



## Jayakwadi Hydro-Power plant- A Birds Eye view

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### Abstract

Energy is required now more than ever due to population growth, industrialization and modernization. Challenges such as carbon dioxide (CO<sub>2</sub>) emissions and depletion of conventional source of energy necessitate for renewable sources, of which hydro energy seems to be the most predictable. Hydro which is hydro energy provides electricity to communities by converting hydro energy into electrical energy. The Jayakwadi Hydro-Power plant at Paithan in Aurangabad is vital Hydro-electricity generator, in Marathwada region. This paper is an overview of Jayakwadi hydro-Power system by reviewing some of its basic components such as turbine and generator that make this conversion process possible. As well as its advantages and limitations will also be reviewed to provide the basic knowledge of hydro-power system.

*Keywords:* Hydro-power, Hydro-turbines, generator, electricity.

### 1. INTRODUCTION

Energy is the most fundamental sector for the progress of a nation [1]. It is inevitable for survival and indispensable for developmental activities to promote education, health, transportation and infrastructure for attaining a reasonable standard of living and is also a critical factor for economic development and employment [2]. Urbanization, economic development, industrialization and rapid increase in population growth have raised the demand for power generation manifolds [3]. As the human population and activities are progressively developing, it is most certain that the demand for energy worldwide is increasing as well, and this trend is most likely to continue in the future [4]. For meeting the expected energy demand as the population will rise and to sustain economic growth, alternative form of energy such as renewable energy needs to be expanded [5]. Hydro power energy is one of the most clean



renewable sources of energy [3]. Water power can be harnessed in many ways; tidal flows can be utilized to produce power by building a barrage across an estuary and releasing water in a controlled manner through a turbine; large dams hold water which can be used to provide large quantities of electricity; Hydropower is one of the most cost-effective energy technologies to be considered for rural electrification in less developed countries [6].

Hydroelectric power captures the energy released from falling water. In the most simplistic terms, water falls due to gravity, which causes kinetic energy to be converted into mechanical energy, which in turn can be converted into a useable form of electrical energy. Ancient Greeks used wooden water wheels to convert kinetic energy into mechanical energy as far back as 2,000 years ago. In 1882 the first hydroelectric power plant was built in the United States using a fast flowing river. Humans in time began creating dams to store water at the most convenient locations in order to best utilize power capacity.


This paper will contain a review of Jayakwadi Hydro-power plant , some of these basic components like Hydro-turbines, Hydro-generators, output energy, merits / demerits and the output energy of a Jayakwadi hydro project system.

## 2. JAYAKWADI PROJECT HISTORY

The harsh project is one of the largest irrigation projects in the Indian state of Maharashtra. It is a multipurpose project. The water is mainly used to irrigate agricultural land in the drought-prone Marathwada Region region of the state. It also provides water for drinking and industrial usage to nearby towns and villages and to the municipalities and industrial areas of Aurangabad and Jalna district. A plan to build a dam on Godavari river in the drought-prone Marathwada region was first conceived during rule of state of Hyderabad. The plan was to build a dam in Beed district near village Jayakwadi with storage capacity of 2,147 MCM (million cubic meters).[7] The project came to be known as Jayakwadi project after the name of the village. However, after formation of new state of Maharashtra and comparative analysis on alternative places, it was decided to build a dam 100 km upstream at Paithan. Building dam at higher level made it possible to have longer canals and thus providing irrigation facility to a larger region. The project proposal for this was completed by 1964. The foundation of the dam was laid by the then Prime minister of India Lal Bahadur Shastri on 18 October 1965. The dam was inaugurated on 24 February 1976 by the then Prime minister Indira Gandhi.[7] The chief engineer of this project was Mr. A.A.A. Siddiqui. A hydroelectric power plant of 12 MW capacity is installed on the right bank of the river. The water used for electricity generation was pumped back into main reservoir from tail pond by using reversible hydro turbine. Fig.1. and Fig.2. give Jayakwadi Dam and Jayakwadi project details.

## Jaikwadi Dam

- Largest earthen dam in Asia
- Dam wall 10.2 km across
- Dam height : 82 ft below 40 ft above
- Catchment area 21,750 sq.km
- Expenditure  
Planned - 800 cr.  
Actual - 4,700 cr.  
To date - 11,000 cr.



