 against stiff global competition. The paper narrates the various challenges faced and resolved due to hostile customer, communication due to language, multiple transshipments during transportation, very tight project execution schedule. It is an interesting story of transformation of a hostile customer into a very supportive as a result of BHEL's positive attitude and professional skills in executing such a challenging export contract.*

**Keywords:** Mingeaur Dam, Challenges in hydro power project, retrofitting in hydro power house.

## I INTRODUCTION

The Mingeaurhydropower plant in Azerbaijan (Formerly a part of USSR), was originally commissioned in 1953, and a modernization project was completed in 2018. The project located about 300 km from the capital Baku is near Mingeaur city is the largest hydroelectric generation facility in the country. There is 260 feet high, 5,090-ft-long earth-fill embankment dam impounding Kura River creating reservoir. The active storage capacity of the Mingeaur dam is 7.3 million acre-feet.

Mingeaur Hydro Project was the first export order in CIS Countries won by BHEL in October 1999 against stiff global competition with international companies like ABB, Electrosila etc. The customer is a government company named Azerenergy. From tender stage itself, customer was pro M/s Electrosila, Russia and BHEL had won this contract which made customer very hostile and non-cooperative. Project is located near Mingeaur city which is about 300 km from Baku, the capital of Azerbaijan.

Mingeaur Hydro Electric plant was originally commissioned with six units of 60 MW each. After collapse of Soviet Union, Azerbaijan came on the world map as a sovereign country. The newly formed nation was not financially stable and they were upgrading the generating units of Mingeaur Hydro Power Project one by one through loans from European Bank and World Bank. In the first stage, customer had replaced hydro turbines of all the six units by M/s LMZ, Russia make. Subsequently, hydro generator & Auxiliaries of five units were replaced by M/s Electrosila, Russia make. For remaining one unit (Unit no. 4), the customer invited global tender as per the pre-condition of lending agency EBRD (European bank). Although, customer was keen to place the order on M/s Electrosila, the contract was won by BHEL and the customer was compelled to place order on BHEL.

The author was deputed as the Project Manager on behalf of BHEL for Mingeaur Hydro Project. The author shares his experiences on major challenges faced and how they were overcome during execution of the contract.

The Figure 1 shows an overview of the project in which penstocks, surge shafts, power house, tail race can be seen.



**Fig. 1: Mingechaur hydropower project [1]**

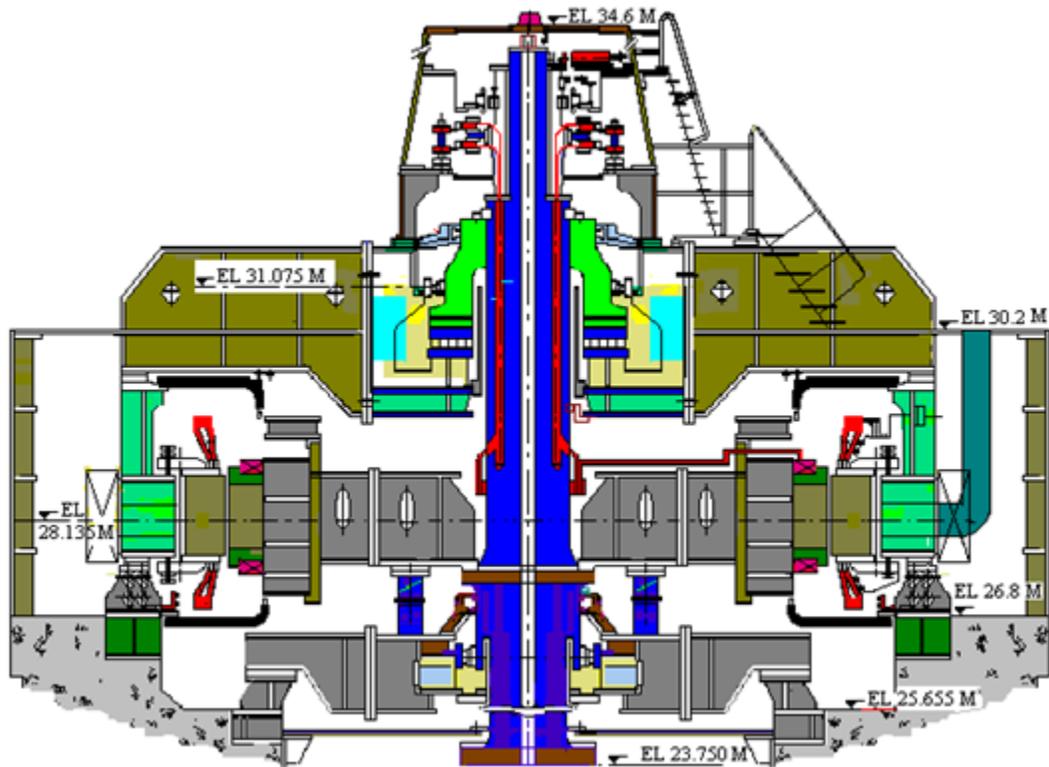
## **II BHEL's SCOPE OF WORK**

The generating units of the hydropower projects depend basically on the hydraulic parameters, mainly head and discharge of the site. It makes each site unique resulting in tailor made design of turbines, and generators etc. and the station layout. In fact, the transport limitations (weight and dimensions) vary from site to site and compel to design the large assemblies in number of segments or even

manufacturing and /or assembly at site. The design of hydro generators basically depends on the turbine data and the requirement of governing system to contain speed rise and pressure rise. The brief specifications of the generator supplied by BHEL to match with the M/s LMZ make vertical axis Francis turbine with a rated speed of 150rpm are as given below:

Generator rated output	70 MW (78.2 MVA), 13.8 kV, 50 Hz, 0.9-lag
No. of stator segments	4
Bearing arrangement	Suspended (thrust bearing above rotor)
Thrust bearing	Spring mattress type with babbitt lining
Excitation system	Static
Weights	
Stator assembly	180 T
Rotor assembly	200 T (Lifting by 2 cranes in tandem)
Total Generator weight	600 T

Figure 2 shows the general arrangement of generator and the scope of BHEL's work could be visualized.



