SMOOTHING OF COMBINED CYCLE STEAM TURBINE GOVERNOR PERFORMANCE BY MODELING AND SIMULATION

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by

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DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated. It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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I endorse the declaration by the candidate.

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Abstract

The combined cycle power plant is a non-linear closed loop system, which consists of the gas turbine (GT), heat recovery steam generator (HRSG), high pressure (HP) and low pressure (LP) steam turbines. The gas turbine and HP, LP steam turbines operate concurrently to generate power. Through the fuel combustion process taking place inside the combustion chamber, the gas turbine is driven, after which the exhaust gas of the combustion flows into the HRSG to generate superheated steam to be used for driving the HP and LP steam turbines.

The steam turbine in a combined cycle power plant is similar to that of a steam turbine in a conventional steam plant. The major difference is in the control philosophy of the turbine. In a combined cycle system, the steam turbine can be operated in two different modes; sliding pressure or fixed steam inlet pressure control. In practice, a combination of these operation modes is commonly used for combined-cycle power plants, depending on the level of power output required.

During sliding pressure control, the throttling or control valves are fully open. The steam pressure is a function of the steam mass flow entering the steam turbine. When operating near the base load, most of the steam turbines of combined cycle plants operate on sliding pressure mode.

In this thesis, the cause for fluctuation of the HP steam turbine governor after it gets fully opened (governor hunting), is investigated. A dynamic model is developed to represent this status of the steam turbine mainly based on the sliding pressure control mode. Being the components that cause major influence, only the HRSG's HP section, HP governor and HP, LP turbines are used for modeling. This component level modeling is done using the realistic plant operating data. The solutions are simulated using C programming with derived plant data. Whenever plant data is not available, approximated data is being used with reasonable assumptions. When compared the simulation results with the corresponding plant data, it is seen that they are in good agreement. This indicates that the developed models for the components could be used to represent the combined cycle power plant's high pressure section, when operating on sliding pressure control mode.

Through the analysis of simulation results, it can be seen that the HP governor hunting takes place due to variation of the pre-defined sliding pressure set point. Generally that happens due to ageing of the HP turbine that is reflected through reduced plant efficiency.

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T.N. Nishantha

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LIST OF ACRONYMS

ST - Steam Turbine

CEB - Ceylon Electricity Board

GT - Gas Turbine

HRSG - Heat Recovery Steam Generator

TFM - Turbine Following Mode

BOF - Boiler Following Mode

SPM - Sliding Pressure Mode

KCCP - Kelanitissa Combined Cycle Power Station

HP - High Pressure

LP - Low Pressure

SH - Super Heater

O&M - Operation and Maintenance

SC - Sub Cooled

PU - Per Unit

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