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Controlling Scheme of Remotely Connected Micro Hydro Power Plant

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Abstract
Electricity is the real need of the rapid growing world. Ensuring uninterrupted power supply to the end users is extremely important and a foremost concern for the power resources. In the hilly regions and in several remote sites finding a national grid is very difficult. Micro Hydro Power Plants can thus be accessiblein these small villages and towns where feasibility of electrical grid is not available. Therefore, to generate electricity in such places, micro hydro plant is best suited and easily availablefor supplying power to hilly areas and small villages. There are however particular issues with insufficient power generation from small hydroelectric plants. One such problem is water distribution or available water flow rate to generate power. The water distribution at the potential sites is small and this distribution is always variable and variable which in turn affects the electricity generated by the MHPP. This paper introduces a controlling schemeof remotely connectedmicro hydro power plant (MHPP) to maximize the amount of electrical energy available from the available hydropower in such a way that the power generated constant regardless of the variations of water flow rate.

Keywords: *micro hydro power plant (MHPP), water flow rate, water distribution, electric grid.*

I. Introduction

"Micro Hydro Power Plant (MHPP) is a type of hydro plant that can generate power from 5KW to 100KW or up to 1 MW".[1]MHPP construction is usually done by river type because only little flow of water is required to rotate the turbine. Primarily, water is sent from the river to the pipeline, which is termed as penstock. Penstock maintains the head needed for power generation. From Penstock, water moves to the powerhouse building, that consists of a hydro turbine and a generator set[2], [3]. This hydro turbine while receiving the flowing water converts the flow rate and pressure of the water into a rotational energythat is essentialfor the generator for generating electricity[4], [5]. The basic structural diagram of micro hydro plant is represented in figure.1. it consists of water inlet entrance, penstock, turbine and electric generator set. For generating of electric power, the high rate of flowing water passes through the penstock and rotates the hydro turbine thereby generating electricity[6].

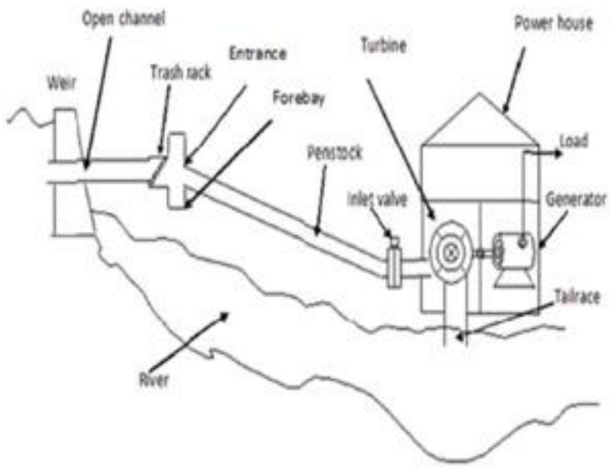

Fig. 1: Schematic diagram of micro-hydro electric power plant

II. Controlling Approach of Micro Hydro Power Plant

The proposed scheme for controlling the Micro Hydro Power Plant is illustrated by a schematicdrawingexposed in Fig. 2. For the purpose of controlling the water flow in big hydro plants in conventional times a hydro control system was used.For controlling the water discharge in the micro hydro plant this conventional controller cannot be used as these controller makes the system more complicated. Such controller is not feasible for small power plant as it increases the cost with the rapid maintenance. conventional irrigation controller system to control the discharge of water to a turbine is used in large-scale hydroelectric plants[7], [8]. They cannot be used at micro hydro level as it would make the system more complex. So, it is inefficientfor theusageof conventional system as the control method.

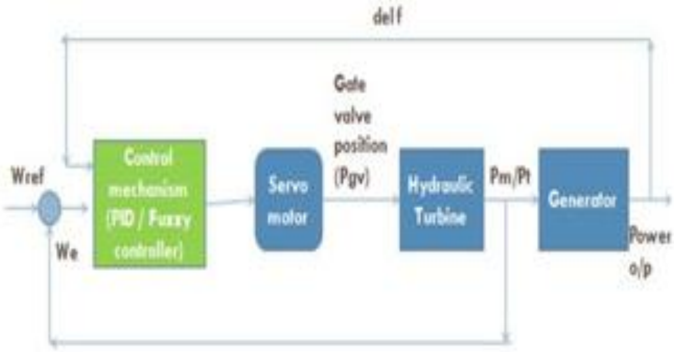

Fig. 2 Controlling Scheme

When the power is produced from the remotely connected wind power plant, the generated power consists of fluctuated power, this power when transmitted to the appliances may lead to damage of various loads. Therefore, to eliminate these losses, the fluctuation mitigating device known as electronic load controller is placed in the control room. Whenever there is a fluctuation, the electronic load controller maintains the constant power as required by the customer. The servo motor is used for regulating the water flow of turbine which is installed in the hydraulic turbine. The following parameters as used in fig.2 stands for:

Wref = reference speed

We = actual turbine speed

Pm/Pt = Mechanical power/Turbine output power

Pgv = position of the gate valve

delf = change in frequency

The equation for discharging water is given by;

$$Q = Ar * Vr \ (m^3 / sec)$$

Where Ar = cross-sectional area of the river

Vr = average flow speed

Vr = Vrs * 0.75 (m/sec)

Vrs = L / t (m/sec)

Where Vrs = surface speed (m/sec)

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At the variable values of gross head of plant, the flow rate also varies with the variation of mechanical power which is shown in fig. 3. Therefore, for the purpose of analysing the behaviour of the flow rate with the difference.The monthly discharge of river for the potential site must be estimated to analyse the behaviour of mechanical power with the variable flow rate. “The source of required data for the analysis is Energy Utilization Management Bureau.”

