Prospect of Micro Hydro Power in Hilly Area

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Abstract— The purpose of this thesis is to first conduct a literature review regarding the technical specifications and design parametres required to design a working Micro Hydro Power System MHS (Micro Hydropower System). After review of the theory and principles of Micro Hydro System design; these principles are applied to the real case of Lamaya Khola Micro Hydro Project in Pangrang Village Development Committee (VDC) of Hilly Area. The field data required to design the civil components of the micro hydro project were derived from secondary data sources such as the study conducted by the village development committe as well as other independent project surveys. The micro hydro designed in this thesis was of "run-of-the river" type. Similarly, system components designed in this thesis are intake structure, headrace canal to divert the water from the source, forebay tank, sedimentation basin and the penstock assembly. Owing to the complexity and lengthy process of designing all of the system components; only these specific civil structures are designed in this study.

Key words: Micro-Hydro System Design, Implementation, Micro-Hydropower in Hilly Area

I. INTRODUCTION

A. *Micro Hydro Power System:*

A micro hydro system is a water-diversion electricity generation and supply intended to provide a village, hamlet etc. with electricity for various applications such as the following. Hydropower is a renewable, non-polluting and environmentally benign source of energy. Hydropower is based on simple concepts. Moving water turns a turbine, the turbine spins a Generator and electricity is produced. Many other components may be in a system, but it all begins with the energy in the moving water. The use of water falling through a height has been utilized as a source of energy since a long time. It is perhaps the oldest renewable energy Technique known to the mankind for mechanical energy conversion as well as electricity Generation. In the ancient times waterwheels were used extensively, but it was only at the beginning of the 19th Century with the invention of the hydro turbines that the use of hydropower got popularized.

Small-scale hydropower was the most common way of electricity generating in the early 20th Century. India has a century old history of hydropower and the beginning was from small hydro. The first hydro power plant was of 130 kW set up in Darjeeling during 1897, marked the development of hydropower in the country. Similarly, by 1924 Switzerland had nearly7000 small scale hydropower stations in use.

B. *Power Generation Capacity:*

Hydro power projects are generally categorized in two segments i.e. small and large hydro. The different countries have different criteria to classify hydro power plants a general classification of hydro power plants is as follows.

Type	Capacity
Large-hydro	More than 100 MW and usually feeding into a large electricity grid
Medium-hydro	More than 100 MW and usually feeding into a large electricity grid
Small-hydro	15 – 100 MW - usually feeding a grid
Mini-hydro	1 - 15 MW - usually feeding into a grid
Micro-hydro	Above 100 kW, but below 1 MW; either standalone schemes or more often feeding into the grid
Pico-hydro	From a few hundred watts up to 5Kw

Table 1.1: common classification of power plant based on capacity generation

In India though, hydro projects up to 25 MW station capacities have been categorized as Small Hydro Power (SHP) projects. The Ministry of New and Renewable Energy, Government of India is the agency responsible for planning, financing and installation of SHP up to 25 MW capacities.

Type	Capacity in KW
Micro-hydro	Up to 100 KW
Mini-hydro	101 to2000 KW
Small-hydro	2001 to 25000 KW
Large-hydro	>25000 KW

Table 1.2: Classification of power plant in India

Apart from the above classification, some of the other terms in vogue nowadays when describing very small hydro power plants are 'Pico Hydro' (less than 5 kW) and 'Tiny Hydro' (less than 1kW).

Small hydro plants are also classified according to the "Head" or the vertical distance through which the water is made to impact the turbines. The usual classifications are given below:

Type	Head range.
High-head	100-m and above
Medium-head	30-100 m
Small-head	2-3 m

Table 1.3: Classification of power plant on the basis of Head range

1) Classification Of Hydro Plants On The Basis Of Hydraulic Characteristics:

On the basis of this classification, the hydro plants may be divided into the following types.

(1) Run-off river plants
(2) Storage plants
(3) Pumped storage plants
(4) Tidal plants

Most of the small hydro power plants are "run-of-river" schemes, implying that they do not have any water storage capability. The power is generated only when enough water is available from the river/stream. When the stream/river flow reduces below the design flow value, the generation ceases as the water does not flow through the intake structure into the turbines. Small hydro plants may be stand alone systems in isolated areas/sites, but could also be grid connected (either local grids or regional/national grids). The connection to the grid has the advantage of easier control of the electrical system frequency of the electricity, but has the disadvantage of being ripped off the system due to problems outside of the plant operator's control.

