Developing an Innovative Working Model of Hydro Electric Power Plant through 'Kabad Se Jugad'

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ABSRACT
AISECT University is the first university in private sector in Madhya Pradesh which focused on research, practical exposure and skill development in higher education. One of the initiatives taken was the creation of a Centre for Renewable Energy (CRE) in the university which is developing various training facilities and also making efforts towards a greener campus. An Energy Park is a part of CRE which will have many working demonstration models of energy generation, management and conservation. What sets this Energy Park apart from similar other set-ups is the fact that this is being developed using university's own resources with lot of innovative ideas. A full working model of Hydro Electric Power Plant has been developed for the Energy Park using waste material/scrap (kabad). This model is the first of its kind which depicts full working of a Hydro Power Plant providing conceptual knowledge to actual working and motivating students for research & innovation.

I INTRODUCTION

Initially efforts were made to procure a model from the market. The manufacturers supply standard pump-motor or turbine only and not the complete 'Power Plant'. This is because plant has several other elements like penstock, generator, valves, draft tube. Overhead crane etc. One company was ready to take-up the total project but the price quoted was prohibitive.

The idea emerged that university should develop a model of Hydro Electric Power Plant in its own workshop. This required creation following main parts of Hydro Electric Power Plant:

(a) Hydro turbine
(b) Generator
(c) Main inlet valve
(d) Draft tube
(e) EOT Crane
(f) Goliath crane
(g) Lift

II THE FIRST JUGAD- CONVERTING A CENTRIFUGAL PUMP IN TO A TURBINE

A Centrifugal pump is similar in construction to Francis turbine and hence can be converted in to Francis Turbine. The outline diagrams of Centrifugal Pump and Francis Turbine are shown in Fig. 1 and Fig. 2 respectively.

- The rotor of centrifugal pump and Francis turbine are called impeller and runner respectively.
- The water passages in a centrifugal pump/Francis Turbine are radial.
- They can have horizontal or vertical configuration.
- The directions of fluid flow in pump and turbine are reverse to each other.

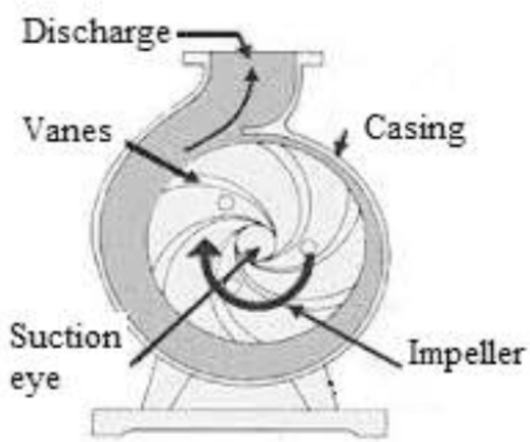

Fig. 1: Centrifugal pump

Table-1
Brief Comparison between Pump and Turbine

Centrifugal Pump	Francis Turbine
• Pump converts mechanical energy into Hydraulic energy.	• Turbine converts the energy of water into torque.
• The pump impeller is driven by elective motor, engine etc.	• Turbine is driven by the mechanical energy contained in water.
• Pump is used to raise the water from lower level to higher level. This is achieved by creating a low pressure at inlet or suction end and high pressure at outlet or discharge or delivery end.	• A coupled generator converts the mechanical energy into electrical energy.
• In pump, water enters axially from the center of the impeller, flows radially outwards and then rises vertically upwards.	• Water from penstock enters spiral casing and passes radially inwards and rotates the runner. It comes out axially downwards through draft tube.

(a) Centrifugal pump

It was decided to procure suitable centrifugal pump for converting it into Francis turbine. Accordingly a hunt was launched to get an appropriate centrifugal pump. An old 3.5 H.P. Centrifugal pump was purchased from 'Kabad Khaana', Bhopal. It is shown in Fig. 3.

