STUDY AND IMPLEMENTATION OF CO-ORDINATED MASTER CONTROL SCHEME FOR 800MW AT THERMAL POWER PLANT USING MATLAB

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Abstract: An application of model-based coordinated master control concept for improving the performance of thermal power plant. In this structure, the controller used to generate the reference trajectories for the plant‘s subsystems. The setpoints for fuel, electrical power, and steam pressure are provided by FF controller with respect to load demands. In order to diminish the effect of disturbances and to compensate deviations between variables and corresponding feed-forward setpoints, feedback controllers are considered. The error signal denied by the deviation of desired boiler output pressure from its actual value is used to compensate the demand signals for turbine and boiler. The performance of the proposed control system is compared with that of a conventional Turbine Follower and Boiler follower mode is co-ordinated master control during load changes. The results indicates the MEGA WATT SET and PRESSURE SET according to Turbine demand and Boiler Demand.

The responses of plant with new coordinated control were compared with the real plant responses over a wide range of operations, where the real system has a conventional turbine-follower control strategy.

Keywords: The thermal power plant, the steam boiler, cascadecontrol, PID controller,boiler-turbine co-ordinate control.

1. INTRODUCTION

Sri Damodaram Sanjeevaiah Thermal Power Station Units #1 & 2 (2x800MW) was established extending the wide electrical network in the state of Andhra Pradesh. And this plant consists of mainly 9 parts. And they are

- Boiler
- Steam Turbines
- Generators
- Switch Yard
- Electro Static Precipitators
- Water Treatment Plant
- Cooling Towers
- Coal Handling Plant
- Ash Handling Plant

1.1 BOILER:

Generation of fire is done with the help of oil and lighters. Oil is sprayed from four corners of the furnace with help of oil guns and lighters at four ends of the furnace release sparks. This sparks make the oil to catch fire. Now coal is carried from PC Bunkers with the help of PA Fan. Cola is kept hot i.e. at a temperature around 70degreeC for effective burning of coal. This temperature is maintained with the help of hot air from PA fans and secondary air.

1.2 STEAM TURBINE:

To generate EMF the rotor of the generator need to be rotated which in turn is operated by a shaft which is rotated with the help of three turbines.
a) HIGH PRESSURE TURBINE (HP TURBINE)
b) INTERMEDIATE/MEDIUM PRESSURE TURBINE (IP TURBINE)
c) LOW PRESSURE TURBINE

Each turbine has its own operating temperature and pressure. Steam from the super heater coils is fed directly to the HP turbine at a temperature of 540degreeC and a pressure around140Kg/cm2. The enthalpy of the steam gets converted to mechanical energy which makes the turbine to rotate. From the law of thermodynamics ―a perpetual motion machine of second kind From doesn‘t exist‖, heat energy cannot be completely converted to work. So some amount of energy still remains in the steam. To re-utilize this energy this steam is made to interact with another turbine called Intermediate/Medium Pressure Turbine. Before making them to interact the outlet steam from the HP turbine is sent back to furnace and reheated through reheater coils .This is a part of regenerative system for efficient utilization of heat energy. Steam from reheater coil is fed to IP.

2. CONTROL SYSTEMS

2.1. OPEN LOOP CONTROL SYSTEM:

In an open-loop controller, also called a non-feedback controller, the control action from the controller is independent of the "process output", which is the process variable that is being controlled. It does not use feedback to determine if its output has achieved the desired goal of the input command or process "set point".

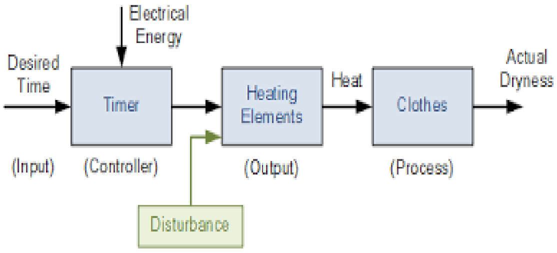

Fig 2.1: Open loop control system

2.2.CLOSED LOOP CONTROL SYSTEM:

A Closed -loop Control System, also known as a feedback control system is a control system which uses the concept of an open loop system as its forward path but has one or more feedback loops (hence its name) or paths between its output and its input. The reference to "feedback", simply means that some portion of the output is returned "back" to the input to form part of the systems excitation.

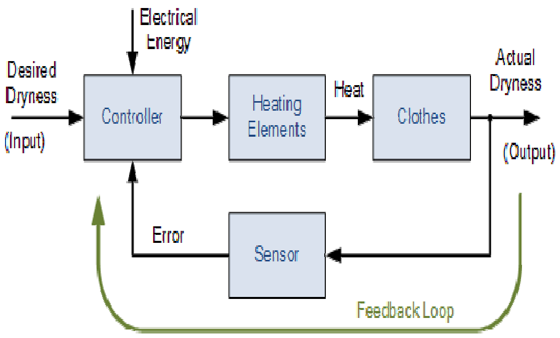

Fig 2.2: Closed loop control system

Closed-loop systems have many advantages over open-loop systems. The primary advantage of a closed-loop feedback control system is its ability to reduce a system's sensitivity to external disturbances, for example opening of the dryer door, giving the system a more robust control as any changes in the feedback signal will result in compensation by the controller.

