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A review on turbines for micro hydro power plant

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ABSTRACT

In recent years design of micro hydro power plants has been examined by various groups throughout the world due to its merits of offering better performance than the conventional fossil fuels to meet the energy need. Considering the portfolio of energy, the improvement of hydro power will partake in decrease of greenhouse gas emission and better malleability in the grid operation. This inquisition study examined the turbine of small hydro plant from the perspective of efficiency improvement while maintaining the global cost of the project per kW arrive within confined range. In this documentation an extensive epitomize of turbines available in India and other countries has been described. The selection of head, runner diameter along with its accomplishment are also presented. This study reveals an improvement for the design of turbines while comparing the functioning of other existing system for similar operating condition. Since most power plants now-a-day's use large turbines for the low power production, losses and overall cost increases, hence this survey will be helpful to reduce the cost of the plant. The reviews mainly focus on the study of existing turbines upto 100 kW. The importance of the turbine in micro hydro projects with respect to our current energy scenario is also highlighted.

1. Introduction

The power shortage is a major hurdle India had to face. For the country's economy to sustain, electricity is the artifact of it. A stand alone electric power generation [1] using renewable resources is one among the most required and productive methodology to generate electricity. Especially in places lagging grid connection, such as rural side of the country micro hydro power is an important resource [2–4] in which electricity is generated by converting the potential energy of water which stands as the puriest form of energy in the world. The water thus generated is also kept for irrigation [5–8] and other domestic purposes after generation of electricity. The concept of using running waters to generate electricity was begun by the introduction of water wheel in Wisconsin in 1882 at the Fox river. In this century hydro power had marked a place in electrical energy production around the world. The power generation various from plant to plant depending on several aspects and those plants which generate electricity lesser than 100 kW are termed as micro hydro power plants. These small hydro plants consume less space, reliable and cost effective then the fossil fuels [9]. Due to its salient features it pays a path in establishment and development of small sized hydro plants in the country rather than the mega hydro projects that occupies more space [10].

Huge number of sites with high potential and greater demand for electricity have been identified as low head pico resources and use of such potential sites is important [11,12]. Several of the pico hydro plants are located in forest range or in remote areas [13]. The main issue faced by these plants is the inadequate supply of turbine or high cost [14]. The heart of any micro hydro project is the turbine that is capable of generating electricity through the rotation of the shaft. Hence much attention had to be taken in genuine choice and performance of such turbine [15] as the clue rest in the coherence transfiguration of the energy in the water to useful electrical energy. According to head, turbines are classified [16] as

a) Low Head (upto 40 m) – Propeller and Kaplan Turbine.
b) Medium Head (40–100 m) – Francis, Pump as Turbine, Cross Flow and Pelton Wheel.
c) High Head (> 100 m) – Turgo and Pelton Wheel.

Even though lot of research work on hydro power plant design had been reported in the previous years, most of them are confined to either medium or large hydro power plants. Since the present study is focused on micro hydro power plant and no study has been reported for turbine that are used for micro hydro power plants, if a suitably low rated turbine were to be readily available in the market, then the operational cost of micro power generation would be considerably lower. The

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reason for non-availability of these turbines in the local market is mainly because of their limited demand from only South India on account of the existence of many waterfalls of lower heads here. If the production of these low rated turbines is enhanced then the whole of South India would generate greater amount of electricity thereby resolving the power shortage to a large extent. The non-availability of suitably rated turbines in the market is an eye opener for the researchers in the field of turbine development, as indicated in the above survey of this paper. Hence this present research work is focused on turbines pertaining to the review small and micro hydro plants.

2. Micro hydro power plant – a study

Hydro power is the harnessing of energy from the flowing waters that are converted into useful mechanical form [17], thereby generating electricity by using a generator. Few of the hydro power systems are classified as micro hydro power system when the energy generating capacity of the plant is within 100 kW [18,19] then it is termed as micro hydro power system. They are relatively small power sources that may be used to supply power to a small group of communities, who are independent of the general electrical supply grid [20].

In a typical micro hydro power plant as shown in Fig. 1, the river waters passes through the forebay tank and reaches the turbine. The turbine converts the hydraulic power into mechanical energy. The mechanical energy is subsequently then converted into electrical energy by a generator. The presence of a forebay tank aids in continues supply of water to the system [8]. The hydraulic system also comprises of a valve control system and the system will be able to produce maximum power only if the gate valve is kept fully opened. The mechanical power thus generated is send to the electrical unit which comprises of the synchronous generator connected to a shaft to produce useful electrical power to pamper the wants of the rural community and thus the water is released back to the river or stream without causing erosion [6].

3. Review on turbine manufacturers in India

Table 1 gives the details about the review on turbines manufacturers in India. The need of energy had paved path to the development of several turbine manufactures in India but the interested parameter is that lower power rated turbine design are in scarcity.

