Power System Stability Analysis of Small Scale Hydro Plant and its Enhancement using PI Controller

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Abstract: The sensitivity of power system stability to generator parameters (including parameters of generator model, excitation model and exciter) is analyzed in depth by simulations. Here in this paper the simulated model was created by modeling the various components of a practically operating canal based small hydro power plant in a Matlab/Simulik based environment. The plant is located in Bathinda Punjab and is connected to the local grid. Using the model, the aim is to study the behavior of power angle and electromagnetic torque of the generator. The corresponding results for these are obtained for analysis. Later a PI controller will be designed in order to increase its performance.

***Index-Terms* - Mathematical models, Park Transformation, Small hydro-electric power plants, Controller, Proportional, Integral, Matlab/Simulink.**

I. INTRODUCTION

In Irrigation canal based Small Hydro plants, utilizing the heads available gives more or less constant power generation. But it is seen that the head available is almost constant whereas there are large variations in the discharge available. The power generation is completely dependent upon irrigation releases season wise through the canal which depends upon the crop pattern in the region. Power generation is for nine months as months of April, May and August are not considered since discharge is less than 1 cumecs. Fig. 1 shows a representation of our model and in the figure δ is Power Angle.

Fig.1 Machine connected to an infinite bus

Under normal operating conditions, the relative position of the rotor axis and the infinite bus axis is fixed. The angle between the rotor and the infinite bus axis is called the power angle or torque angle δ. Whenever the rotor speed decelerates or accelerates with respect to the synchronous rotating air gap mmf, the equation describing this relative motion is called the swing equation which is given by

$$M\frac{d^2\delta}{dt^2} = P_a - P_e$$

As shown in Fig.2, in an unstable system, δ increases indefinitely with time and machine looses synchronism. In a stable system, δ undergoes oscillations, which eventually die out due to damping.

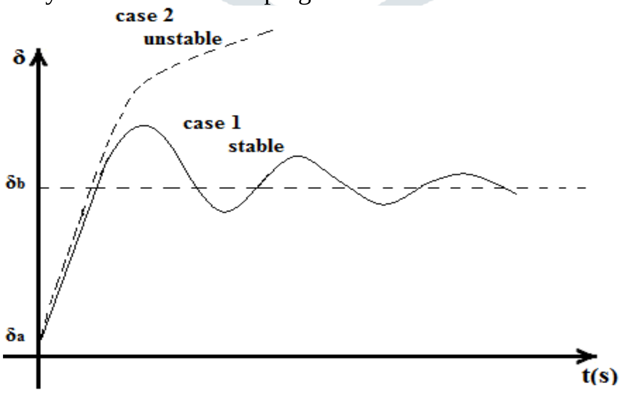

Fig.2 Power Angle

II. MATHEMATICAL MODELING

Generally differential equations are used to describe the various power system components. Study of the dynamic behavior of the system depends upon the nature of the differential equations.

Small System: If the system equations are linear, the techniques of linear system analysis are used to study dynamic behavior. Each component is simulated by transfer function and these transfer functions blocks are connected to represent the system under study.