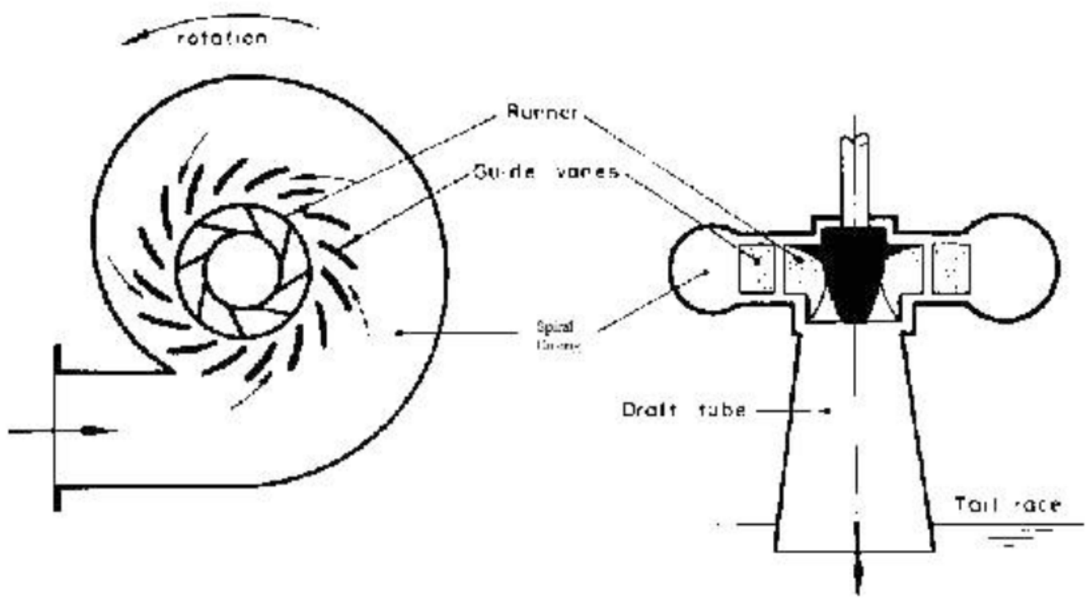

Fig. 2: Francis turbine

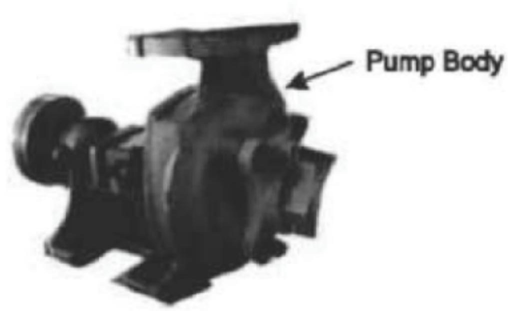

Fig. 3: Centrifugal pump

Impeller can be seen in Fig. 4 where body of the pump has been opened out.