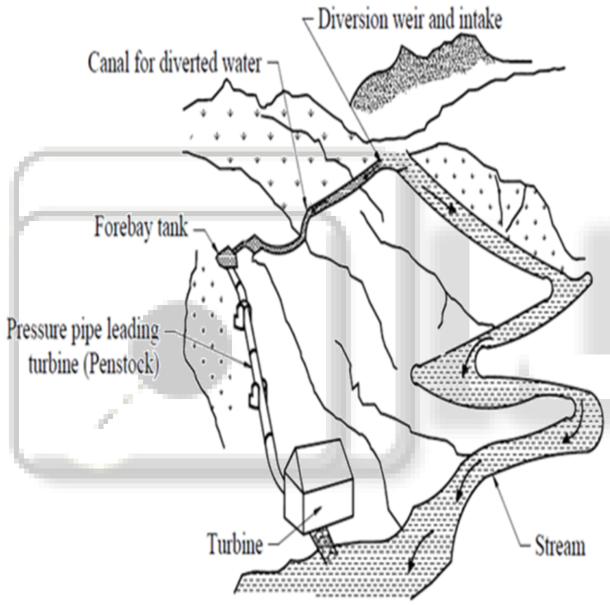

Fig 1.1: Classification of power plant based on capacity generation

C. Technical specifications of micro hydro power plant scheme:

The water in the river is diverted by the weir through an opening in the river side (the 'intake') into a channel (this could be open or buried depending upon the site conditions). Settling basins built in to the channel to remove sand and silt from the water. The channel follows the contour of the area so as to preserve the elevation of the diverted water. The channel directs the water into a small reservoir/tank known as the 'fore bay' from where it is directed on to the turbines through a closed pipe known as the 'penstock'. The penstock essentially directs the water in a uniform stream on to the turbine at a lower level. The turning shaft of the turbine can be used to rotate a mechanical device (such as a grinding mill, oil expeller, wood lathe, etc.) directly, or to operate an electricity generator. The machinery or appliances which are energized by the turbine (or MHP) are called the 'load'. When electricity is generated, the 'power house' where the generator is located transfers the electricity to a step-up 'transformer' which is then transmitted to the grid sub-station or to the village/area where this electricity is to be used.

Basic components of a typical micro-hydro system and shown in the following figure and may be described as follows:

D. Main Component Of MHP Plant:

MHP plant is designed to generate electrical or mechanical power according to the demand of local community. Main components of MHP plant are civil component, mechanical component, and electrical/electronic component. A civil component includes diversion, intake, de-sanding basins, canal, fore-bay, spillway, penstock, power house, tailrace etc.

These components are Diversion structure is a structure designed to raise the water level in the stream in order to enable water to be diverted off the river. The weir may be of natural or an artificial weir (temporary or permanent construction). In MHP, generally temporary structures are built for this purpose. These structures are in most cases simply consists of boulder/mud piling resembling the diversion practiced in traditional watermills. In some cases gabion weirs are also used for diverting water.

E. Civil Works Components:

1) Diversion Weir And Intake:

The diversion weir a barrier built across the river used to divert water through an opening in the riverside (the 'Intake' opening) into a settling basin. The receiving a flow from river in required quantity and that directing it towards the waterways of a hydropower system with minimal structural interventions is called intake. It is the point from where water flows from the river stream. Therefore intake is the beginning of the conveyance of water diverted for MHP Types of intake structure are chiefly distinguished by the method used to divert water from the river. In micro hydropower, mainly two types of intake considered are side intake and bottom intake. Trash racks are placed at the intake to prevent logs, boulders and other large water-born objects from entering the waterway.

2) Canal:

The headrace of a micro-hydropower scheme is a canal or a pipe that conveys water from the intake to the fore-bay. In MHP sometimes pipes substitute canals. Many types of headrace canal made of different materials and using different methods of construction are used in MHP schemes. The types and the design depends on site condition (seepage, land slide, crossing) and availability of material and manpower. The common types of canal used in MHP plant are earth canal, stone masonry in mud mortar canal, stone masonry in cement mortar canal, concrete canal, covered canals and pipes, Most headrace pipes used in MHP are HDPE pipes. The length of headrace can be from a few meters to over a kilometer. Generally small slopes are preferred for designing canals. The slopes are med just enough for the flow of water in the canal. Higher slope means higher velocity of water in canal. This not only erode canal surface, it also lose water energy available.

3) Settling Basin:

The settling basin is used to trap sand or suspended silt from the water before entering the penstock. It may be built at the intake or at the fore bay. The water diverted from the stream and carried by the channel usually carries a suspension of small particles such as sand that are hard and abrasive and can cause expensive damage and rapid wear to turbine runners. To get rid of such particles and sediments, the water flow is allowed to slow down in 'settling basins' so that the sand and silt particles settle on the basin floor. The deposits are then periodically flushed. The design of settling basin depends upon the flow quantity, speed of flow and the tolerance level of the turbine (smallest particle that can be allowed). The maximum speed of the water in the settling basin can thus be calculated as slower the flow, lower is the carrying capacity of the water. The flow speed in the settling basin can be lowered by increasing the cross section area Sediments get deposited in the canal and fore-bay, which reduces carrying capacity of the canal. The design canal capacity can be maintained only through frequent clearing, which is very expensive. Sediment among others consists of hard silica compounds. These compounds erode the penstock and turbine. This at the one hand increases the operating costs and at the other decreases efficiency of the MHP.