**Fig. 2: Sectional arrangement of hydro generator**

BHEL's scope of work involved the dismantling of existing hydro generator and associated auxiliaries viz. control panels, bus ducts, fire fighting system, generator circuit breaker, earthing switches, cabling etc.

Retrofitting the new 70 MW hydro generator and auxiliary equipment in existing foundation and space as below:

- (a) Hydro Generator
- (b) Static Excitation System
- (c) Synchronizing equipment
- (d) 13.8 kV equipment: NG Equipment, Lighting Arrester, Surge Capacitor, Earthing Switches, CTs, PTs etc.
- (e) Generator Protection Panel
- (f) Unit Control Board

- (g) Bus Ducts
- (h) SF6 generator circuit breaker (M/s ABB, Switzerland make)

Time frame for design of new uprated equipment, manufacturing, transportation, dismantling of existing equipment, erection of new equipment, commissioning and completion of trial run within 18 months from the date of award of contract.

Specially, for hydro generator, it became an uphill task while working in a foreign land with language problem, extreme cold climatic conditions and so on.

Figure 3 shows one old unit with rotating excitation system whereas the others are the replaced new ones with static excitation system.



**Fig. 3 View of power house with one old and other new generating units**

### III CHALLENGES

- (a) **Hostile customer** - Azerbaijan, being a part of former USSR, customer was well conversant with Russian technology and moreover first five generating units were replaced by M/s Electrosila, Russia, hence advantage of similar machine and spare parts was affected.
- (b) **Non availability of basic inputs** - The new equipment was to be retrofitted in the existing foundation, pit and space for which drawings were not available (or not provided) to BHEL. It multiplied the design challenge for BHEL. The only way-out was the reverse engineering. Hence, various measurements were taken and some innovative concepts were applied to facilitate proper assembly of new equipment to match with the existing foundation and turbine.

- (c) **Language constraints** - Not even a single person from customer side was able to communicate in English. All verbal discussions and communication were through interpreter and it was difficult to get an expert interpreter for specialised technical communication. All the correspondence, drawings, documents and manuals were to be submitted to the customer, both in English and Russian languages.
- (d) **Very tight time-frame**- The schedule for completion of contract including design, manufacture, transportation, dismantling of old equipment, erection, commissioning and handing over after trial runs of new equipment *within 18 months* imposed a major challenge.
- (e) **Multiple transshipments** - The transportation of Equipment from Bhopal to Azerbaijan site is shown in Figure 4.



**Fig. 4: Transportation route showing transshipments locations**

Each stage involved loading and unloading of heavy equipment. The multiple transshipment involved risk of damage of critical items, more time consuming at a higher cost and very complex coordination with several agencies in different countries.

- (f) **Custom Clearance** - The custom clearance of equipment was included in BHEL scope on a specific request by customer. For this, Baku

based custom clearance agency was engaged. Custom clearance activity was to be done at Iran, Azerbaijan and finally at custom clearance office near the site. The custom clearance was to be completed within 24 hours for each trailer. It necessitated very close and dynamic coordination and rapport with transporter and custom clearance agencies.

#### IV PROBLEMS AND RESOLUTION

- (a) **Damages during transportation** - The wound Stator assembly was in four segments. Each segment weighing 50 tonnes was transported on a separate trailer. Incidentally, 3 segments toppled from trailer while negotiating sharp

turning during road transportation. A wound stator segment consists of steel Stator Frame, laminated steel core, and winding. Two stator segments toppled in India were brought back to the BHEL, Bhopal for necessary repair and replacement, as required. The stator segment under repair at site is shown in Figure 5.



**Fig. 5 Repair of stator winding segment at site**

One segment that toppled down in Iran and was brought to site by transporter was a major challenge. The customer was very annoyed and asked BHEL to take back the segment to BHEL works, Bhopal. Transportation time of one segment, to and fro was four months at a cost of US\$ 1,00,000. It was a herculean task but BHEL finally succeeded in convincing the customer for agreeing for repair at site itself. Finally, after arranging additional materials and skilled manpower, the segment was successfully repaired and tested at site which resulted in saving of crucial time and money.

- (b) **Coupling of Turbine and Generator Shaft** - Turbine was supplied by M/s LMZ, Russia. The turbine shaft and generator shaft were to be coupled through number of coupling bolts with very tight tolerance. It imposed severe challenge in absence of a common drill jig to achieve required accuracy. To overcome this problem, an innovative technology had to be evolved in collaboration with M/s LMZ. The coupling bolts were manufactured to the size of existing turbine shaft and generator shaft coupling holes of bigger size. The circular gap was filled with special epoxy material. This process was fast and well suited at site.



**Fig. 6 lowering of the rotor assembly**

- (c) **Jamming of the Dam Gate** - After completion of installation of generator and other auxiliaries, it was ready for spinning. However, due to the prolonged shutdown, the Dam Gate (same as penstock gate) were closed for a long period resulting in jamming of the gates. Since the gates could not be opened, special divers were arranged by the customer for opening of these gates. This delayed the spinning by a week.
- (d) **Dry out of stator winding** - The dry out took 14 days since stator windings were drenched in water during sea transportation from Mumbai to Iran. It was necessary to achieve the required insulation resistance and polarization index by dry out before conducting the destructive high voltage test. It was not possible to dry the stator winding by external heating. Hence, heating of winding insulation was done by building-up the voltage and flowing the current in the short circuited stator winding. The temperature of the stator winding was maintained at 90-100° C. It took 14 days running of unit to dry out completely and finally HV test was successfully conducted.
- (e) **Damage of Thrust Bearing Pads** - The thrust bearings are designed to withstand the load of rotating parts of turbine and generating besides the hydraulic thrust which are transferred to the generator foundation. The total load on thrust bearing was 800 tonnes. It is a pre-requisite to have levelling, surface matching, aligning within tight permissible limits besides freedom of bearing oil from foreign materials. After completion of the pre-commissioning activities, unit was loaded in steps of 10 MW. As load

increased, vertical load on thrust bearing also increased and thrust pads got damaged. All Thrust pads were dismantled and replaced by the spare set of 12 nos. thrust pads after bedding and blue matching of the bearing surfaces. This activity took 7 days. Subsequently, unit was commissioned followed by 72 hours successful trial run.

