Design of Micro Hydro Power Plant and Energy Recovery from Cooling Water Outlet 210mw LMW Turbine in MTPS

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Abstract

Micro – Hydro – Electric Power is both an efficient and reliable form of clean source of renewable energy. It can be an excellent method of harnessing renewable energy from small rivers and streams. The Micro – Hydro project designed to be a run -of-river type, because it requires very little or no reservoir in order to power the turbine. The water will run straight through the turbine and back into the river or stream to use it for the other purposes. This has a minimal environmental impact on the local ecosystem.The choice of the turbine type depending mainly on the site head and flow rate. The turbine power and speed were directly proportional with the site head, but there were specific points for maximum turbine power and speed with the variation of the site water flow rate. The head losses in the penstock could range from 5 to 10 percent of the gross head, depending on the length of the penstock, quantity of water flow rate and its velocity. The turbine efficiency could range from 80 to 95 percent depending on the turbine type, and the generator efficiency about 90 percent. The design study showed that construction of Micro-Hydro-Electric project was feasible in the project site and there were no major problems apparent at the design and implementation stages of the micro-hydro-electric power plant.

Keywords---*Turbine, Mat lab-Simulink, Generator*.

I. INTRODUCTION

Energy is one of the most ultimate elements of our Universe. It is inevitability for survival and indispensable for development 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 .In the last decade, problems related to energy crisis such as oil crisis, climatic change, electrical demand and restrictions of whole sale markets have a risen world-wide. These difficulties are continuously increasing, which suggest the need of technological alternatives to assure their solution. One of these technological alternatives is generating electricity as near as possible of the consumption site, using the renewable energy sources that do not cause environmental pollutions, such as wind, solar, tidal and Hydro-Electric power plants. Hydro-electric power is a form of renewable energy resource, which comes from the flowing water. To generate electricity, water must be in motion. When the water is falling by the force of gravity, its potential energy converts into kinetic energy. This kinetic energy of the flowing water turns blades or vanes in a hydraulic turbines, the form of energy is changed to mechanical energy. The turbine turns the generator rotor which then converts this mechanical energy into electrical energy. The power generated from falling water has been harnessed in various applications such as milling grains, sawing wood and pumping water for irrigation. The slow-moving water wheels are used to harness the mechanical power from flowing water. The design and efficiency improvements made to these early water wheels led to the rise of the hydro-electric turbines.

Block Diagram of Proposed System

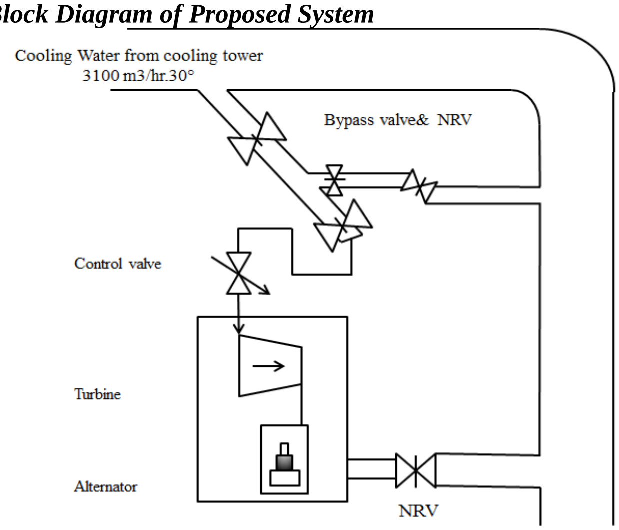

Figure 1: Block Diagram of Hydro Electric Power Plant

The diagram shows proposed system of Micro-hydroelectric power plant. It consists of an alternator, turbine and valves for controls. Cooling water is circulated through cooling water basin from condenser outlet to cooling water pump house. We just bypass the water of having water flow of $0.8m^{3/s}$, by reduce the length of the path it increase the water flow to $1.6m^{3/s}$. Huge amount of energy is wasted in the outlet of turbine as heat. Since hydro is a non-renewable energy, saving of water source is essential.The second function for water in such a thermal power plant is to cool the system so as to content the low pressure steam and recycle it. As the steam in the internal circuit condenses back to water the waste heat which is removed from it needs to be discharged by the transfer to the air or to the body of water.