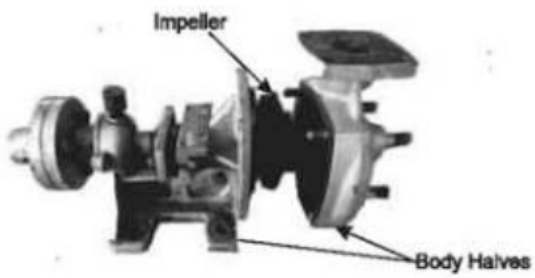

Fig. 4: Impeller in a centrifugal pump

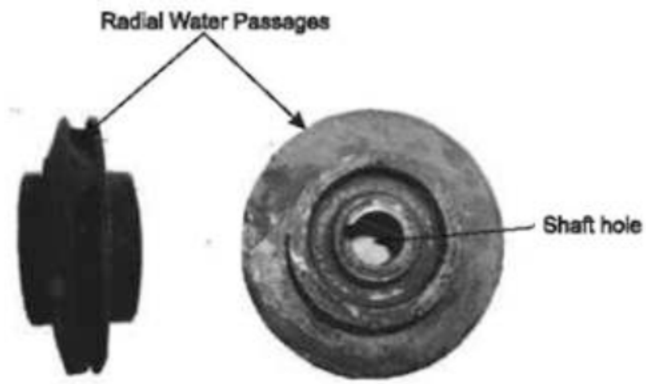

Fig. 5: Two views of impeller

(b) Modifications

(i) Trial of a pump as a pump

Centrifugal pump was operating due to heavy rust, misalignment; bend in the shaft, jamming and leakages due to damaged seals.

Creative measures

- Scrapped and de-rusted the body and parts thoroughly.
- Straightening of shaft using hydraulic press.
- Assembly of the new seals.
- Assembled the parts again.
- Applied oil and grease properly prior to further operation as a pump.

(ii) Operation of a pump as a turbine

- Rotation of turbine was slow
- There was no control on inlet water flow for which it was felt necessary to provide a valve called Main Inlet Valve (MIV).

(c) Development of MIV and Draft Tube

Using in-house knowledge, MIV and draft tube were developed with innovations, assumptions and application of plumbing, casting and sheet metal work.

MIV, draft tube and their assembly on turbine are shown in Fig. 6, Fig. 7 and Fig. 8 respectively.

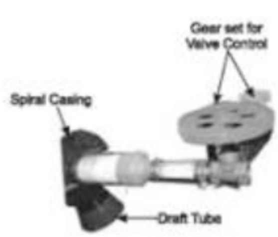

Fig. 6: Inlet valve and gear

Fig. 7: Draft tube assembly

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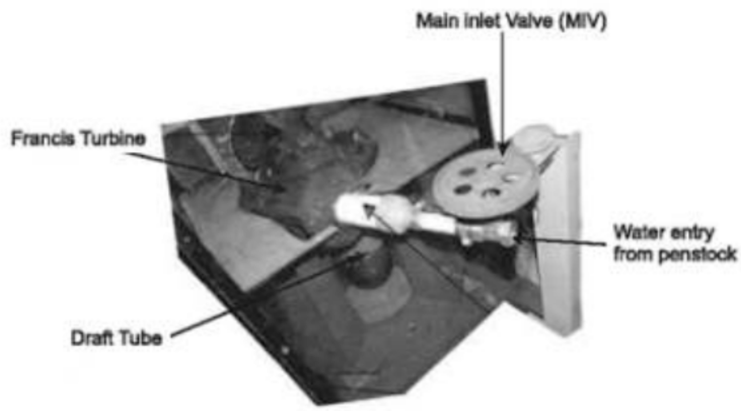

Fig. 8: Main Inlet Valve and Draft Tube

III TRIALS, TESTING & MODIFICATIONS

(a) Trial After Assembly of Inlet Pipe and Draft Tube

OBSERVATIONS:

- Flow of water controlled to certain extent at either end of the turbine.
- Rotation increased but still higher speed was required.

Fig 9 : Divergent Nozzle

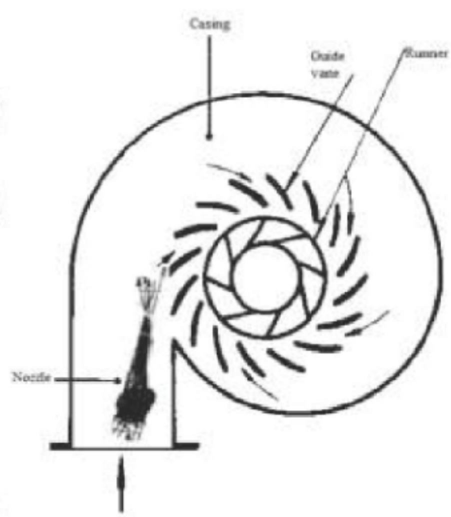

Fig. 10: Modified arrangement of Francis Turbine

- In order to obtain higher speed of rotation, some innovative solution was to be found out.
- Similar to an impulse turbine, a nozzle was used which helped to obtain higher speed of rotation.