### **V WINNING CUSTOMER CONFIDENCE**

- (a) The customer was very hostile and non-cooperative since the very beginning. However, BHEL maintained positive attitude with due regard to customer, sincerity and hard work. Slowly customer realized BHEL's strength and appreciated the dedicated efforts.
- (b) During the course of execution, customer's confidence was fully built-up in BHEL.
- (c) Local media gave good coverage in news papers and television. There was paradigm shift in Customer's behaviour. They became so supportive that ABB make SF6 Circuit Breakers could be commissioned without the supplier. Similar was the case with Fire fighting Equipment which resulted in substantial reduction in time and cost. The customer also helped in procurement of bearing oil (14,000 litres) directly from factory at 1/4<sup>th</sup> of the market price.
- (d) After completion of work, a fresh order worth Rs. 4.0 Crores was placed on BHEL for supply and installation of bus-ducts,

earthing switches, cabling etc. for other units.

Figure 7 shows the inauguration of the unit jointly by the Ambassador of India and Mayor of Mingechaur.



**Fig. 7: Inauguration of the generating unit**

## V CONCLUSION

It was a happy and confidence boosting contract for BHEL. In spite of various challenges and problems faced, the generating unit was commissioned in April 2001 in a **record time of 18 months** from the date of award of contract with full satisfaction of customer. Innovative ideas and applying out of box solutions to overcome all the design and installation problems, was the key to the success. The customer was delighted and placed a new order for the supply of additional equipment worth Rs. 4 Crore. It was a landmark achievement to close the contract within a

month of commissioning which otherwise in some cases lingers on for years.

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# Thermal Power Projects: Past, Present and Future

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## ABSTRACT

*The commercial electric power generation started from coal based thermal and hydro in the 1880s. Today, not only the coal fired but diesel and gas based power generation technologies are well proven. However, emission of polluting green house gases emitted due to the burning of fossil fuels has become a matter of serious concern. This challenge is well accepted by the researchers which has resulted in the development of green power generation technologies. These technologies burn the fossil fuels more efficiently with lower emissions. This paper will discuss conventional as well as green power generation from coal in addition to the carbon capture technologies.*

**Keywords:** Subcritical boiler, supercritical boiler, IGCC, carbon capture

## I INTRODUCTION

A coal based thermal power plant converts the chemical energy of the coal into electrical energy. In 1884 Sir Charles Parsons built the first coal fired boiler (with a thermal efficiency of just 1.6%). The efficiency was improved by introducing the first condensing turbine coupled to the AC generator. The efforts continued and by the early 1900s, the capacity reached in the range of 1 MW to 10 MW by providing an economizer, evaporator, and a superheater in the boiler. By the 1910s, the coal-fired power plant cycle was improved even more by introducing turbines with steam extractions for feed

water heating and boilers with air preheaters which resulted in the increase in net boiler efficiency to about 15%.

In India, on 17 April 1899, the first thermal power plant of The Calcutta Electric Supply Corporation Limited was commissioned at Emambagh Lane. In 1902, the Calcutta Tramways Company switched to electric driven from horse-drawn carriages.

In 1947, the year of India's independence, total installed power capacity was 1363 MW with 855 MW share of thermal power. The installed thermal power capacity as on December 2020 is given in Table 1.

**Table 1**

**Installed thermal power capacity in India [1]**

Fuel	Capacity, MW
Coal	199864.5
Lignite	6260.0
Gas	24956.5
Diesel	509.7
Total	231590.7

The installed thermal power capacity given in Table 1 was 61.7% of the total capacity of 3,75,323 MW from all the sources of energy including renewables.

The performance of the boiler depends on the combustion of coal which depends on 3Ts i.e. temperature, time and turbulence. Ideally there should be complete combustion. The combustion improves with the increase in temperature, travel time

of the fuel particles and turbulence inside the boiler. Hence, the trend is to achieve complete combustion by operating at higher temperature. This has led to the development of supercritical boilers i.e. the boilers operating at a temperature and pressure above the critical point of water (221 bar and 374° C) as shown in Figure 1.

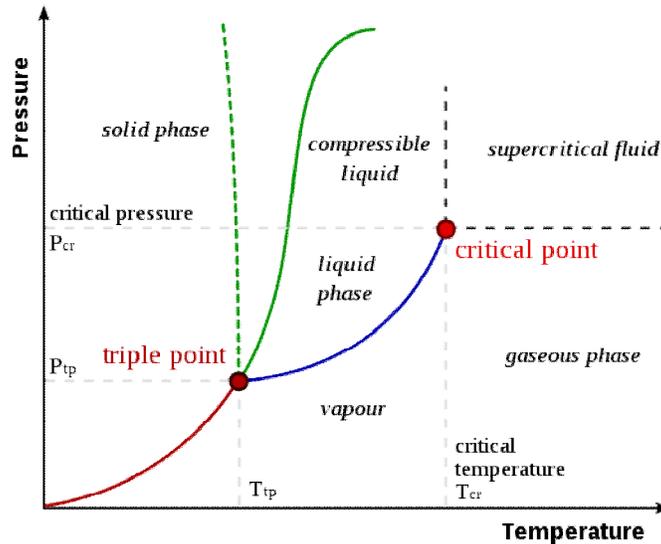


Fig. 1 Change of water phases with temperature and pressure [2]

Above critical point of water, the phase boundaries disappear. The classification of the boilers and

increase in efficiency with pressure and temperature are shown in Figure 2.