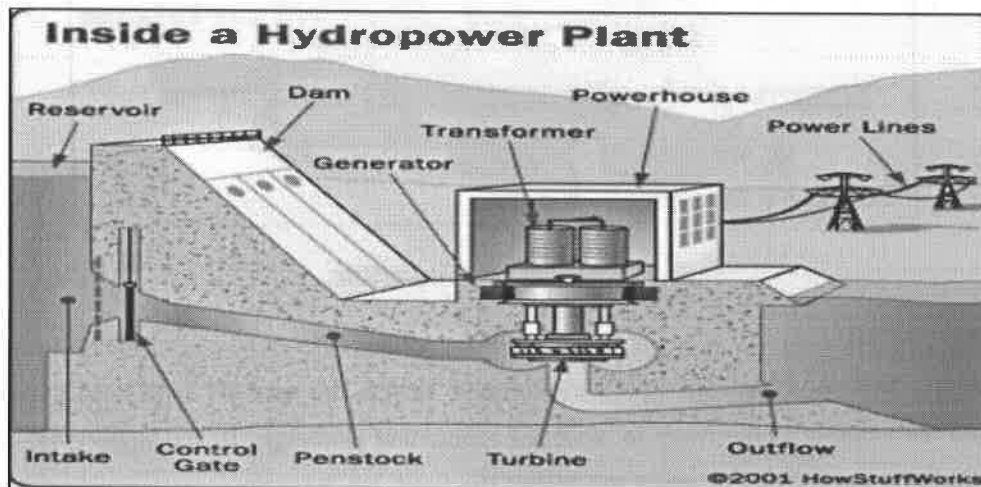
<b>Official name</b>	Jayakwadi-I D02995
<b>Location</b>	Jayakwadi, Maharashtra India
<b>Coordinates</b>	19°29'8.7"N 75°22'12"E
<b>Construction began</b>	1965
<b>Opening date</b>	1976 <sup>(1)</sup>
<b>Construction cost</b>	4,700 cr <sup>(2)</sup>
<b>Owner(s)</b>	Government of Maharashtra
<b>Dam and spillways</b>	
<b>Type of dam</b>	Earthen da
<b>Impounds</b>	Godavari River
<b>Height</b>	41.30 m (135 ft)
<b>Length</b>	9,998 m (32,802 ft)
<b>Reservoir</b>	
<b>Creates</b>	Nath Sagar Jalashay (Marathi: नाथसागर जलाशय)
<b>Total capacity</b>	2.909 km <sup>3</sup> (1.027 × 10 <sup>11</sup> cu ft)
<b>Catchment area</b>	21,750 km <sup>2</sup> (8,398 sq mi)
<b>Surface area</b>	350 km <sup>2</sup> (135 sq mi)
<b>Power Station</b>	
<b>Installed capacity</b>	12 MW

Fig.1.Jayakwadi Dam

Fig.2. Jayakwadi Project Details

### 3. JAYAKWADI HYDRO-PLANT SETUP AND POWER GENERATION

#### 3.1 HYDRO-PLANT SETUP

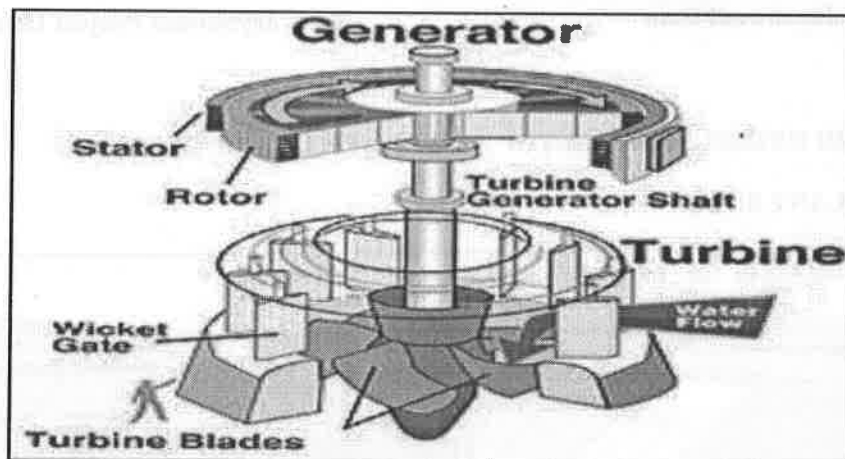


**Fig.3.1. Jayakwadi hydro-power plant overview**

The water from a river, reservoir or lake flows through the PENSTOCK, a large pipe that can be above or below ground, into the Powerhouse. The Turbine, Generator, Step-up Transformer and all associated Mechanical & Electrical Auxiliaries are generally located in the POWERHOUSE. The TURBINE Blades are pushed by flowing Water from the Penstock, causing them to rotate. The Rotor of the GENERATOR connected to the Turbine Shaft rotates as the Turbine move, producing Electricity. The STEP-UP TRANSFORMER increases the voltage of the Electricity produced by the Generator. The TRANSMISSION LINES carry Electricity from Power Plant Substation to Substations in our communities. The voltage is decreased and distributed to home & businesses.