The purpose of de-sanding basin is to trap sediments so that these do not enter the canal. The de-sanding basin is, as a rule, built at the head of the canal and it is regarded as a part of the head works. The de-sanding basin is wide and long pool designed to settle the sediments carried by the diverted water through reduction in the speed of water. Most de-sanding basins are designed to settle particles above 0.2 – 0.3 mm. De-sanding basin is provided with a sediment flush in order to reduce the cost associated with its cleaning. During the rainy season daily flushing of the de-sanding basin may be required.

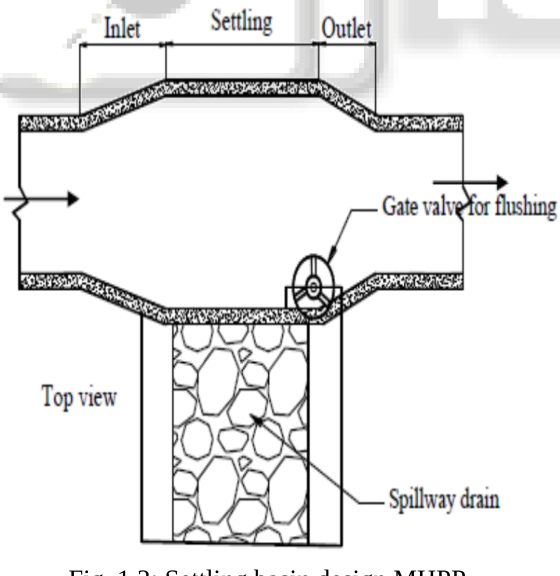

Fig. 1.2: Settling basin design MHPP

4) Spillways:

Spillways along the power channel are designed to permit overflow at certain points along the channel. The spillway acts as a flow regulator for the channel. During floods the water flow through the intake can be twice the normal channel flow, so the spillway must be large enough to

Divert this excess flow. The spillway can also be designed with control gates to empty the channel. The spillway should be designed in such a manner that the excess flow is fed back to the without damaging the foundations of the channel.

5) Fore Bay:

A Fore-bay is located at the end of headrace. A fore bay is a wide and deep pool from which the penstock draws water. The purpose of the fore-bay is to avoid air trapping by the water entering the penstock, as the entry of air through the penstock may cause cavitations, which is a type of erosion created by the explosion of trapped air bubbles under the high pressure, of both penstock and turbine. It has air vet for the release of air. The water level at the fore-bay determines the operational head of the micro-hydro scheme.

A small overflow is to be maintained from the fore-bay in order to avoid fluctuation of its level and consequently the possible entry of air to the penstock. At the fore-bay to spill the entire design flow in case of sudden valve closure at the powerhouse such overflow may continue for long time if the canal intake is not closed.

The fore bay tank serves the purpose of providing steady and continuous flow into the turbine through the penstocks. Fore bay also acts as the last settling basin and allows the last particles to settle down before the water enters the penstock. Fore bay can also be a reservoir to store water depending on its size (large dams or reservoirs in large hydropower schemes are technically fore bay). A sluice will make it possible to close the entrance to the penstock. In front of the penstock a Trash rack need to be installed to prevent large particles to enter the penstock. A spillway completes the fore bay tank. The fore bay in the form of a tank connects the headrace to the penstock. The tank may be made in stone or brick masonry.

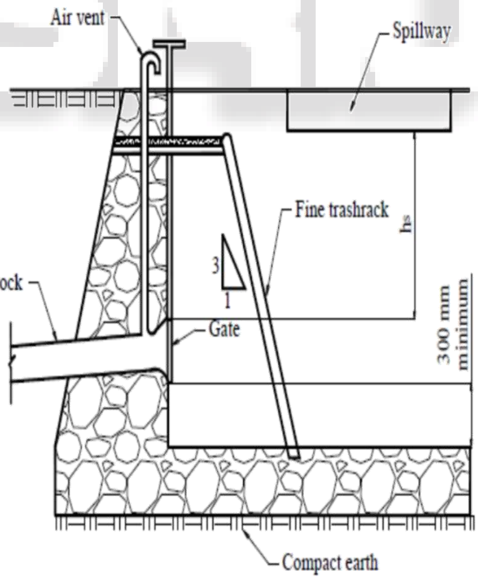

Fig. 1.3: Design of fore bay in MHPP

6) Penstock:

A penstock is a close conduct pipe that conveys the flow from the fore-bay to the turbine. Penstock is made of steel or HDPE, and rarely of timber. Recently PVC penstock has also been introduced. If HDPE penstock is prevalent at lower heads, steel penstock is prevalent at higher heads. The MHP head varies from a few meters to over hundred meters. Ghandruk MHP of Nepal has a head of 220 m, which is the highest in Nepal among MHP. Mild steel and HDPE pipes are the most common materials used for the penstock in

MHP schemes. HDPE pipes are usually economical for low heads and flows and are easy to join and repair.