(b) Further Improvement

A nozzle was developed such that jet of water hit directly on runner. Fig. 9 shows nozzle whereas Fig. 10 shows the nozzle assembled at the entry of spiral casing.

IV JUGAD TO DEVELOP OTHER COMPONENTS

(a) Generator-

The basic idea was to demonstrate working of 'Hydro Electric Power Plant'. Instead of complicated 3-phase synchronous or induction generator, it was decided to use a D.C. dynamo with a gear wheel to increase the rotational speed as shown in Fig. 11. When turbine runner rotates, dynamo produces electricity which is indicated by glow of LED.

Fig. 11: Dynamo

(b) Gear Mechanism - In order to increase the speed of rotation of dynamo, a large gear wheel was used as shown in Fig. 12.

Fig. 12: Large Gear Wheel

(c) **Casing -** Generator casing encloses mainly slipring assembly, toothed wheel of speed signal generator and dome light. The casing is shown in Fig. 13.

Fig. 13: Generator Casing

(d) **Power Plant Crane -** EOT Overhead Crane for handling of materials/ equipments is shown in Fig. 14. It provides up-down, longitudinal and lateral motions to the make access throughout the power house. The motion of the EOT Crane is controlled by wireless remote operation.

Fig. 14: Power plant overhead crane

(e) Goliath Crane moves on rails. It is provided to operate Draft tube gate as shown in Fig. 15. It is operated by wireless remote control.

Fig. 15: Goliath Crane

(f) **Lift -** A lift has been provided for access of the employees to different floors of the power plant including control room. It is shown in Fig. 16.

V FINAL ASSEMBLY

Structure to provide rigid support to turbine-generator is fabricated using steel channels/angles.

At various stages of modifications, sub-assemblies were tested for operation. The functional model demonstrates working of a hydro power plant.

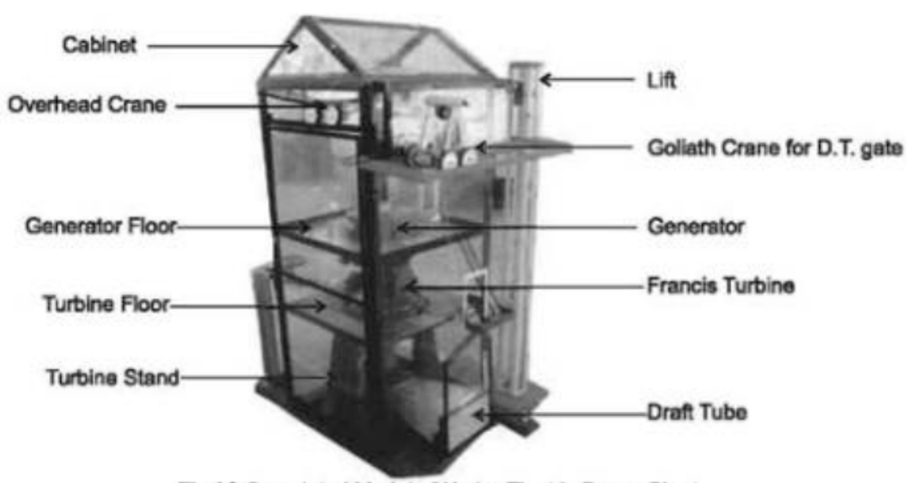

Fig 16: Completed Model of Hydro Electric Power Plant

VI CONCLUSION

Successful development of working model of the Hydro Electric Power Plant has been encouraging. This will be connected with the penstock after construction of dam and reservoir in Energy Park. The model tested with water displayed working of an actual Hydro Power Plant. It can motivate a student not only to understand but use this model for further research and innovation.

VII ACKNOWLEDGMENT

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