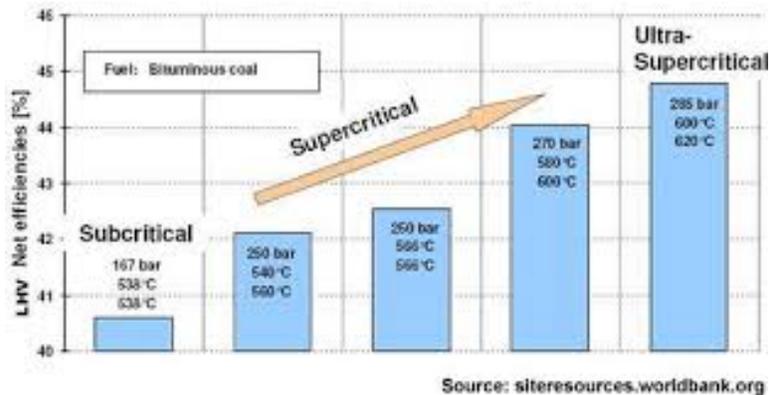


Fig. 2 Rise in efficiency thermal power plant with evolution of technologies [3]

- (a) **Largest unit capacity in India** - In supercritical boilers, the emission of gases is reduced and the efficiency is increased. In supercritical boilers 660 MW and 800 MW units are installed in several power plants. The first highest capacity 800 MW coal fired thermal power generating unit based on supercritical technology was commissioned in Mundra Power Plant, Gujarat by Tata Power in 2012.
- (b) **Largest unit capacity in the world** -The 6000 MW Dangjin Thermal Power Plant in South Korea has  $10 \times 500$  MW +  $2 \times 1020$  MW. The 1020 MW units are probably the largest unit capacity. The generation from this plant was 32,000 GWh in 2016.
- (c) **Generator capacity**-In India, the nominal frequency of the power grid is 50 Hz. The generating units in thermal power plants mostly have 2 poles synchronous generators which operate in synchronism with the grid at a nominal speed of 3000 rpm. However, actual speed of rotation at any instant depends on the grid frequency. In some countries including USA, Brazil etc., the power grid frequency is 60

Hz and hence power plant generated operate at a speed of 3600 rpm.

The output of a synchronous generator P is given by:  
 $P = K \times D^2 \times L \times N$   
 where

- K Output coefficient (electric loading, magnetic loading, etc.)
- D Internal diameter of the stator core
- L Stator core length
- N Speed of rotation

If the rotating speed N is constant, an increase of generator capacity can be attained by increasing the output coefficient K or the generator size ( $D^2 \times L$ ).

The capacity of generator can be increased up to 20% by improving the cooling of generator windings. However, while doing so, it will be necessary to take care of temperature and vibration level of each part to be within the permissible limits. The basis of design would be to increase the output coefficient by about 15% and restrict the size to about 3%. [4]

**(d) Cooling of generator winding** - During operation, the generators emit heat which has to be dissipated to enable the generators to operate at maximum efficiency. The higher temperatures of the windings reduce the life of insulation. The air is used as the cooling medium in smaller units, although, the technical advancements have resulted in the development of air-cooled generators up to 500 MVA. The large generators typically use hydrogen whereas very large capacity generators resort to water/hydrogen cooling of generator windings. [5]

In hydrogen cooled generator, the stator winding is indirectly cooled whereas the rotor winding is exposed and hence is directly cooled. Hydrogen has several advantages over air including high specific heat, very low viscosity, lower windage losses than air-cooled generators. The windage loss due to friction between the hydrogen and the rotor may account for 30-40% of the total generator losses.

Water-hydrogen is another variant of cooling in which stator winding is directly cooled by water flowing through the hollow conductors whereas the exposed surfaces of rotor winding are directly cooled by hydrogen.

Figure 3 shows the transition in generator capacity achieved mainly by cooling media.

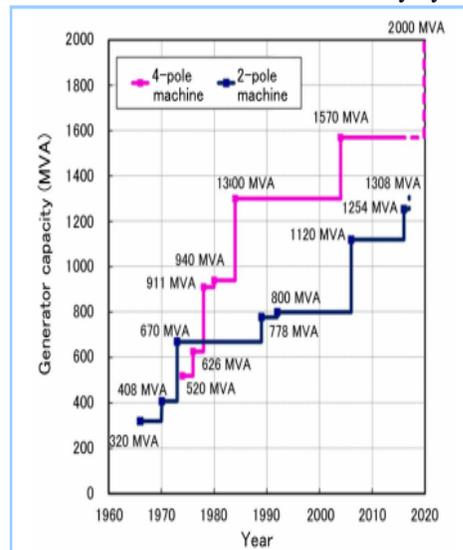


Fig.3 Transition of unit capacity of turbine-generator [4]

## II CONVENTIONAL POWER GENERATION

The fossil fuels are available in solid (coal), liquid (furnace oil, light diesel oil, Low sulphur heavy stock) and gaseous (natural gas, propane and butane) forms. Figure 4 shows a process diagram of a sub-

critical coal fired power plant having conventional sub-critical boiler which operate at a temperature and pressure below critical point as explained earlier. In sub-critical, there is a non-homogenous mixture of water and steam. Thus, two phases viz. liquid and gaseous phases co-exist.