The width of the cooling water pump is 10feet and the flow of the water in this pump is $0.9m^{3/s}$ the width of the pump is reduced to 5 feet then the water flow is increased double times. The water flow is $1.6m^{3/s}$ when the width is reduced to 5 feet. This water flow is given to Francis turbine which is increase 15m head. NRV's are used to restrict the back flow of water from the cooling water basin. It is help full to avoid the reversal of turbine operation. bypass valves are used when maintenance work are process.

II. EXISTING SYSTEM

Assessing the impacts from a new technology implementation is not simple, as the small hydro project design process is highly intricate and complex. For example, there is often more than one type of turbine technology that is technically suitable for installation at a site, necessitating that the final decision be made based on economic performance. However, no tools currently exist to evaluate trade-offs among different technology options. The trade-offs among different components of a hydropower plant (e.g., equipment or civil works costs), between initial capital costs and operation and maintenance costs, or between lifecycle costs and revenues (e.g., related to project capacity, efficiency, and energy production) can make an initial comparison difficult. Often, the capital associated with a new technology is more expensive than traditional alternatives, but secondary impacts on plant system design and generating performance make the novel approach a superior economic choice. In short, a plant performance evaluation and system design are necessary to capture the full range of economic impacts resulting from application of a technology; and understanding how emerging small hydro technologies are applicable across hydropower resources requires a holistic approach to modeling plant design and costs.

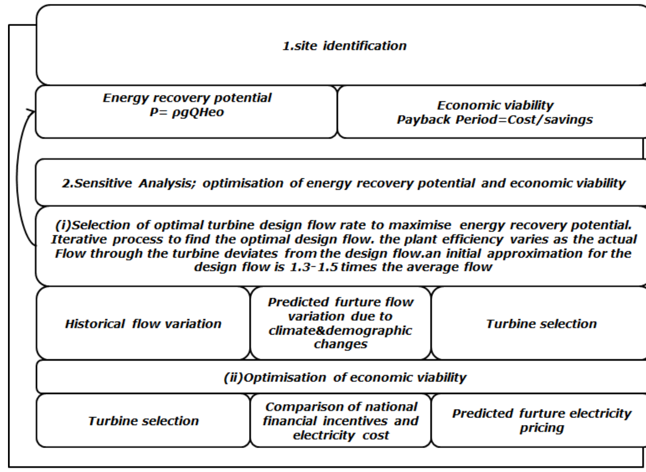

Figure.2: Block diagram of existing system

III. PROPOSED SYSTEM

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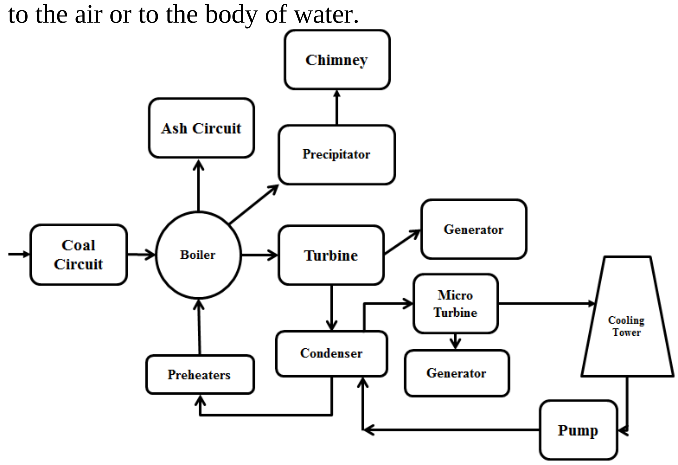

Figure.3: Block Diagram

IV. IMPLEMENTATION METHODOLOGY

This chapter will be described the methods that has been implement in this research. This research implementation method will be divide into 4 phases in order to make everything more systematic, manageable and easier to troubleshoot. Below is the 4 phases that will be done throughout this research:

Phase 1 : Project planning
Phase 2 : Project research
Phase 3 : Project development
Phase 4 : Project verification and analysis

A. Phase 1: Project Planning

The project planning is most important to develop the project because it is involving the whole processes from the project title until the end. It also as a guideline for project implementation. At this phase, the title of project is choosing after have a discussion with the supervisor. From the discussion that have done, the problem statement, objective and the scope of limitation have been identified to develop this project.

