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A Review: Kaplan/Propeller Turbine in Pipe System to Generate Electricity (Renewable Energy)

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Abstract: Energy has become one of the important needed in this era. There are many kinds of ways to gain sources of energy, whether it is renewable or non-renewable energy. Renewable energy is more eco-friendly than non-renewable energy. Hydro power is classified as a renewable energy source. As humans are using water in pipe in their life cycle, this flowing water with high pressure can be used to create electrical energy using the water turbine concept in the pipeline. Where a small turbine generator can be plug into the pipeline so that the kinetic energy due to flowing water can become electrical energy. However, to gain energy from this method, it is important to properly operate the operation so that maximum energy can be produced. In now era, hydro power turbine in pipeline had gain more interest as it had low environmental impacts.In this study, a review of turbines uses in hydraulics power system in generating electricity use for human being that are renewable to overcome the issues of environment. Where this method had been categorized as a renewable energy, which means less harmful towards the environment rather than using the fossil fuel that can pollute them. Burning fossil fuel can produce carbon dioxide that makes the earth hot. The objectives of this study are identify the relationship of flow rate and design power, evaluate the relationship of flow rate and turbine efficiency and Summarize the most efficient hydraulic turbine used for hydraulic system in generating electricity. This study waas made by reviewing past studies, journals and articles. In 1999, based on analysis made by Fraenkel, found that axial type of turbine is the most suitable used in pipe system.

Keywords: Hydraulic Turbines, Pipe System

1. Introduction

Electricity had become the main needed for human being as many electrical goods are produced from time to time. In this era, with high growth in technologies and society, there are many rises in

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issues that happened due to the growth. There changes from the climate changes due to the pollution occurs. Electricity energy had become one of the problems as the energy is not enough to distribute to the people. A search for renewable sources for electrical energy is still been search through.

Hydro power is one of the main sources of renewable energy all around the world where state that in 2016, 71% energy supply was from hydro power. [2] as power station had showed harmful impacts toward the environment. Small hydro power is classified as small-scale hydro as there are no dam use to generate electricity. There are three class in small hydro power which are mini, micro or pico based on the energy it can generate. However, the definition of 'small' hydro had yet been used worldwide. 10 MW is the value that is accepted in the worldwide. According to the jargon industry, mini-hydro power can generate under 2 MW, micro-hydro power below 500 kW and for pico-hydro power, it is be under 10 kW. [7] As micro-hydro power can supply up to 100 kW, it is enough to supply towards house or village.

Electrical has been main requirement for living human. Water supply also had been used in human daily life. As the flowing water had produce kinetics energy where it can use to produce electrical energy. The kinetics energy should not be wasted, so water turbine can be design in pipe line to generate electricity. However, water turbine design for pipeline is different from water turbine that use dam as way to produce kinetics than transform into electrical energy. The usage of water turbine to generate electricity had been started with the creation of wooden waterwheel. The first water turbine is created in 1820 by Benoit's Fourneyron came from France. He named his creation as hydraulic motor. The earliest hydraulic power plant was built in 1870 at England. In this study, a review of turbines uses in hydraulics power system in generating electricity use for human being that are renewable to overcome the issues of environment. Where this method had been categorized as a renewable energy, which means less harmful towards the environment rather than using the fossil fuel that can pollute them. Burning fossil fuel can produce carbon dioxide that makes the earth hot.

The aim for this research is to evaluate the relationship of flow rate and design power, identify the relationship of flow rate and turbine efficiency and summarize the most efficient hydraulic turbine used for hydraulic system in generating electricity. This study is made through reading from journal, books and other writing resources. This study was conducted to study on the renewable energy where it is less harmful than the non-renewable energy that is widely use in the world. The non-renewable energy source is commonly fossil fuels which are natural gases, coal and petroleum. They were burnt to generate electricity which can produce carbon dioxide and simply heat up the earth while the renewable energy that use turbine in hydraulics system does not require and burning activity. Turbine is use to generate electricity for hydro-power. As water is a must use nowadays in pipe-system, a study is made to summarized on how the turbine can be use in to generate electricity from the kinetic force comes from the water flow in hydraulics system. The velocity of the water and flow rate of the water in pipe system will influence the kinetic energy towards the turbine. In this study also will be summarizing the most efficient hydro turbine based on past study cases.

2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study.

2.1 Materials of turbine blades

The choice of substances for specific elements of the turbine relies upon at the power or tension/compression the element can with stand, warmness switch coefficient and thermal resistivity make certain that the whole weight need to be minimal. In deciding on substances, excessive attention became given to light-weight substances which could resist pressure and pressure of that unique element compared to heavy or cumbersome substances. In view of the fact that turbine blades of water turbines are always exposed to power and immersed in water, they are required to have high strength and corrosion resistance.