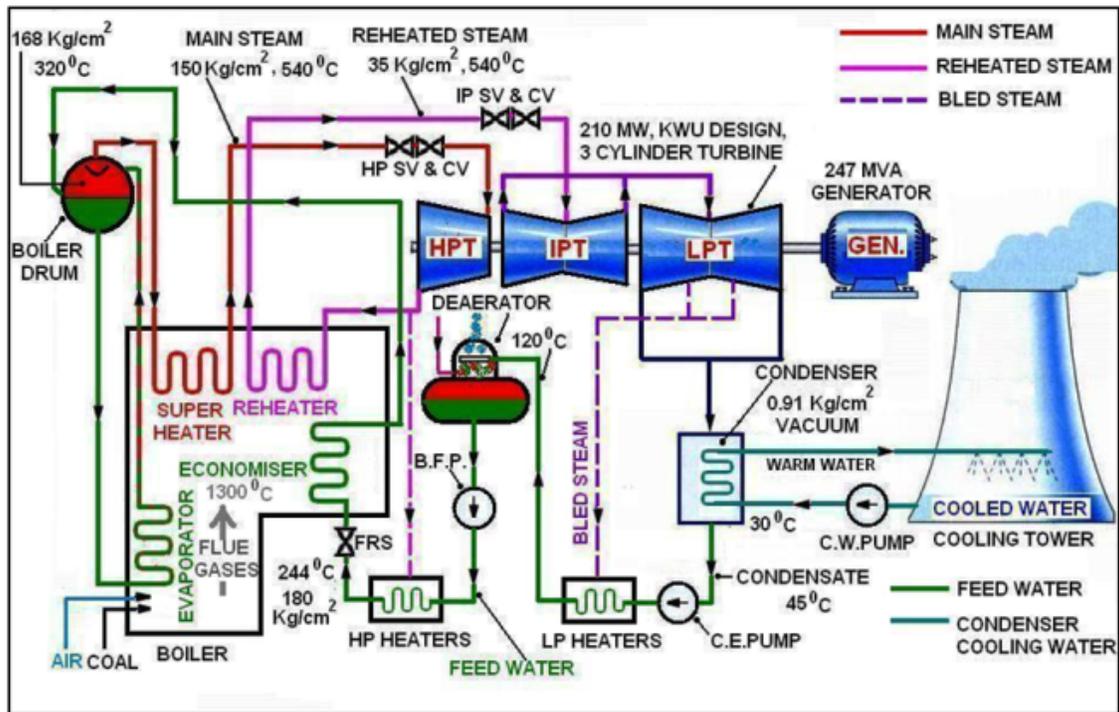


Fig.4 Process diagram of a sub-critical coal fired power plant [6]

(a) **Working of a power plant - Coal management:**  
 In a thermal power plant, coal is transported from coal mines to the power plant by railwagons or in a merry-go-round system. Coal is unloaded from the wagons to a moving underground conveyor belt. The coal from the mines is of non-uniform size. Weighing of coal is done and recorded at sending and receiving ends. Coal samples are taken from each wagon as per agreed procedure. The samples are tested for calorific value and ash content whose values determine the billing. This is main dispute between coal supplier and power stations. Continuous followup of coal goods racks is required to ensure timely supply.

The coal from mines carries stones also. The stones are removed manually by deploying dedicated labourers. The stones if get crushed with the coal, it damages coal mill balls and also reduces efficiency of boiler. It also harms boiler. The percentage of stones in coal is a major dispute between mine owners and power stations.

**Crusher:** The coal is taken to the Crusher and crushed to a size of say, 20 mm. The crushed coal is stored as below:

Dead storage generally 40 days coal supply

Live storage 8 hours coal supply in the coal bunker in the boiler house

**Coal pulverization:** The coal from the bunker is powdered (pulverized) to 200 mesh size.

**Coal combustion in boiler:** The powdered coal is blown into the boiler by pressurized hot air to create turbulence in the combustion zone of boiler. The coal-air mixture is burnt in the modern boilers by

tangential firing system i.e. the burner nozzles form tangential to a circle. The burning zone is called fire ball where the temperature is of the order of 1300°C.

**Water to steam:** The boiler consists of tubes hanging from the top. A closed cylindrical chamber is created by welding the adjacent tubes. Water pumped to the boiler tubes is converted into steam and supplied to the boiler drum.

**Boiler drum:** A boiler drum is provided for separating the steam from water before it is superheated for feeding into the H.P. turbine.

**Superheating:** The saturated steam from the boiler drum passes through the superheater for superheating.

**HP steam turbine:** The superheated steam from the superheater is supplied to the High Pressure Steam Turbine. The steam pressure is utilized to rotate the turbine.

**Re heater:** The steam from the outlet of HP turbine is wet. The wet steam is taken to the reheater installed inside of the boiler to dry and raise its temperature.

**Intermediate Pressure (IP) turbine:** After reheating, the steam is supplied to the IP turbine. In some designs, there is no IP turbine and the steam from reheater is supplied directly to the low pressure (LP) turbine.

**Low pressure turbine:** The steam from the LP turbine is sent to the condenser.

In a 500 MW turbine set, the sharing of power by HP, IP and LP turbines were found as below:[7]  
 $HP = 27.3\%$   $IP = 35.1\%$   $LP = 37.6\%$

**Condenser:** The steam is condensed back to water. The condensed water is collected in a hot well.

Water for boiler tubes: The water used for making steam is generally drawn from a river and is demineralized by chemical treatment to prolong the life of boiler tubes. It is quite costly and hence same water is reused in a closed loop. The steam from LP turbine flows to the condenser for cooling and then fed to the boiler. The lost water is compensated from demineralized water plant.

Feed water to the boiler: The water from condenser is again circulated in the boiler in a closed loop by a boiler feed pump.

Generator: The shafts of turbine and generator are coupled. The mechanical energy imparted by the turbine to generator. The generator converts mechanical energy into electrical energy.