### 3.2 HYDRO-TURBINES

The turbine is the heart of hydro power system, where water power is converted into rotational force that drives the generator [8] as shown in Fig.3.2. They are classified as impulse turbine and reaction turbine [8-12]. On the basis of flow of direction, they are further classified as: Tangential flow, radial flow, axial flow and mixed flow [9]. The water strikes the turbine blades and turns the turbine, which is attached to a generator by a shaft [13]. Turbine is connected either directly to the generator or is connected by means of gears or belts and pulleys, depending on the speed required for the generator .

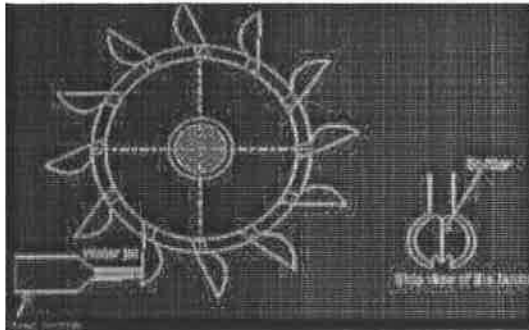


**Fig.3.2. Turbine Generator**

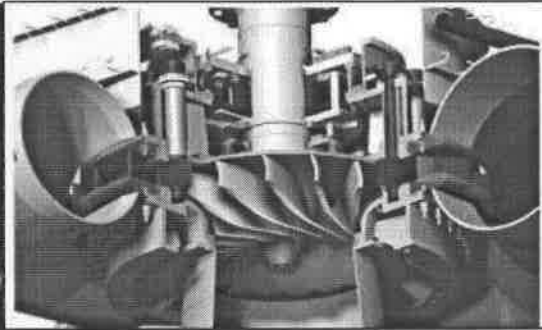
#### 1. Impulse turbine

Impulse turbines, which have the least complex design, are used for high head hydro systems [14]. They use the velocity of the water to move the runner and discharge to atmospheric pressure [15]. These turbines are more efficient, since the higher the head, the lesser the water required for a given amount of power, so smaller and hence less costly equipment [7]. Water is driven into the pipeline at

forebay. This pipeline leads the water to a nozzle, where the kinetic energy of the water is used to push or impulse the blades coupled to the alternator. The most common types of impulse turbines used are Pelton turbine (Fig 3.2(a)).



**Fig.3.2 (a). Pelton Impulse turbine**



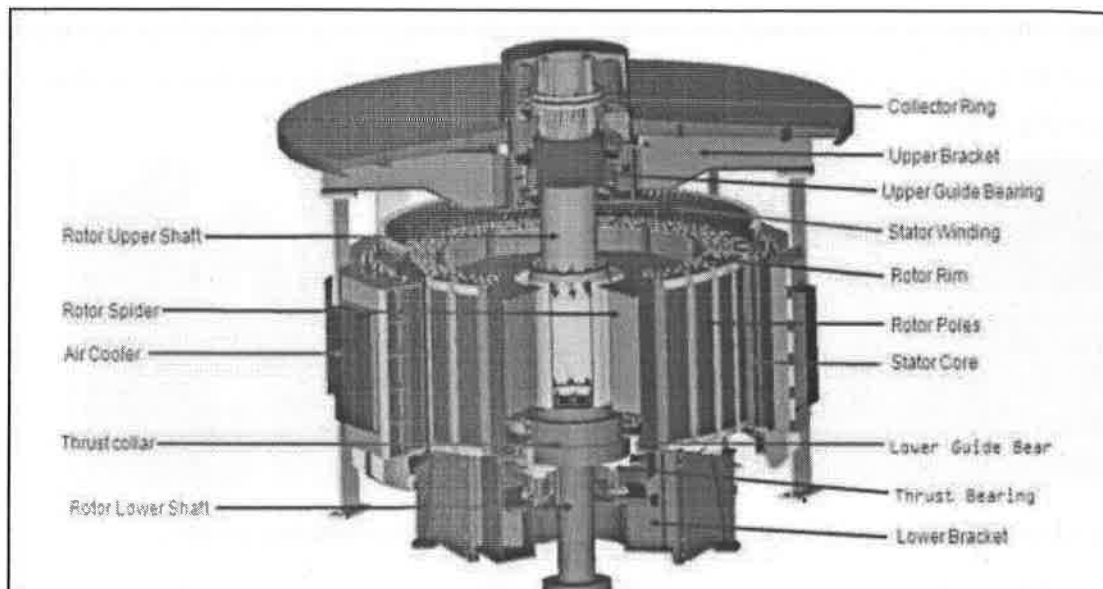
**Fig.3.2(b). Reaction turbine**

## 2. Reaction turbine

Reaction turbines, which are highly efficient, depend on pressure rather than velocity to produce energy [14]. They have better performance in this Hydro-power plant with low head and high flow [8]. Reaction turbines (Fig.3.2(b)) exploit the oncoming flow of water to generate hydrodynamic lift forces to propel the runner blades [7], and run fully immersed in water [8]. They can operate on heads as low as 2 feet, but require much higher flow rates than an impulse turbine [9].

