Chapter 8
Simulation and Modeling:
Design of a Fuzzy Logic Based Hydraulic Turbine Governing System

Tawanda Mushiri
University of Johannesburg, South Africa

Charles Mbohwa
University of Johannesburg, South Africa

ABSTRACT

The chapter describes the design of the speed governing system of 150 MW Francis turbines at a power station. The turbine governing system is vital for the safety and availability of a power plant. The dynamic characteristics of the turbine system are nonlinear and difficult to predict. The identification, development and implementation of the hydraulic system for the power plant were done via literature survey and computer based simulations and also analyzed by comparing different controllers through simulation. The governor system parameters were simulated with the actual data available in the power plant. Traditional PID controller parameters are difficult to tune when used in control systems and a fuzzy PID which can tune the parameters on-line is introduced to be appropriate in the turbine governing control system. In MATLAB/SMULINK simulation environment, the simulation results show that fuzzy logic PID control strategy has better performances than traditional PID controller.

1.0: INTRODUCTION

The Power Station (PS) under study has six generators with an output of 125MW each. Each generator produces 18kV which is stepped up to 330kV by generator transformers. The stepped up voltage is fed to the substation where it is dispatched into the national grid system. Highly integrated communication systems are in place which link generators to the grid system. The turbine governor controls the frequency, speed and load regulation of the generators in relation to the grid system.

DOI: 10.4018/978-1-4666-8823-0.ch008

1.1 Statement of the Problem

The Power Station has been experiencing constant generator trips due to the turbine governor system's slow response to system disturbances.

1.2 AIM

To improve the electricity power generation for the station

1.3 Objectives

- To improve turbine response to system disturbances.
- To reduce plant down time from 9% to almost 2%.

1.4 Scope of the Research

The research project will be limited to Francis turbines in hydro power plants. PLC programming is not going to be carried out since the research intends to find the effect of Fuzzy logic to the traditional PID controller.

2.0: HYDROPOWER PLANT

2.1 Introduction

This consists of a comprehensive search of recent and relevant research, historical and empirical reviews laying the foundation for the present study. This literature review clearly explains the existing turbine governing system technology and tries to avoid bias. Information from different authors is gathered, evaluated and clearly presented.

2.1.1 Importance of Governing System

The Governor is an important controller in the power plant as it regulates the turbine speed, power and participates in the grid frequency regulation. It is the main operator interface

1. To start the turbine from still rest.
2. To vary the load on the turbo-generator when it is on bars (Synchronized) and
3. To protect the turbine from damages in the cases of any unsafe operating conditions.

The steady state and dynamic response behavior of the turbine is influenced mainly by the characteristics need for the Governing system. The load on the turbo-generator does not remain constant but vary as per the consumer (Grid) demand requirements. The presence of a perpetual mismatch between the generation and the demand in a larger network results into variations in frequency and necessitates a continuous adjustment of the turbo-governor.