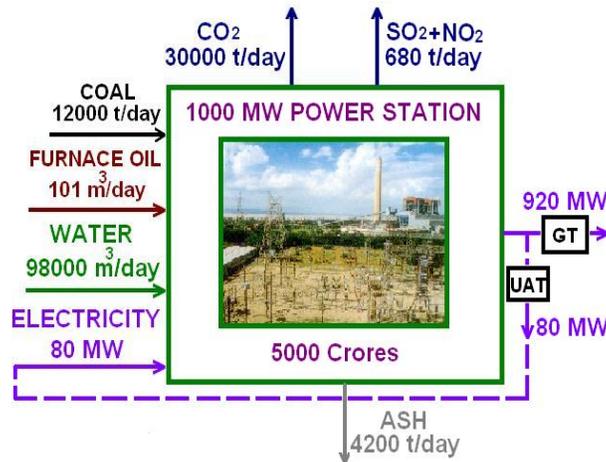


Fig.5 Inputs, outputs and byproducts of a 1000 MW coal power plant [6]

(b) **Cooling water system** - Due to environmental rules and regulations, majority of power plants adopt 'closed-cycle' cooling water system to conserve water. A typical recirculating cooling water system is shown in Figure 6. In this system, a separate stream of water is used to

cool and condense the steam coming out of the L.P. turbine. In this process, the cooling water coming out of condenser gets heated-up. The hot water is then sprayed into a cooling tower. Some of the hot water droplets evaporate out of the cooling tower into the atmosphere.

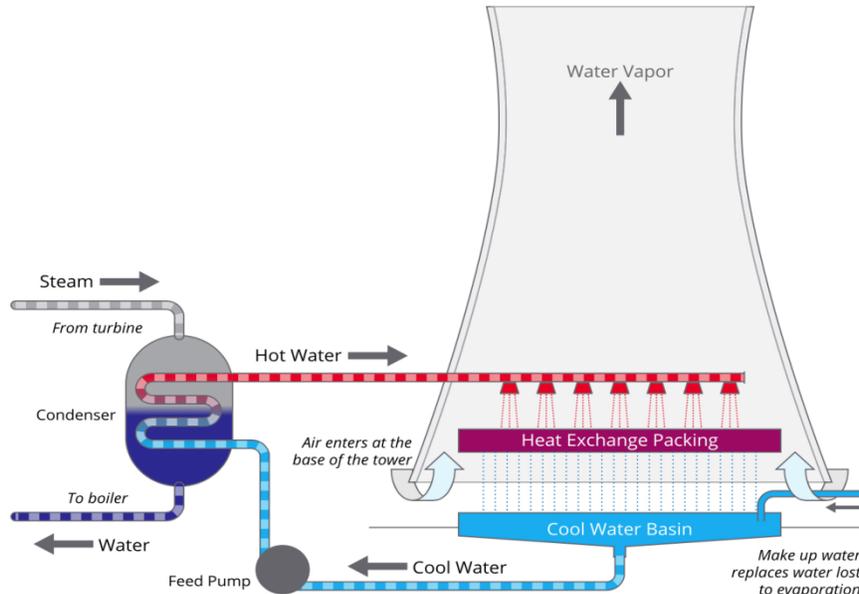


Fig.6 Typical cooling water system in a thermal power plant [8]

(c) **Ash handling system** - The ash handling system of a thermal power plant collects the ash and residues from select points, transport it to storage bins or silos, and prepare the ash for transport or disposal. The characteristics of ashes vary from the boiler to the environmental

equipment, the collection, transport and storage systems. Hence, separate systems are provided to suit the boiler and collection points. The bottom ash collection is done mostly in wet form whereas fly ash is invariably collected in dry form.

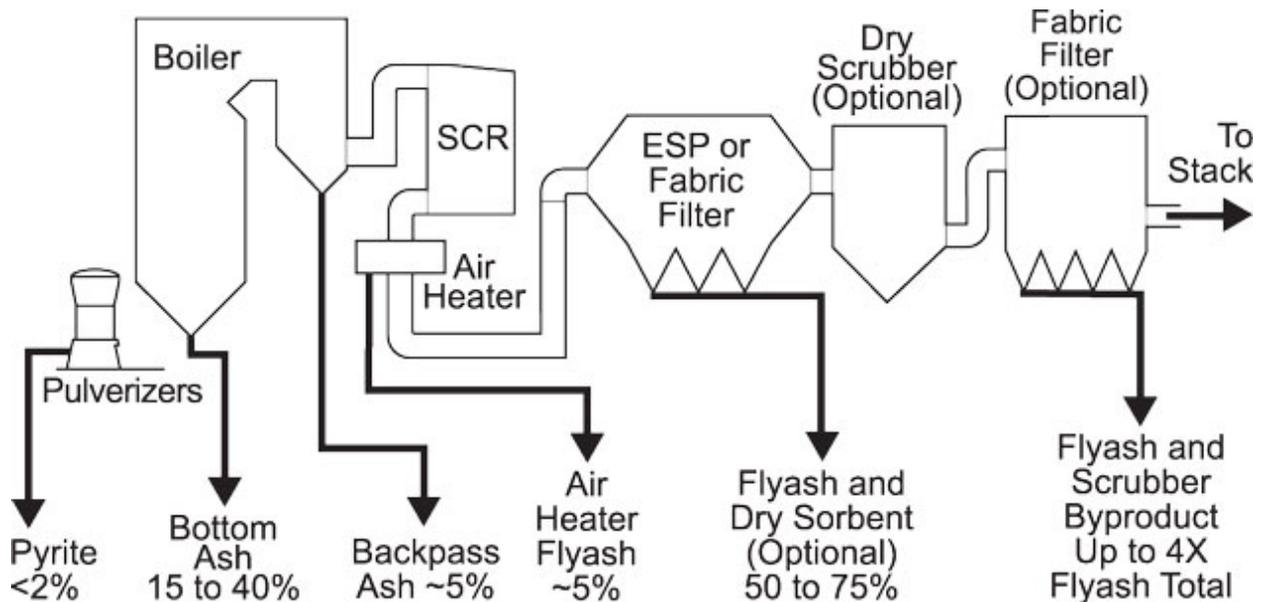


Fig. 7 Process flow diagram of ash handling system [9]

(d) **Bottom ash**-Bottom ash is generally conveyed in the form of wet slurry in which it flows and is delivered to either an ash pond or to a remote dewatering device. Alternatively, mechanical drag systems are used to convey bottom ash to the dewatering storage bin because they need less water and usually have a lower initial cost. Both systems are designed to handle ash at high temperatures of say 1300° C, requiring each system to have a quenching by water at the bottom ash hopper.