## 3.3. HYDRO GENERATOR

Generators convert the mechanical (rotational) energy produced by the turbine to electrical energy [11]. The principle of generator operation is quite simple: when a coil of wire is moved past a magnetic field, a voltage is induced in the wire [12]. As the turbine blades turn, the rotor inside the generator also turns and electric current is produced as magnets rotate inside the fixed-coil generator to produce current . There are basically two types of generator which are induction and synchronous generator [13]. Fig.3.3 shows 3-D view of Hydro generator.



**Fig. 3.3 – 3-D view of Hydro Power Generator**

#### 4. THE OUTPUT ENERGY

The generation of electrical energy is simply conversion of energy from one form to another. The turbine converts water energy into rotational energy at its shaft, which is further converted into electrical energy by the generator. Part of the energy will be used to overcome frictional force at every point of conversion. The energy generated per year (KWH) can be calculated by using formulae as:

$$E = \rho * Q * Hn * \eta * n \quad (1)$$

Where  $g$  is gravitational constant ( $9.8 \text{ m/s}^2$ ),  $\rho$  is water density ( $1000 \text{ kg/m}^3$ ),  $Q$  is flow rate ( $\text{m}^3/\text{s}$ ),  $Hn$  is net head (m) and  $n$  is number of hours in year for which the specified flow occurs.  $\eta$  is efficiency which is a measure of how much energy is actually converted [15]

$$\eta = \eta_{tu} * \eta_{ge} * \eta_{gb} * \eta_{tr} \quad (2)$$

Where:  $\eta_{tu}$  is turbine efficiency,  $\eta_{ge}$  is generator efficiency,  $\eta_{gb}$  is gear box efficiency and  $\eta_{tr}$  is transformer efficiency. The head and flow determine everything that needs to be known about the hydro system such as pipeline size, turbine type, rotational speed, generator size [15].



## 5. MERITS AND DEMERITS

The merits of Jayakwadi Hydro-power plant has the same size wind, wave and solar power plants are : High efficiency as compared to best of all energy technologies, slow rate of change, output power variation is very slow. We can say in general Jayakwadi Hydro-power plant energy are predictable, start up time small and output time can be easily adjusted, low operating cost, longlife technology and no environmental pollution. Despite the aforementioned merits, hydro technology is limited level of expansion unlike wind and solar. Methane emissions lower positive impacts are found in the tropical regions, The fact that hydropower requires high initial capital cost and water is not readily available all season round contributes to the low level of investment in the technology.

## 6. CONCLUSION

In this paper the basic component of Jayakwadi hydro-power system such as turbine, generator, has been discussed with emphasis on the technology involved application. This discussion helps to increase knowledge and awareness of people about Jayakwadi hydro power plant. It also give an idea about merits and Demerits of Hydro-power generation. It can serve as an excellent decentralized electricity generation grid or as a secondary power generating unit, making the grid more robust.

## 7. REFERENCES

- [1]. Rifat A. and Mahzuba I. (2014) —A Case Study and Model of Micro Hydro Power Plant Using the Kinetic Energy of Flowing Water of Surma and Meghna Rivers of Bangladeshl The International Journal Of Science & Technology volume 2 issue1. pp 87-95. [www.theijst.com](http://www.theijst.com)
- [2]. Bilal A. N. (2013) —Design of Micro - Hydro - Electric Power Stationl International Journal of Engineering and Advanced Technology (IJEAT) Volume-2, Issue-5, pp 39-47
- [3]. Ravi S. M. and Tanweer D. (2016) — Spatial Technology for Mapping Suitable Sites for Run-of-River Hydro Power Plantsl International Journal of Emerging Trends in Engineering and Development Issue 6, Vol. 4 [http://www.rpublication.com/ijeted/ijeted\\_index.htm](http://www.rpublication.com/ijeted/ijeted_index.htm)
- [4]. Abdullah M. O. et al. (2011) —Renewable Energy Potential from Micro Hydro for Techno-Economic Uplift - A Brief Reviewl IJRRAS 7 4 (4) [www.arpapress.com/Volumes/Vol7Issue4/IJRRAS\\_7\\_4\\_03.pdf](http://www.arpapress.com/Volumes/Vol7Issue4/IJRRAS_7_4_03.pdf)