3. EXISITING SYSTEMS

The system is operated in 4 ways those are Auto and Manual operation by Boiler Master and Turbine Master Controls.

Table. 1: Master Boiler and Turbine Master Operation

MODE	BOILER MASTER	TURBINE MASTER
Base Load	Manual	Manual
Boiler Follow	Auto	Manual
Turbine Follow	Manual	Auto
Co-ordinated	Auto	Auto

3.1 BOILER MASTER:

The boiler master control loop receives the drum pressure signal from the drum pressure transmitter and compares it to the operator-entered setpoint. The controller modulates its output in order to eliminate any difference between the signal and the setpoint. The output of the controller represents the boiler demand for steam, and is sent to the variable speed drives on the feeders or distributors if automatic feed control is used. It is also sent to the fuel/air ratio station. The operator may adjust the setpoint in automatic or place the controller in manual to fire the boiler manually. The controller rejects to Manual on bad signal quality. A high/low pressure alarm is shown in figure 3..

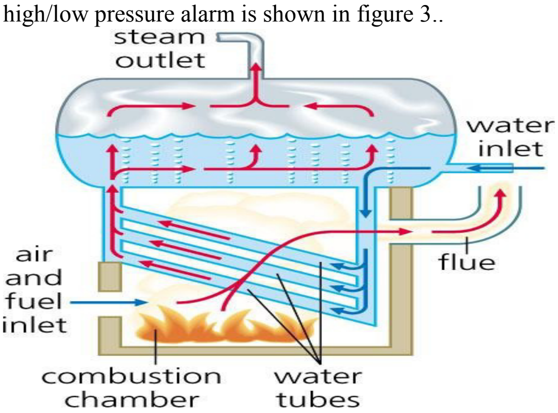

Fig 3.1: Boiler Master

3.2 TURBINE MASTER:

The turbine generator consists of a series of steam **turbines**interconnected to each other and a generator on a common shaft. There is a high pressure turbine at one end, followed by an intermediate pressure turbine, two low pressure turbines, and the generator. As steam moves through the system and loses pressure and thermal energy it expands in volume, requiring increasing diameter and longer blades at each succeeding stage to extract the remaining energy. The entire rotating mass may be over 200 metric tons and

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100 feet (30 m) long. It is so heavy that it must be kept turning slowly even when shut down (at 3 **rpm**) so that the shaft will not bow even slightly and become unbalanced. This is so important that it is one of only five functions of blackout emergency power batteries on site. Other functions are **emergency lighting**, station alarms and turbogenerator lube oil.

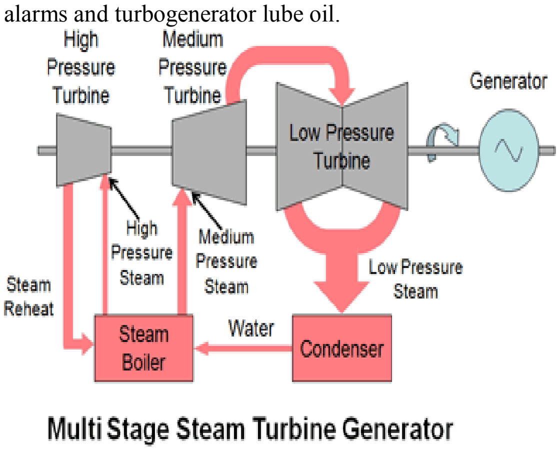

Fig 3.2: Turbine master

3.3 TURBINE CONTROL

A turbine driving an electric generator must run at constant speed. The performance of a steam turbine is conventionally measured in terms of its heat rate—i.e., the amount of heat that has to be supplied to the feedwater in order to produce a specified generator power output. The heat rate depends on the steam generator exit temperature and pressure, the condenser pressure, the efficiency of the turbine in converting the thermal energy of the steam into work, the mechanical and bearing losses, the exhaust loss due to the kinetic energy of the steam leaving the final turbine stage, and the generator losses. The lower the heat rate, the less the thermal energy required and the better the efficiency. **Steam Turbine** Governing is the procedure of monitoring and **controlling** the flow rate of **steam** into the **turbine** with the objective of maintaining its **speed** of rotation as constant. The flow rate of **steam** is monitored and **controlled** by interposing valves between the boiler and the **turbine**.