A recent development, the ash conveyor system handles the ash in dry condition. It means that this system operates without water for quenching and delivers a dry, lower carbon content material to the discharge end of conveyor. The rejects from the pulverizer are transported generally via bottom ash conveyance system.

(e) **Fly ash** - The fly ash consists of low density fine particles. Most of the ash from a pulverized coal-fired boiler is carried through the boiler and air heater by the flue gases. The **particulate control** device, such as a fabric filter or ESP carry 50% to 70% of the total ash generated by the combustion of pulverized coal. These devices have rows of collection hoppers that are emptied regularly by the **fly ash transportation system**. The temperature of fly ash is much lower than the bottom ash and it is mostly transported pneumatically as dry ash only. The pneumatic transport systems are vacuum,

pressure, combination of vacuum/pressure or dense phase type.

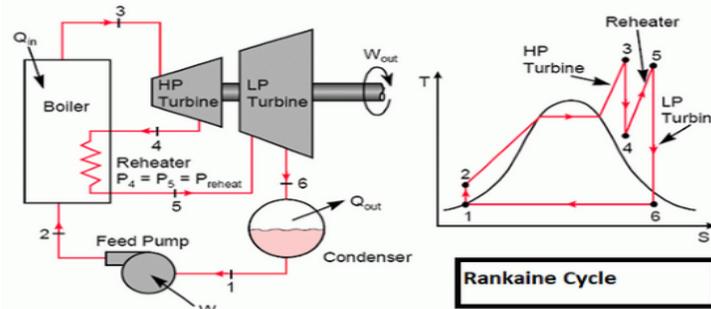
In view of the environmental concerns associated with the huge amount of ash, it has been made mandatory for thermal power plants to have tie-up with the cement industry, Further, it has been made mandatory for the cement industries to blend ash with the cement.

Fly ash can be used as prime material in Portland cement concrete pavement (PCC), road construction, concrete block, brick etc. which provides significant financial gains.

### III ENERGY EFFICIENT TECHNOLOGIES

The supercritical thermal power plants and Integrated coal gasification combined cycle operate at higher efficiencies with reduced emission of gases.

(a) **Supercritical boilers** - The supercritical boilers operate at a temperature and pressure above the critical point i.e. above 221 bars and 374° C (Refer Figure 1). Above critical point, there is no distinction between steam and water phases i.e. water and steam lose their individual identity and behave like a fluid as a single entity. Figure 8 shows a process diagram of a generating unit equipped with supercritical boiler along with its correlation with Rankine cycle.



**Fig.8 Process diagram of generating unit equipped with supercritical boiler [10]**

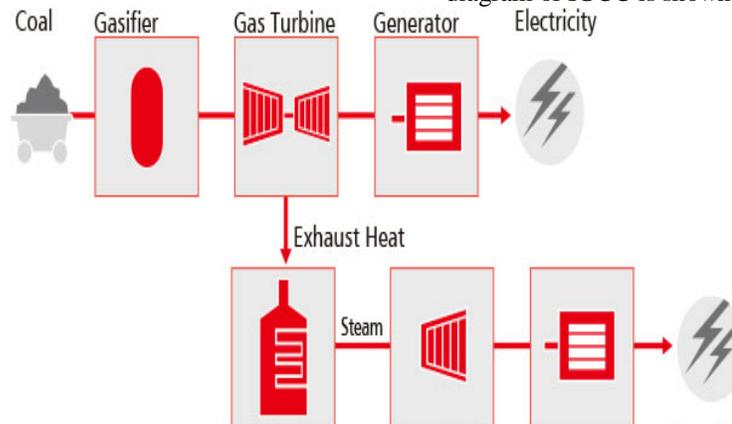
The main differences between subcritical and supercritical technologies are summarized below:

- (i) **Output:** Due to higher temperature difference between the entry of steam at turbine and exit of steam, more is the output. The fuel needed is less for the same output. Since the fuel is less, the emissions are also reduced.
- (ii) **Part load operation:** Lower the pressure would be lower (because then efficiency is higher because steam throttling is avoided in the turbine) the operation becomes subcritical.
- (iii) **Boiler drum:** Due to same liquid phase, no bubbles and no dry-out and hence, drum is not needed. This is why supercritical operation is also known as once through technology
- (iv) **Efficiency:** Increase in the thermodynamic efficiency of the Rankine cycle with 170 bar and 540 / 540° C (SH / RH) the efficiency of 38 %. Supercritical boiler units operating at 250 bar and 600/615 ° C and can have efficiencies of about 42 %. Ultra supercritical boiler units at 300 bar and 615 /

630 °C will may achieve efficiency up to 44 %.

- (v) **Water purity:** The water in the boiler has to be of extremely pure, otherwise f impurities may result in deposits on turbine blade.
- (vi) **Materials:** Supercritical power plants use special high grade materials for the boiler tubes with the turbine blades of improved design and materials. In fact, the very increase in higher pressure and temperature designs is an metallurgical issue and depends on the development of newer and newer alloys and tube materials.