The control system model of MHP presented in this paper is created using MATLAB/Simulink software. The block diagram of the model is shown in Fig. 4. The flow rate of water is controlled using the PID controller. The PID controller regulates the operation of the servomotor and the servomotor maintains the gate valve position constant. Thus, water Discharge (Q) would be made to rise to its peak value in a short period of time and attains a constant position after that

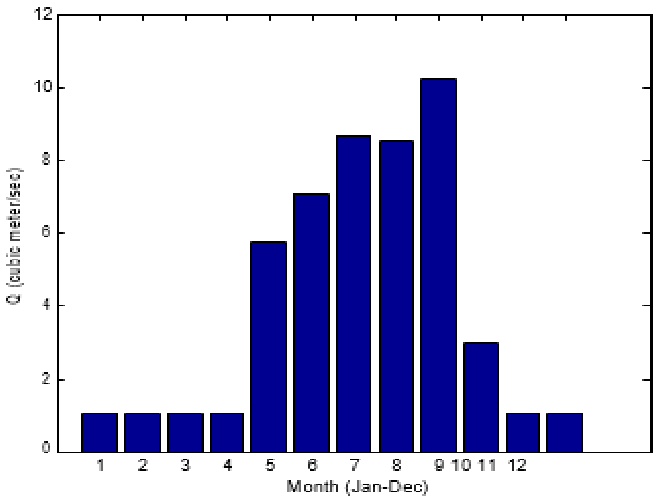

Fig. 3 variable flow rate with variation of mechanical flow rate

Table 1

Month	Monthly Discharge of the river (m3/sec)
January	1.03
February	1.03
March	1.03
April	1.03
May	5.72
June	7.07
July	8.69
August	8.51
September	10.22
October	2.96
November	1.03
December	1.03

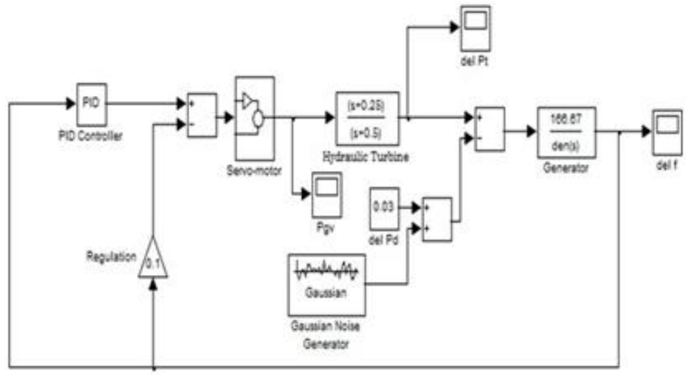

Fig. 4 Simulation model of MHP

III. RESULTS AND DISCUSSIONS

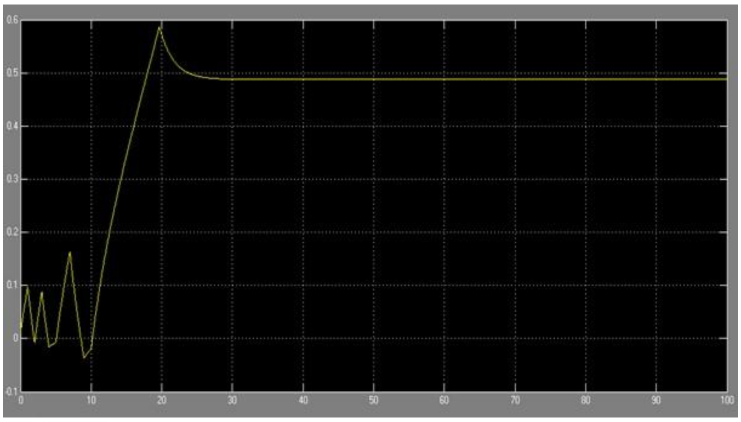

Fig.5 Mechanical output power variation with time t

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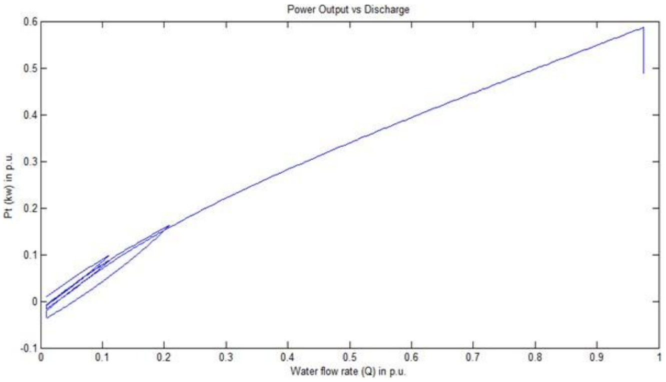

Fig.6 Output power versus water flow rate (Q)

The proposed MHP control system provides a linear relationship between machine power and variable water flow, as shown in Figure 5. When the variable flow rate becomes constant, the output reaches the maximum value. Figure 6 shows the change in water flow with time.generate enough power for those who cannot easily access it. The controlling approach used in this way keeps the drainage constant at its maximum value. In addition, various controllers can be used to analyse the behaviour of output power generated for variable water flow rates and heads. The proposed approach evidences very valuable in the case of system load fluctuations and other failures.

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