The conversion of potential energy of water into kinetic energy takes place in the penstock. The typical velocity of water in the penstock is around 3 m/sec. In order to reduce the head loss in penstock it is desirable to make the penstock short and less bends. For this purpose penstock is located in a steep slope, which is very often over 450 too. Above ground penstock pipes are subjected to expansion or contraction in length as a result of changes in the ambient temperature. A sliding type of expansion joint is commonly used in MHP schemes. It can be placed between two consecutive pipe lengths and can either be welded or bolted to the pipes. Anchor blocks are used to holds the penstock to restrain the pipe movement in all directions. It is a mass of concrete fixed into the ground. Support piers are short columns that are placed between anchor blocks along straight sections of exposed penstock pipe. Support piers prevent the pipe from sagging and becoming over stressed.

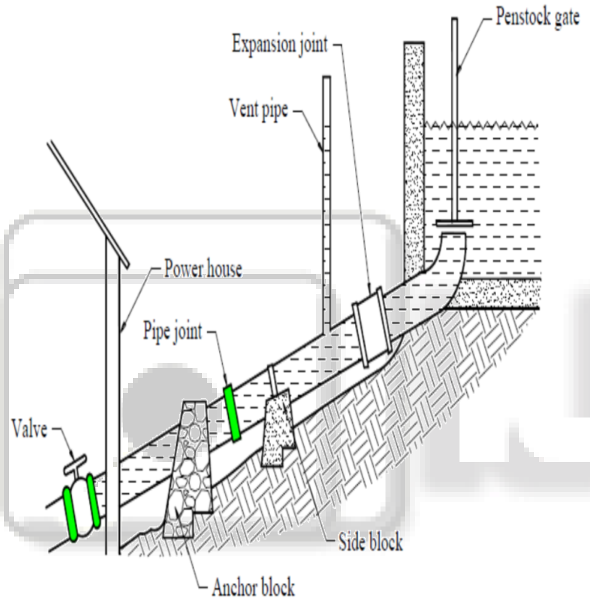

Fig. 1.4: Design of Penstock pipe in MHPP

7) Powerhouse:

The powerhouse accommodates electro-mechanical equipment such as the turbine, generator, agro processing units and control panels. Conversion of mechanical energy of water into electrical energy takes place in the powerhouse. The main function of the powerhouse is to protect the electro mechanical units from rain and other weather effects as well as possible mishandling by un authorized person.

8) Tailrace:

The tailrace is the final civil structure that conveys the design flow from the turbine (after power generation) back into the stream, generally the same stream from which the water was initially withdrawn. Similar to the headrace, open channel or pipes can be used for the tailrace section.

F. Electrical Component:

1) Water Turbine And Generator:

A water turbine is a machine to directly convert the kinetic energy of the flowing water into a useful rotational energy while a generator is a device used to convert mechanical energy into electrical energy. A hydraulic turbine is a prime mover that uses the energy of flowing water and converts it into the mechanical energy (in the form of rotation of the runner). Science ancient time turbines are used under the name of water wheels, made out of wood. The water wheels have very low efficiency and short life.

There are different types and sizes of turbine available but the particular type and size for the particular site is determined by,

(1) Designed head and discharge at which the turbine is to operate,
(2) Availability and cost of the turbine
(3) Availability of skill man power after sales services and cost etc.

Particular speed of each turbine rotor at which it performs best is called its optimum speed. The turbine needs to be operated at this speed at all loading conditions to get the maximum output.

2) Types Of Turbines:

Principally, according to the working of turbine it can be categorized into two types, as impulse turbines, and reaction turbines. Under these two main categories there come many types of impulse turbines which can be selected for given site.

Types of turbine	**High head**	**Medium head**	**Low head**
Impulse turbines	Pelton Turgo	Cross-flow Multi-jet pelton Turgo	Cross-flow
Reaction turbines		Francis	Propeller Kaplan

Table 1.4: Head used according to types of turbine

a) Impulse Turbine:

There are three types of impulse turbines known as Peloton turbine, Turgo turbine and Cross flow turbine. In these turbines the rotor rotates freely in atmospheric pressure. The rotor is never be submerged in water of the tail race. It is kept above the tail race water level and the nozzles of these turbines are free jet type. In this turbine pressure energy in water is converted into kinetic energy when water passed through nozzle. Free high velocity water jet impinges on the bucket mounted on the periphery of the runner. Impulse force on the bucket rotates the runner and shaft of turbine.

b) Peloton Turbine:

Consists of a wheel with a series of split buckets set around its rim; a high velocity jet of water is directed tangentially at the wheel. The jet hits each bucket and is split in half, so that each half is turned and deflected back almost through 180º. Nearly all the energy of the water goes into propelling the bucket and the deflected water falls into a discharge channel.