- (b) **Integrated coal gasification combined cycle plant -** Integrated coal gasification combined cycle (IGCC) power plants are a next-generation thermal power system. They enhance power generation efficiency by coal gasification and the Gas Turbine Combined Cycle (GTCC) system. Large-type IGCC systems can improve power generation efficiency by about 15% and reduce CO<sub>2</sub> emissions compared to conventional coal-fired thermal power generation. A block diagram of IGCC is shown in Figure 8.



**Fig. 8 Schematic of IGCC plant [11]**

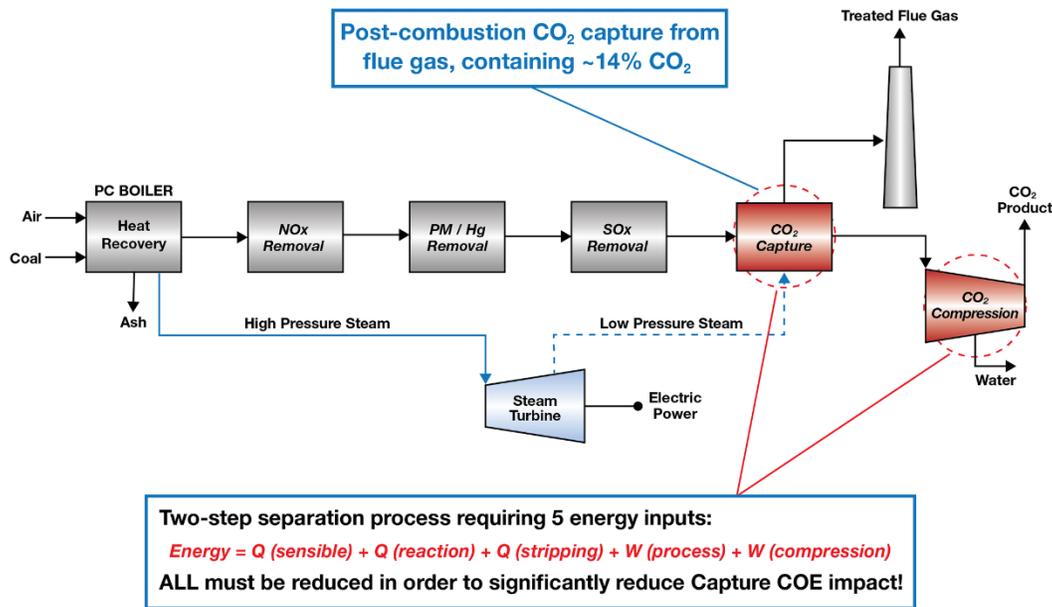
BHEL set-up a 6.2 MW IGCC plant in 1989 at a cost of Rs. 15 crore at its Tiruchirapalli unit. It was the first coal-based IGCC plant in Asia and the second in the whole world. IGCC is the ideal technology for India as it will help utilise the country's abundant quantities of low grade coal without much serious health and environmental implications. BHEL has

demonstrated the capability to scale up the technology to 100 MW.

## IV CARBON CAPTURE TECHNOLOGIES

Atmospheric carbon dioxide comes from two primary sources—natural and human activities. Natural sources of carbon dioxide include mostly the animals which exhale carbon dioxide. Human activities responsible for emission of carbon dioxide is the burning of fossil fuels in thermal power plants. Carbon dioxide is the most commonly produced greenhouse gas.

The three common technologies viz. pre-combustion, post-combustion, and oxy-fuel are for CO<sub>2</sub> capture. In post-combustion capture technology, CO<sub>2</sub> is separated from the flue gases before releasing into the atmosphere through chimney. The most common technology uses amine gas to remove CO<sub>2</sub> by aqueous solutions of amines. After removing the CO<sub>2</sub> from the amine solvent, it is dried and compressed to reduce its volume before storage.



**Fig. 9 Process diagram of post-combustion carbon capture and compression [12]**

In a pre-combustion capture technology, fossil fuels are gasified to produce a syngas (synthesis gas) or fuel gas composed of carbon monoxide and hydrogen. Additional water (steam) is then added and the mixture is passed through a series of catalyst beds for the water-gas shift reaction to approach equilibrium, after which CO<sub>2</sub> can be separated to leave a hydrogen-rich fuel gas. The energy needed in pre-combustion capture may be about 50% of that required in post-combustion capture. However, the water requirement in pre-combustion process is more.

In the oxy-fuel capture, pure oxygen is used for combustion. It gives a flue gas mixture mainly of CO<sub>2</sub> and condensable water vapour, which can be separated and cleaned relatively easily during the compression process.

Post-combustion capture is useful for separating CO<sub>2</sub> from exhaust gases released by burning of fossil fuel. The exhaust gases, a mixture of CO<sub>2</sub>, nitrogen and some oxygenated compounds (SO<sub>2</sub>, NO<sub>2</sub> and O<sub>2</sub>) are first treated to remove particulate matter and the oxides of nitrogen and sulphur. Generally, they are in contact with a liquid solvent, typically an aqueous amine solution. The amine selectively absorbs the CO<sub>2</sub>, capturing more than 85% of the CO<sub>2</sub> and enabling nitrogen and oxygen to be released into the

atmosphere. A CO<sub>2</sub>-rich amine is regenerated by stripping the CO<sub>2</sub> out of the liquid with steam, allowing the lean amine to be recycled to the absorber while producing a concentrated CO<sub>2</sub>. The CO<sub>2</sub> is compressed and cooled in liquid form.

## V CONCLUSION

The climate change has emerged as one of the biggest challenges of the 21<sup>st</sup> century. The main cause of which is the emission of green house gases from the power plant generation based on burning of fossil fuels. It has thrown a challenge on the well established coal fired thermal power plant technologies. A new era has started to deal with such challenges by developing green power generation technologies. Supercritical boilers which operate at higher temperature and pressure at higher efficiencies and emit less gas. Similarly, IGCC, and carbon capture technologies have emerged and are briefly presented in this paper.

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