- Steel alloy

2.2 Methods

To conduct the review, readings from writing sources had been made. Where a study of flow rate and efficiency had been made. Firstly, to understand how the pipe system work. Then, identify the most suitable turbine that can be used in pipe system. As the pipe system had large rate of water flow, it can be summarized from the reading made that the suitable turbine is an axial flow turbine design. Then, identify the turbines that had an axial flow design. There are 7 steps in selecting the turbine which are:

- Specification of turbine used.
- Selection criteria.
- Analysis of quantitative between impulse or axial type of turbine.
- Analysis of qualitative.
- Turbine choice.
- Top level requirement.
- Final turbine selection.

Every each of turbine system has its own specifications and needed to be fulfil, which are formulated through discussions together. It consists of the condition on the site where the requirement like flow and head or the requirement of the output power. It will also consist with requirement of the environment such as, the location of the site may not be reach, the place had a high degree of temperature or a few regulations needed to comply with. The turbine could be capable of its own routine maintenance inspections by on-site operators, or may need operated by control from the remote, so it should only need minimal maintenance with highly reliable. [10]

By using specifications and requirement been derived, then the development from the selection criteria can be made. The selection of the criteria that can be apply and class them into two class which are qualitative and quantitative standards. Allocation is not decisive, because some criteria may be qualitative or quantitative. [10]

In this study, turbine is then divided into two classification which, first is the reaction turbine and second is impulse type of turbine. For the type of impulse turbine, the speed of the triangle of water jet impinging on the turbine blades is used to analyse the pulse turbine. [5]

The qualitative analysis use is interpreted as criteria to determine the qualitative aspects of turbine selection. Each criterion is assigned a unique definition and a scoring system. The scoring system is defined between 1 to 5 where it is from poor to excellent, which is the normal extreme used in this conceptual evaluation method. Then each wind turbine is scored according to the scoring system in the group discussion. Scoring system is specify for each of the different selection criteria. If there are multiple aspects in a standard, then the following standard is used to completely specify every of the different aspects. Use arithmetic or weighted average to combine these to form score for the standard. Then normalize the quality score to the maximum value. [8]

By using the results from the qualitative analysis and quantitative analysis, this will rank the turbines and provide various options to be choose from. The top-level requirements are depended on the opinions and real-life valuable issues. For example, the direction of management, the availability of components and materials, or the capabilities of the company's manufacturing. [10] Candidate turbine selection is evaluated by the top selected requirements and solutions. The solution chosen in the end probably not be the highest-ranked selected candidate because it may not meet the top-level requirements. [10]

3. Results and Discussion

As usual in conduct project, expectation to the positive result is need. Every data was analysed and make a conclusion based on result.

3.1 Turbine efficiency

The efficiency of the turbine is set on the flow rate, and the operating range of the turbine and head is displayed in Figure 1, which can be selected according to the power capacity and head. If a certain power output is required, this figure can also be used as a reference for selecting the most suitable type of micro-hydro turbine. An important factor showing the applicability of micro-turbine types is their relative efficiency under different flow rates, design points and heads. Each type of turbine has its characteristic efficiency under different heads and split flows.