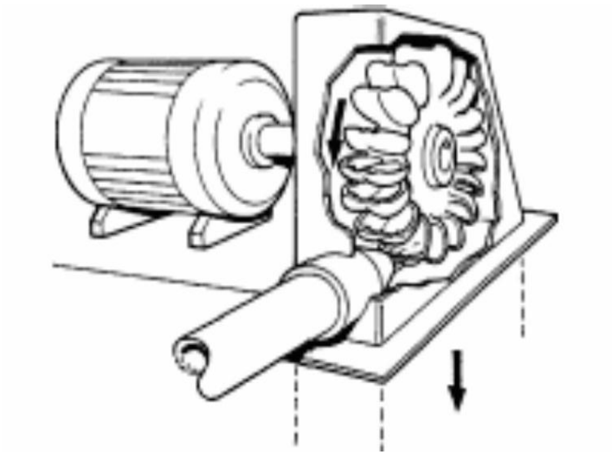

Fig. 1.5: Design of Peloton Turbine

c) Turbo turbine:

Turbo turbine is similar to the Peloton but the jet strikes the plane of the runner at an angle (typically 20°) so that the water enters the runner on one side and exits on the other. Therefore the flow rate is not limited by the discharged fluid interfering with the incoming jet (as is the case with Peloton turbines). As a consequence, a Turbo turbine can have a smaller diameter runner than a Peloton for an equivalent power.

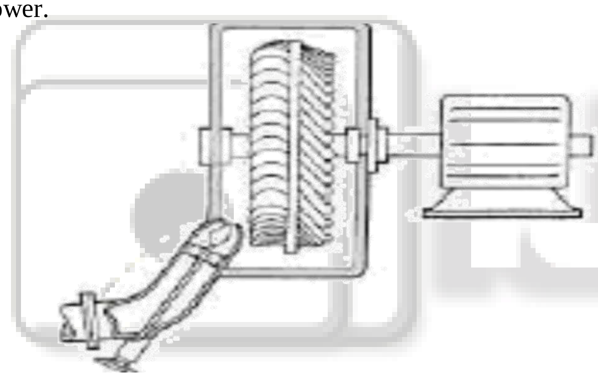

Fig. 1.6: Design of Turbo Turbine

d) Cross Flow Turbine:

Cross flow turbine has a drum-like rotor with a solid disk at each end and gutter-shaped "slats" joining the two disks. A jet of water enters the top of the rotor through the curved blades, emerging on the far side of the rotor by passing through the blades a 2nd time. The shape of the blades is such that on each passage through the periphery of the rotor the water transfers some of its momentum, before falling away with little residual energy.

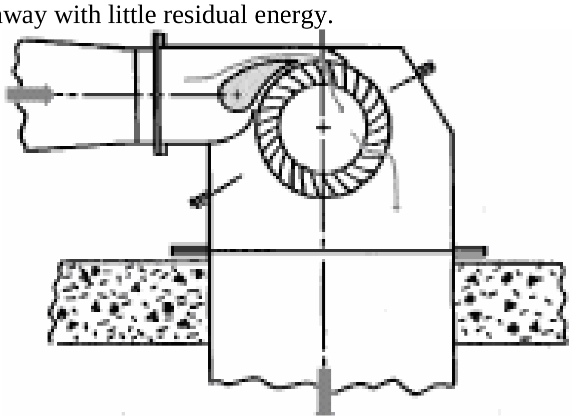

Fig. 1.7: Design of Cross flow turbine

e) Reaction Turbine:

In reaction turbine s rotor remains immersed in water all the time and water acting on wheel is under pressure which is greater than atmospheric pressure. Draft tube is an integral part of the reaction turbine fitted at outlet. It runs by the reaction force of the exiting fluid. Potential energy and kinetic energy of the fluid come to stationary part of turbine blades and partly changes potential energy and kinetic energy. Moving part (runner) utilize.

f) Propeller Turbine:

Propeller turbines are similar in principle to the propeller of a ship, but operating in reversed mode. Various configurations of propeller turbine exist; a key feature is that for good efficiency the water needs to be given some swirl before entering the turbine runner. With good design, the swirl is absorbed by the runner and the water that emerges flows straight into the draft tube. Methods for adding inlet swirl include the use of a set of guide vanes mounted upstream of the runner with water spiraling into the runner through them.

g) Francis Turbine:

Francis turbine is essentially a modified form of propeller turbine in which water flows radically inwards into runner and is turned to emerge axially. For medium-head schemes Runner is most commonly mounted in a spiral casing with internal adjustable guide vanes.

Since the cross-flow turbine is less costly (though less efficient) alternative to the spiral-case Francis, it is rare for these turbines to be used on sites of less than 100 kW output. Francis turbine was originally designed as a low-head machine, installed in an open chamber without a spiral casing. Although an efficient turbine, it was eventually superseded by the propeller turbine which is more compact and faster-running for the same head and flow conditions.

h) Design And Selection Of Turbine:

For selection of a proper turbine for a specified head (Z) and flow rate (φv), turbine Diameter (D) and rotational speed of the turbine (ω) play a significant role.

