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DESIGN AND FABRICATION OF CROSS FLOW TURBINE

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Abstract

The cross-flow hydraulic turbine was gaining popularity in low head and small water flow rate, in establishment of small hydro-power plant, due to its simple structure and ease of manufacturing in the site of the power plant. To obtain a cross-flow turbine with maximum efficiency, the turbine parameters must be included in the design. We have worked on the design and fabrication of cross flow turbine. We have redesigned the blades of the turbine to improve the efficiency and productivity of the turbine.

Introduction

Hydropower is an important source of renewable energy in the world today. In the industrialized nations this industry has expanded over the past decades, and the demand for knowledge and capital needed to build efficient power plants have increased rapidly. The main focus lies in utilizing the available resources as efficient as possible. However, this development has not reached the less–developed countries in the world. The main objective for these nations is to achieve a reliable source of energy in order to increase the standard of living. However, although there are available resources, the less–developed countries lack both capital and knowledge to utilize them. Therefore, a need for a more simple, but efficient, way to build a power plant is sought after.

A Cross flow turbine, Banki-Michell turbine, or ossberger turbine is a water turbine developed by AustrailianAnthonyMichell the Hungarian DonátBánki and the German Fritz Ossberger. Michell obtained patents for his turbine design in 1903, and the manufacturing company Weymouth made it for many years. Ossberger's first patent was granted in 1933 ("Free Jet Turbine" 1922, Imperial Patent No. 361593 and the "Cross Flow Turbine" 1933, Imperial Patent No. 615445), and he manufactured this turbine as a standard product. Today, the company founded by Ossberger is the leading manufacturer of this type of turbine. Cross flow turbine is known as wide range of heads overlapping those of Kaplan, Francis and Pelton. It can operate with heads between 5 and 10 m. It allows the water to pass through the runner and crosses it two times before leaving the turbine. This simple design makes it cheap and easy to repair in case of runner brakes due to the important mechanical stresses. The Cross-flow turbines have low efficiency compared to other turbines and the important loss of head due to the clearance between the runner and the downstream level should be taken into consideration when dealing with low and medium heads. Moreover, high head cross-flow runners may have some troubles with reliability due to high mechanical stress. It is an interesting alternative when one has enough water, defined power needs and low investment possibilities, such as for rural electrification programs. In the above scenario, a cross flow micro turbine is designed developed and tested for its performance.

The exploitation of renewable energy sources (RES) is necessary due to many contingent factors: increase in oil prices, depletion of fossil fuels and the emission limitations imposed by the Kyoto Protocol. The use of RES includes small hydroelectric power located along small rivers or along water transmission and distribution pipeline systems and characterized by continual changes occurring in the turbine operating conditions (discharge and/or load). Unfortunately, there is a lack of good design practice for small hydroelectric power-plants, probably because of the wide variability of the operating conditions (read variations in discharge and load, geometry of grip and release, *etc*.). Only a few authors provide guidelines and this deficit severely limits the uptake and development of minor hydropower plants. Banki-Michell turbines—also called cross-flow are frequently used along small rivers. Their popularity stems from the simplicity of design and construction. An analytical approach is generally used to assess the geometry of the turbine at the best efficiency point (BEP), based on the available experimental and numerical tests. A number of rules for the choice of turbine inlet, turbine impeller and turbine chamber parameters have also been given simply based on the results of numerical simulations. On the other hand, also due to the large range of possible operating conditions, Banki-Michell devices are still far from having a standard design rule and the development of the turbine for any specific case is still pioneering.

Cross-flow turbines are often constructed as two turbines of different capacity that share the same shaft. The turbine wheels are the same diameter, but different lengths to handle different volumes at the same pressure. The subdivided wheels are usually built with volumes in ratios of 1:2. The subdivided regulating unit, the guide vane system in the turbine's upstream section, provides flexible operation, with 33, 66 or 100 output, depending on the flow. Low operating costs are obtained with the turbine's relatively simple construction.

The standard models manufactured have the following characteristics:

The maximum power does not normally exceed 2,000 kW.