B. Phase 2: Project Research

In this phase, the research of the project that will be developing is done and the software that will be used in this project has been studied. By this way, it will make easier to work on this software because the understanding about this software has been studied.
During the research, the books, thesis and journal are also used to get the information for developing this project. A few websites that are related with this project has been surfing in order to get more information to develop this project.

C. Phase 3: Project Development

In the system development phase, the parameter that are normally used in micro hydro system are collected. After that, design the modeling of the micro hydro system.

D. Phase 4: Project Verification and Analysis

The last phase of this research is, the modelling that has been designed will be tested to make sure it operates successfully or not. If the modelling design is not operated the analysis of this project will be occurred to identify the problem to make sure this modelling design work successful.

FRANCIS TURBINE

Francis turbines are the most common water turbine in use today. They operate in a water head from 10 to 600 m (130 to 2,000 feet) and are primarily used for electrical power production. The electric generators that most often use this type of turbine have a power output that generally ranges from just a few kilowatts up to 800 MW, though mini hydro installations may be lower. Penstock (input pipes) diameters are between 3 and 33 feet (0.91 and 10 m). The speed range of the turbine is from 75 to 1000 rpm. A wicket gate around the outside of the turbine's rotating runner controls the rate of water flow through the turbine for different power production rates. Francis turbines are most always mounted with the shaft vertical so as to isolate water from the generator. This also facilitates installation and maintenance. Francis turbines may be designed for a wide range of heads and flows. This, along with their high efficiency, has made them the most widely used turbine in the world. Large Francis turbines are individually designed for each site to operate with the given water supply and water head at the highest possible efficiency, typically over 90%.

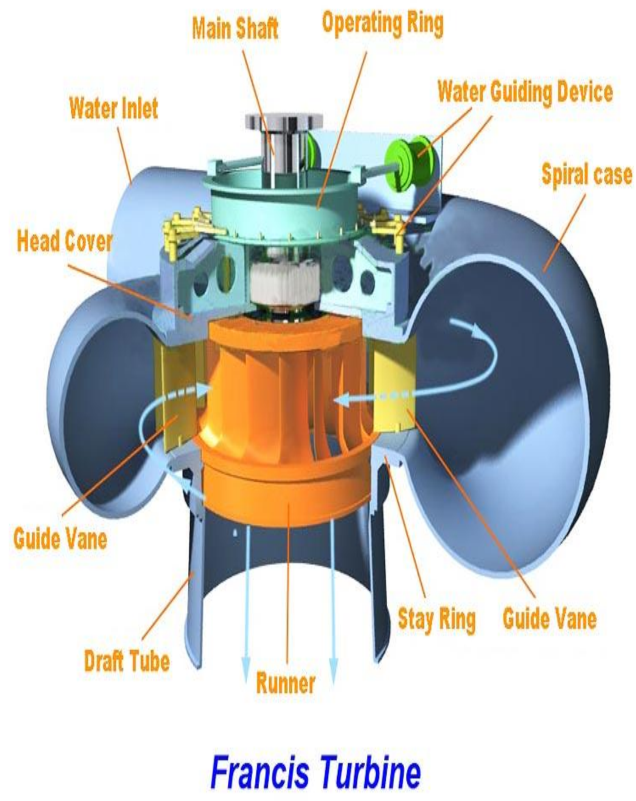

Figure.4 Francis Turbine

COMPONENTS

A Francis turbine consists of the following main parts:

Spiral casing

The spiral casing around the runner of the turbine is known as the volute casing or scroll case. Throughout its length, it has numerous openings at regular intervals to allow the working fluid to impinge on the blades of the runner. These openings convert the pressure energy of the fluid into momentum energy just before the fluid impinges on the blades. This maintains a constant velocity despite the fact that numerous openings have been provided for the fluid to enter the blades, as the cross-sectional area of this casing decreases uniformly along the circumference.