(1) Diameter in relation to head and flow rate

$$\phi_v = \frac{\pi}{4} d^2 \sqrt{2gZ} \quad \text{or} \quad D = 7{,}7\frac{\left(\phi_v{}^{1/2}\right)}{(gZ)^{1/4}}$$

$7{,}7 = \Delta, specific\ diameter$

(2) Angular velocity in relation to head and flow rate

$$\omega = \frac{2u}{D} = \frac{20{,}48\sqrt{2gZ}}{D} \quad \text{or} \quad \omega = 0{,}178\frac{(gZ)^{1/4}}{\phi_v{}^{1/2}}$$

$0{,}178 = \Omega$, specific angular velocity

In the figure below gives an idea for the selection of a turbine for various combinations of Net head and discharge rate.

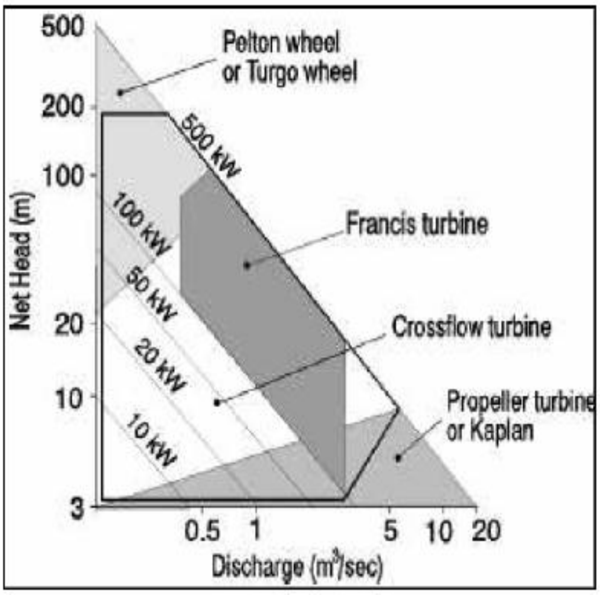

Fig. 1.8: Turbine selection based on Head and Discharge

i) Turbine Efficiency:

A significant factor in the comparison of different turbine types is their relative efficiencies both at their design point and at reduced flows. Typical efficiency curves are shown in the figure below. An important point to note is that the Peloton and Kaplan turbines retain very high efficiencies when running below design flow; in contrast the efficiency of the Cross flow and Francis turbines falls away more sharply if run at below half their normal flow. Most fixed-pitch propeller turbines perform poorly except above 80% of full flow.

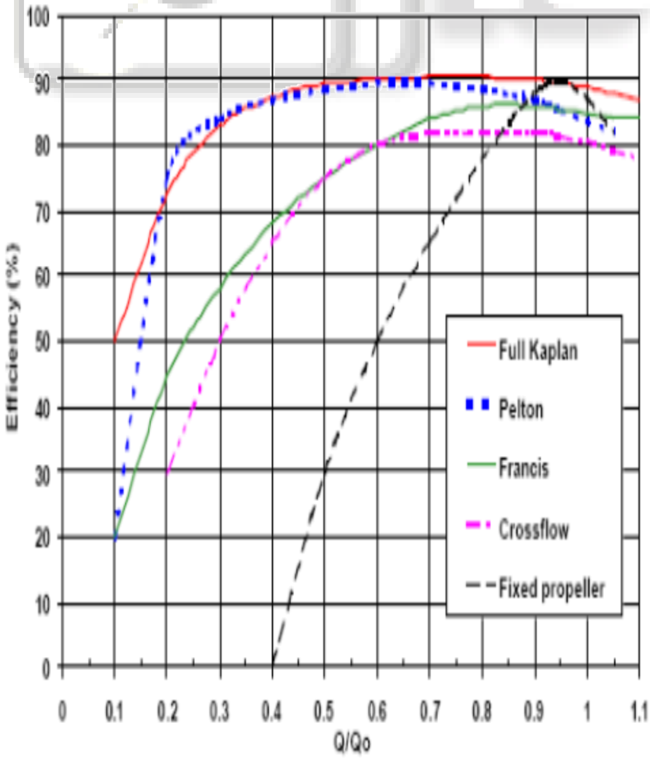

Fig. 1.9: Efficiency of various turbines of based on Discharge rate

3) Generator:

a) Type Of Generator:

Two kinds of generator can be adopted for generating electric power from the energy produced by water turbines.

(1) Fundamental classification of AC generator (DC generator is not usually used for small-scale hydropower plant)

– Synchronous generator Independent exciter of rotor is provided for each unit Applicable for both independent and existing power network.

– Induction generator No exciter of rotor is provided (squirrel cage type) (Asynchronous) usually applicable for network with other power source. Sometimes applicable for independent network with additional capacitors for less than 25 kW but not sores commendable for independent network due to difficulty of voltage control and life time of capacitors except cost Saving. Shaft arrangement either vertical shaft or horizontal shaft is applied to both type of above generators. (Mainly horizontal high speed type in case of micro/small plant except reverse pump turbine)

(2) Another classification is also applied to AC generator as follows;

– Three phase generator Star (λ) connection For 3 phase 4 wire networks Delta (Δ) connection for single phase 2 wire networks.