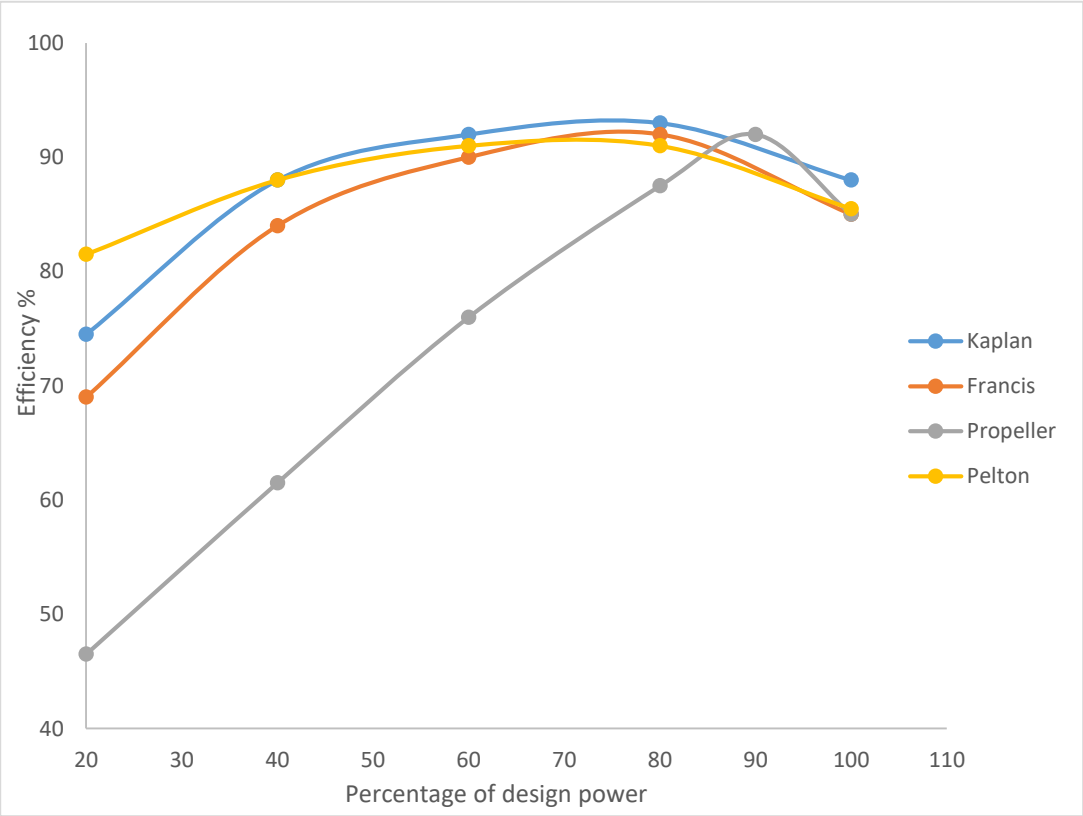

Figure 1: Design power vs Turbine efficiency

3.2 Relationship of turbine efficiency and flow rate

The turbines efficiency is being highly influenced by the rate of the water flow (Table 1). Some studies are made that shows the effects from the different rates of flow to come out with the highest efficiency [4]

Table 1: Flow rate vs Turbine efficiency

Flow Rate, gpm	Percentage of efficiency
9.4	8.90
11.2	8.60
12.3	9.50
15.4	8.70
17.4	18.00
19.1	19.00
19.7	20.25
22.0	20.00

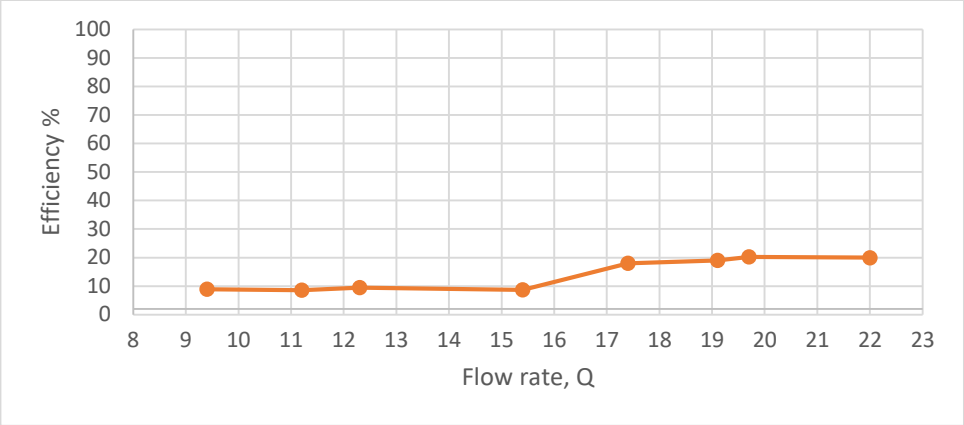

Figure 2: Flow rate vs Turbine efficiency

3.3 Selection of turbine

The type of turbine is selected depending on the maximum discharge taking the range of specific speed and operating head of each types of turbines. There are also other reasons and factors that need to be included during the turbine selection, that involve with the depth where the turbine should be placed, its cost effectiveness and also its performance. [3] Figures 2 shows a diagram in selection of applicable turbine type that been given with discharge and head. In the figure shown, most of turbines might be chosen for the discharged and same head. Hence, the most suitable turbine will be choose based on the conditions of the location that have compensation of the efficiency and comparison of characteristics and the size. [6] In summarize, Propeller turbine with fixed blade can maintain it efficiency where from the study case shows that it can maintain high efficiency over a high design power. This mean that, Propeller turbine can maintain at high flow rate even though it is less efficient at the beginning of the design flow and power.

4. Conclusion

Based from the research made, results included with three objectives were fulfilled. For the first objective, which is to study relationship of design power and efficiency of turbine had being done by reviewing a few journal and articles. Where, from a few journals reviewed made, comparison between turbines is made to know the efficiency of the turbines when the same design power is applied towards them. Second objective is to study on relationship of flow rate and turbine efficiency which successfully done by reviewing articles, journals and books. From the review made, found that, as the velocity increase, the efficiency also increased, which means, transform of kinetic energy to electric energy also increase. However, from the literature review made, and study of design power and efficiency of turbine, a turbine will reach a point where the efficiency will start declining as it reached it maximum efficiency. The third objective which is summarize the most efficient hydraulic turbine. To fulfil objective, a few case studies had been reviewed to analyse the turbines efficiency. From the review made, can be conclude that Kaplan turbine or propeller turbine (fixed blade design) is the most efficient turbine to use in conducting renewable energy. In this review, it found that Kaplan turbine can maintain it efficiency where the efficiency of the turbine in the studies is increasing along with the flow.

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