Guide and stay vanes

The primary function of the guide and stay vanes is to convert the pressure energy of the fluid into the momentum energy. It also serves to direct the flow at design angles to the runner blades.

Runner blades

Runner blades are the heart of any turbine. These are the centers where the fluid strikes and the tangential force of the impact causes the shaft of the turbine to rotate, producing torque. Close attention in design of blade angles at inlet and outlet is necessary, as these are major parameters affecting power production.

Draft tube

The draft tube is a conduit that connects the runner exit to the tail race where the water is discharged from the turbine. Its primary function is to reduce the velocity of discharged water to minimize the loss of kinetic energy at the outlet. This permits the turbine to be set above the tail water without appreciable drop of available head.

THEROY OF OPERATION

Francis turbine is a type of reaction turbine, a category of turbine in which the working fluid comes to the turbine under immense pressure and the energy is extracted by the turbine blades from the working fluid. A part of the energy is given up by the fluid because of pressure changes occurring in the blades of the turbine, quantified by the expression of degree of reaction, while the remaining part of the energy is extracted by the volute casing of the turbine. At the exit, water acts on the spinning cup-shaped runner features, leaving at low velocity and low swirl with very little kinetic or potential energy left. The turbine's exit tube is shaped to help decelerate the water flow and recover the pressure.

RESULT ANALYSIS

Figure: Flow rate [Q]and Head [H]of a stream

In micro hydro system, there are two factors determine the power potential of the water flowing or stream flow and the head. The potential power can be determined as:

$$P = \eta \rho Q g h$$

Where

- P= power [W]
- η =Dimensionless efficiency of the turbine [approx. 0.9]
- ρ=Density of water [1,000 kg/m^3]
- Q =Volumetric flow rate [m^3/s]
- g =Acceleration due to gravity [9.8 m/s^2]
- h =Height difference between inlet and outlet [m]

This potential energy will turn into kinetic energy when the water falls down over the head through the pipeline. This kinetic energy is kind of pressure which will rotate the shaft of hydraulic turbine. Mechanical energy from turbine then will drive synchronous generator to produce electricity in term of alternating current (AC). The electricity will then be distributed to residences. The AC power supply must be maintained at a constant 50 or 60 cycles/second for the reliable operation of any electrical equipment using the supply. This frequency is determined by the speed of the turbine which must be very accurately governed.

V. CONCLUSION

Small scale hydro control keeps on developing far and wide, it is imperative to demonstrate people in general how doable smaller scale hydro frameworks really are in an appropriate site. The main prerequisites for miniaturized scale hydro power are water sources, turbines, generators, appropriate outline and establishment, which helps every distinct individual as well as helps the world and condition all in all. The decision of turbine will depend for the most part on the weight head accessible and the water stream rate. There are two fundamental methods of operation for hydro control turbines: Impulse and response. Motivation turbines are driven by a stream of water and they are appropriate for high heads and low stream rates. Response turbines run loaded with water and utilize both rakish and straight force of the streaming water to run the rotor and they are utilized for medium and low heads and high stream rate. Managed turbines can move their bay guide vanes or runner cutting edges keeping in mind the end goal to increment or lessen the measure of stream they draw. Cross-stream turbines are viewed as best for miniaturized scale hydro ventures with a head of 6 meters or less and water stream rate 0.9m3/s or less. Miniaturized scale hydro control establishments in warm power plant are generally keep running of water from the condenser outlet which drives the turbine to produce the electrical power from a generator and fills in as an auxiliary power plant in the current framework

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