Modeling and Fault Analysis of Canal Type Small Hydro Power Plant

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ABSTRACT:

In this paper, the simulation model of a typical canal type small hydroelectric power plant was developed through interconnection of models of various equipments of the plant under consideration in a MATLAB/Simulink based software environment. The various components of small hydroelectric plant like governor, Semi-Kaplan turbine, synchronous generator, exciter are being considered under modeling and simulation.. The aim is to study its behavior during phase to phase fault. This study helps in verifying costs and safety conditions, in selecting the best alternatives in the early phase of design and to determine the requirements of special protection devices to control over-current and under-voltage.

KEYWORDS *– Mathematical models, small hydro electric power plants, Fault Currents, Fault Voltages, 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.Modeling and simulation of small hydro power plant is valuable tool for planning power plant operations and judging the value of physical improvement by selecting proper system parameters. Earlier this was done for large or small hydro power plants. But for canal type small hydro power plants this study helps in verifying design of windings, costs and safety conditions. It also helps in verifying the parameters of control equipments like water level regulator, governor, exciter etc. and in determining the dynamic forces acting on the system which must be considered in structural analysis of the penstock and their support.

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.

Large System: Here state-space model will be used for system studies described by linear differential equations. However for transient stability study the nonlinear differential equations are used.

III. METHODS USED FOR MODELING FOR CANAL TYPE SMALL HYDRO POWER PLANT.

1.1 The generator model is derived starting from the basic circuit equations and the use of Park's transformation.

1.2 Hydraulic turbine model includes both linear and nonlinear control methods. Nonlinear models are required where speed and power changes are large.

1.3 For governor, mathematical equations of ordinary differential equations representing the dynamic behavior are used. Here the regulator consists of two parts electrical (PID Controller) and electro-hydraulic parts

1.4 For exciters ordinary differential equations are used.

3.1.Mathematical Modeling of a Synchronous Machine:

The synchronous machine under consideration is assumed to have three stator windings, one field winding and two damper windings.