Silver Boat Technologies Pvt. Ltd [21] are known for the scheming and conniving of pico [22,23] and small hydel systems of a wide scaling of 1–100 kW. All the system fabrication is done by Silver Boat Technologies Pvt. Ltd in India and their turbines can be used for both grid and off grid conditions with higher efficiency and reliability.

Ytek [24] is an organization connecting themselves in the component development for micro hydro projects such as extending their help in designing of control equipments for system and also focuses on

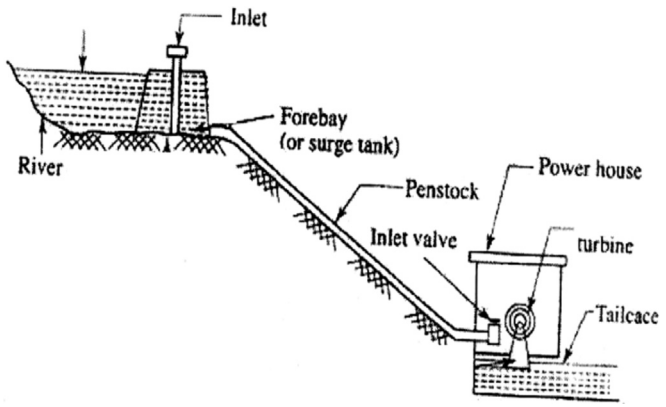

Fig. 1. Schematic of a micro hydro power plant [2].

Table 1
Turbine manufacturers in India.

S.No	Turbine Manufacturer	Output Power (kW)
1	Silver Boat Technologies, Chennai [21]	1–100
2	Ytek Controls, Dehradun [24]	5–100
3	Ape Power Pvt. Ltd, West Bengal [25]	5–100
4	Wasserkraft, New Delhi [26]	5–200
6	Vaigunth Enertek Pvt. Ltd, Chennai [27]	10–200
7	Flowmore Ltd, Haryana [28]	upto 20000
8	Karshni Intertech Pvt. Ltd, Noida [29]	5–100
9	Pentaflo Hydro Pvt. Ltd, New Delhi [30]	5–100
10	Centre for Energy Initiatives, Bangalore [31]	5–100

industrial automation. They cater on micro hydro projects situated in tribal regions of the country which are rich in potential and are off grid and thus can be automated.

APE Power Pvt. Ltd [25] also dealers in turbine development of micro hydro projects and have expanded their work on commissioning and execution of the micro hydro plants. Their turbine production starts from 5 kW turbines and ranges upto 100 kW turbines.

In the state of Kerala, six high potential waterfalls were indentified in the year 2001 by framing their project strategy in electrifying the rural community residing near Mankulam Panchayat in Idukki District. The commissioning of the plant was started in 2001 and it takes the pride of establishing the first off grid hydro project of 110 kW at Pampumkayam, Kerala with a catchment area of 8 Km^2. The project thus progressed and reached the stage of developing the penstock line after which in 2002 the project showed less progress due to the financial need of purchasing the turbine. At this juncture the United Nations Industrial development Organization Regional Centre (UNIDORC) played a vital role in restarting the work of purchasing two generators from china with 55 kW each. All the purchase of the components were done through UNIDO's International Centre on Small Hydro Power (ICSHP). The other economical details of the projects states that the project cost upto Rs. 6.7 million. Another project done in Idukki District was by the Energy Management Centre (EMC) which equipped 2×50 kW horizontal shaft Francis turbine with 100 kW as the output power of the plant and was also approved by the Kerala State Electricity Board (KSEB) [32].

3.1. Inferences from the review on turbines manufactures in India

Various dissertations have been outlined in the documentation of small hydro power plants. Table 1 evidently states that the cost of the plant will naturally increase because of the use of higher rated turbine for low power generation. Despite of the enormous development in the design of small hydro power plant, the plant has certain drawbacks. It is to be closely observed from Table 1 that all the turbine manufactures produces turbine of capacity in the range between 5 and 100 kW and one manufacture from Haryana generates a high powered turbine of 20000 kW [28] and these turbines are used for micro hydro projects as well. Thus, proving evidently that there are no special turbines for micro hydro projects.

Due to these parameters, first, the cost of the plant will be more. Second, erection of the turbine for micro hydropower plant is tedious. A majority of the results that are available are of either for a pico plant or a 100 kW plant and even if it is 50 kW turbine it is been exported. The cause for confined reviews of turbines would be that such turbines of specific rating might not be mobilised in market but the requirement of such turbines is more to electrify the rural community who needs an nominal power generation and not an higher powered turbines. The fact remains conspicuous that more research is to be carried out in future to electrify the rural community with cost effective adaptive turbines.