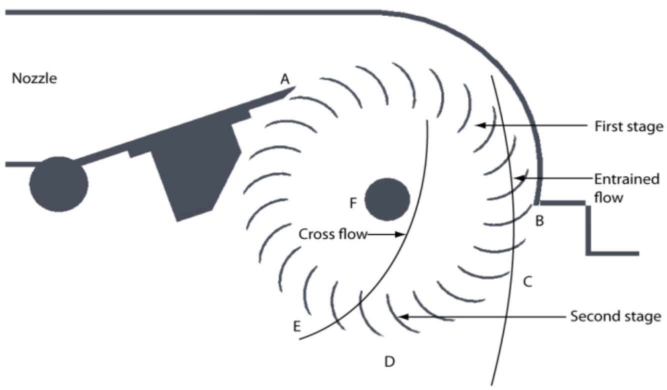
Maximum power is less than 2000kW.

Flow Range L/s to 12,000 L/s

Theory

A cross–flow turbine in its simplest form consists of a runner and a nozzle. Figure shows the manner of operation of a cross–flow turbine. The point A is defined as the nozzle outlet, B is the point where the top cover ends and F is the centre of the shaft. The water flows through the rectangular cross–section nozzle and enters the runner through the nozzle entry arc. This circular arc is defined by the angle that spans out between the line that goes from A to F and the line from F to B. As the water enters through the nozzle entry arc the first stage power is generated. The water then generally crosses the inside of the runner and leaves through the lines between point C, D and E, generating the second stage power.

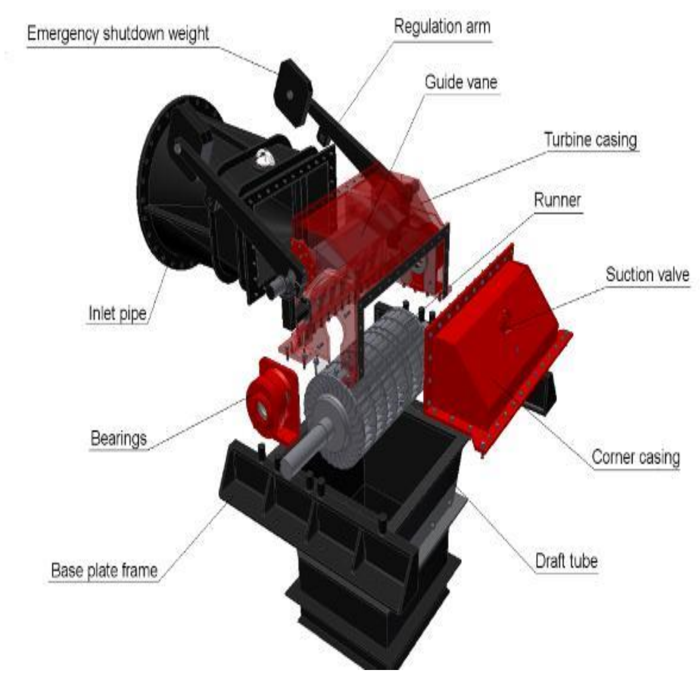
A percentage of the water does not cross through the centre of the runner, but remains entrained after entering the first stage.



Manner of operation

Working principle

Cross flow turbines are radial, slightly overpressure turbines with tangential injection of the runner blades and with a horizontal shaft. They rank among low-speed turbines. The water flow comes through an inlet pipe, then, it is regulated by guide vanes and finally enters the runner of the turbine. After passing through, the water leaves on the opposite side of the runner, providing so additional efficiency. Finally, it flows from the casing either freely or through a draft tube to a stilling basin under the turbine.



Advantage

- The cross-flow turbine has a flat efficiency curve under varying load. With a split runner and turbine chamber, the turbine maintains its efficiency while the flow and load vary.
- Since it has a low price, and good regulation, cross-flow turbines are mostly used in mini and micro hydro power units of less than two thousand kW and with heads less than 0 m.
- Particularly with small run off the river plants, the flat efficiency curve yields better annual performance than other turbine systems, as small rivers water is usually lower in some months
- The mechanical system is simple, so repairs can be performed by local mechanics.

Disadvantage

- Losses are more in this turbines
- As losses are more the efficiency will be less compared to other turbines
- There is no standards are present to prevent losses
- A part-load operation with turbines may result in cavitation

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