– Single phase generator this type is not used in power network system because it is difficult to purchase the generator with capacity of more than 2kW in market. In this case three phase generator with delta connection is applied as shown above.

4) Power Transmission Facility (Speed Increaser):

There are two ways of coupling the turbine and generator. One is a direct coupling with turbine shaft and generator shaft. The other is an indirect coupling by using power transmission facility (speed increaser) between turbine shaft and generator shaft. Rated turbine speed is fixed by the selected type of turbine and the original design condition of net head and water flow (discharge) cannot be changed. On the other hand, generator speed is to be selected from frequency as shown in the above table. Therefore, if the speeds of both turbine and generator are completely the same, turbine and generator can be coupled directly. However, such design of direct coupling is not always applicable due to high cost of turbine and generator, especially in case of micro or small hydropower plant. The power transmission facility (speed increaser) is usually adopted in order to match the speed of turbine and generator and save on cost.

Two kinds of speed increaser adopted for coupling turbine and generator are as follows:

a) Gear Box Type:

Turbine shaft and generator shaft is coupled with parallel shaft helical gears in one box with anti-friction bearing according to the ratio of speed between turbine and generator. The lifetime is long but the cost is relatively high. (Efficiency: 97 – 95% subject to the type) *b) Belt Type:*

Turbine shaft and generator shaft is coupled with pulleys (flywheels) and belt according to the ratio of speed between turbine and generator. The cost is relatively low but lifetime is short. (Efficiency: 98 – 95% subject to the type of belt)

5) Control Facility Of Turbine And Generator:

a) Speed Governor:

The speed governor is adopted to keep the turbine speed constant because the speed fluctuates if there are changes in load, water head and flow. The change of generator rotational speed results in the fluctuation of frequency. The governor consists of speed detector, controller and operation. There are two kinds of governor to control water flow (discharge) through turbine by operation of guide vane or to control the balance of load by interchanging of actual and dummy load as follows:

(1) Mechanical Type:

To control water discharge always with automatic operation of guide vane(s) according to actual load. There are following two types. Pressure oil operating type of guide vane(s) Motor operating type of guide vane(s)

(2) Dummy load type:

To control the balancing of both current of actual load and dummy load by thruster i.e. to keep the summation of both actual and dummy load constant always for the same output and speed of generator.

II. MICRO-HYDRO SYSTEM DESIGN

A. Generation Of Power From Water:

Energy is generated from water since ancient time. In those days water wheels are normally used to generate energy for grinding agricultural products. The efficiency for the production of energy in those days was insignificant. Development has been done by many researchers in the generation of energy from the water. According to the energy equation of Bernoulli, energy in the water is stored in terms of pressure energy, velocity energy and elevation energy as shown in the equation below,

Power (energy/sec) =pressure energy/sec + velocity energy/sec+ elevation energy

$$P = p/\rho g + v^2/2g + z$$

When there is the difference between the energy of water, the difference in the energy can be efficiently converted into useable energy by using hydropower plant. The energy at the intake of HPP will be high and the exits from the HPP will be low thus the energy from the water will be obtain as follow.

$$\text{Power (Energy/sec)} = (p/\rho g + v^2/2g + z)_{intake} - (p/\rho g + v^2/2g + z)_{exit}$$

There will be some loss of power during conversion from the available water energy by using hydropower plant. Those losses are expressed in term of efficiencies. Finally the power that can be generated by HPP is expressed as follow.

$$P = \rho \times g \times H \times Q \times ή$$

Where

P = Electrical or mechanical power produced, W
ρ = Density of water, kg/m3
g = Acceleration due to gravity, m/s2
H = Elevation head of water, m
Q = Flow rate of water, m3/s
ή = Overall efficiency of MHP system

Thus, equation shows that, power generated by the water available depends upon the amount rate (flow rate of water), elevation head (elevation difference between intake and exist of water), gravitation force, density of water and efficiency of the HP system. Thus by using HP plant, available water energy will be converted to the useful mechanical/ electrical energy as an output.

III. DISCUSSIONS

The first micro-hydropower plant was constructed in the 1930’s in San Pablo City, Laguna Province. Although the Philippines has more than 60-year history in micro-hydro development, most of the micro-hydropower plants, particularly those that are recently installed, are not operational or have some problems in their operation. Some identified issues or problems are the results of insufficient site assessment, poor quality of power plant facilities and electro-mechanical equipment, and inadequate operation and maintenance. Micro hydro is a primary source of energy in India especially in the northern and southern regions. Promoting renewable energy sources for energy requirements in conjunction with alleviation of rural poverty, diversification of energy resources and reduction of oil imports are needed to shift the economical growth towards greater sustainability, as well as environmental and social stability.

A. Advantage Of Micro Hydro Power Plant:

(1) Micro-hydro is generally defined as electricity generation capacity up to 100 kW.
(2) These plants do not need impoundment
(3) Hydropower is a renewable, non-polluting and environmentally benign source of energy.
(4) Like all hydro-electric power, run-of-the-river hydro harnesses the natural potential energy of water, eliminating the need to burn coal or natural gas to generate the electricity needed by consumers and industry.
(5) These plants are setup nearer to the load centers. It is According to the requirement of load.
(6) Electricity can be generated constantly.
(7) Power is usually available continuously on demand.
(8) No fuel is required and only limited maintenance are required.
(9) It is long lasting technology.
(10) It has almost no environment impact. Micro hydropower plant has some more advantages. Over other types of plants such as wind, solar power plant.
(11) Capacity factor of micro hydropower plant is high as compared with solar and wind.
(12) The predictability of micro hydropower plant is very high and is vary with annual rainfall patterns.
(13) Output power varies only from day to day not from minute to minute.

(14) A good correlation with demand.
(15) It has high efficiency which is varies from 70% to 90% by far the best of all energy technologies.

B. Disadvantage Of Micro Hydro Power Plant:

(1) River flows often vary considerably during monsoon type climates, and this can limit the firm power output to quite a small fraction of the possible peak output.
(2) There can be conflicts with the interest of fisheries on low head schemes and with irrigation needs on high head schemes.

IV. CONCLUSIONS AND FUTURE SCOPE OF FURTHER

A. Conclusions:

Although, this thesis was about designing the system components for a MHP (Micro Hydro Project), majority of the system components designed included only civil work components which comprised of the side intake, headrace canal, fore bay, sedimentation tank, and spillway and penstock assembly. However, the thesis would have gone be-yond its limitation in scope and length if the design parameters and design process for other civil components such as the physical powerhouse have been added. In addition to civil components, a MHP (Micro Hydro Project) also consists of powerhouse components such as generator, turbine and so on and other components related to electrical distribution. These were not included in this thesis.

Similarly, the practical design of various components that were conducted in this thesis also led to the realization that the design of the system components is very much deter-mined by the location specific factors. From the very beginning, the MHP (Micro Hydro Project) designed was constrained to being “run of the river” type, because the river source, Ram Gad, is situated in a mountainous topographical region Dehradun. Similarly, in the design of spillway, headrace canal and fore bay tank, the choices of materials were already determined by their availability and local topographical conditions. For exam- the choice of stone masonry with cement mortar type of canal for the headrace was considered because in the topographically hilly reason, mud mortar type, for example would have led to seepage of water from the canal and so would have caused landslide in the longer run which is not considered desirable. Similarly, the choice of mild steel for the penstock and the type of turbine selected were also largely selected based on the norm of the region. Altogether the study showed that construction of MHP (Micro Hydro Project) was feasible in the project site and there were no major problems apparent at least at the design stage of the micro hydro project.

1) Future Scope Of Further Studies:

Hydropower is a renewable, non-polluting and environmentally benign source of energy. Hydropower is based on simple concepts. Moving water turns a turbine, the turbine spins generator, and electricity is produced. Many other components may be in a system, but it all begins with the energy in the moving water. The use of water falling through a height has been utilized as a source of energy since a long time. It is perhaps the oldest renewable energy technique known to the mankind for mechanical energy conversion as well as electricity generation. In the ancient times waterwheels were used extensively, but it was only at the beginning of the 19th Century with the invention of the hydro turbines that the use of hydropower got popularized. Small scale hydro power is the most common way of the electricity generation in the early 20th century.

Usually, Micro-Hydroelectric Power, or Micro-Hydro, are used in the rural electrification and does not necessarily supply electricity to the national grid. They are utilized in isolated and off-grid barrages for decentralized electrification. The micro hydropower plant can easily establish in the hilly area using the diversion intake on the river .there is no need of the large dame for the water catchment. It is the more responsible for the local area development in the hilly reason .there are various scope of the micro hydro power plant which is given below.

(1) There is an increasing need in many developing countries for rural electrification purposely to provide illumination at night and to support livelihood projects.
(2) Micro-Hydro schemes can be designed and built by the local people and smaller organizations. Following less strict regulations and using local technology like traditional irrigation facilities or locally fabricated turbines.
(3) The Ghatta and the Multi-Purpose Power Unit can developed in the rural area for the multi-purpose. The Ghatta is a traditional waterwheel with a vertical axis used extensively in the Himalayan region. The water generally hits the waterwheel from above while the axis of the water wheel is vertical. The turbine (waterwheel) is made out of wood to enable simple building. And repair techniques to be used. As a consequence of this design the traditional waterwheel have very low efficiency and power output (maximum 12 kW). All components are made out from the local material as steel or cast iron instead of wood, water delivery system is improved (with pipes as penstock and simple nozzles) and friction losses are reduced compared to the improved Ghatta. Design philosophy was to produce a device as cheap and simple as possible. Special attention was given to transportability.
(4) The water after using used for the irrigation system5.The one or more villages can used and produced the electricity using the micro hydro power plant in hilly area etc.

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