ATRS (Automatic Turbine Runup system) Turbine Governing System

Turbovisory Instruments & turbine protections Interlock, Protection & Control of HPBP system

Open loop control system (interlock & protections) of turbine auxiliaries

Interlock & protections of Seal Oil & Stator water system.

3.4 AUTOMATIC CONTROL SYSTEM & POWER PLANT CONTROL LOOP

Important Closed Loop Controls in a Thermal Power Plant:

- Furnace Draft Control
- Boiler Drum Level Control
- HOT well & D/A level control
- Main Steam Temperature Control
- Air and Fuel Flow to Boiler Control
- Coordinated Master Control(CMC)
- Turbine Speed, Pressure and Load Control

4 .MATLAB

MATLAB® is a high-level language and interactive environment for numerical computation, visualization, and programming

Using MATLAB, you can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java®. You can use MATLAB for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement, computational finace, and computational biology. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing.

- **GUI Building**
- **Simulink**

4.1 GUI Building:

To use a template:

1.Select a template in the left pane. A preview displays in the right pane.

2.Optionally, name your UI now by selecting Save new figure as and typing the name in the field to the right. GUIDE saves the UI before opening it in the Layout Editor.

4.2 Simulink:

Simulink® is a block diagram environment for multidomain simulation and Model-Based Design. It supports system-level design, simulation, automatic code generation, and continuous test and verification of embedded systems. Simulink provides a graphical editor, customizable block libraries, and solvers for modeling and simulating dynamic systems. It is integrated with MATLAB®, enabling you to incorporate MATLAB algorithms into models and export simulation results to MATLAB for further analysis.

Modeling

Design models of time-varying systems

Simulation

Run systems, review results, validate system behavior

Performance

Optimize performance for specific goals, accelerate simulation speed and design efficient models

Component-Based Modeling

Model architecture for large-scale modeling, component reuse, and team- based projects.

4.3 CMC MODEL IN GUI:The Simulink model of a co-ordinated master control is controlled by the gui model.

Fig 4.1: GUI Model of CMC

4.4 RESULT OF CO-ORDINATED MASTER CONTROL:

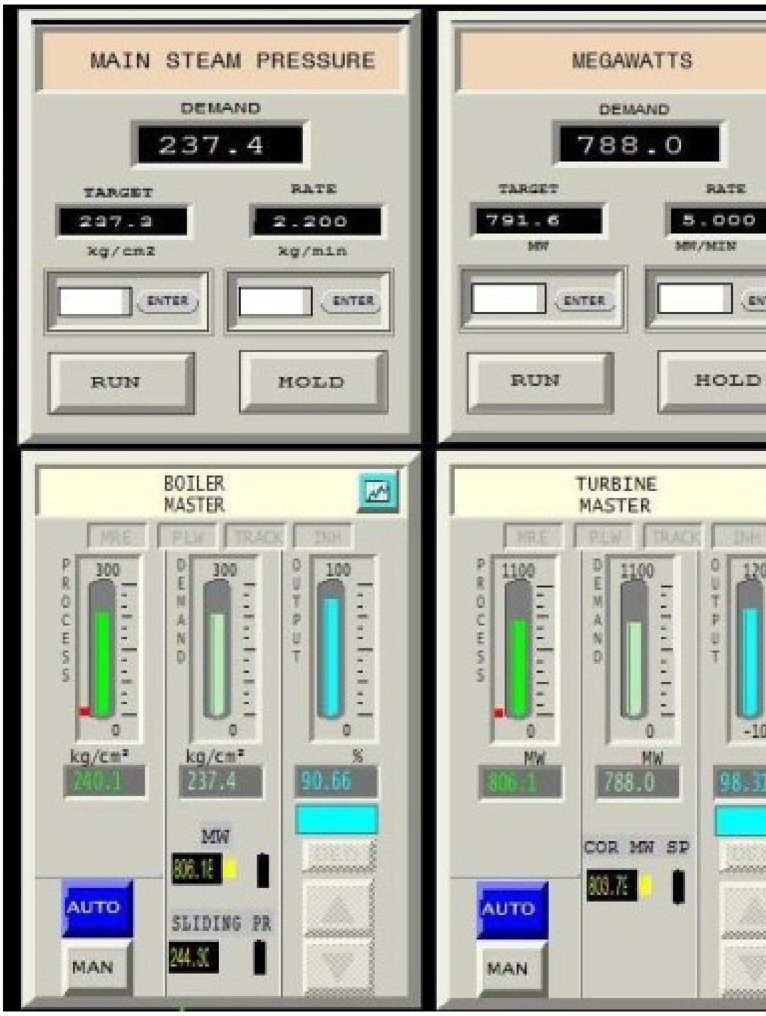

Fig 4.2: Result of co-ordinated master control

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4.5 TIME SCOPE OF CO-ORDINATED MASTER CONTROL:

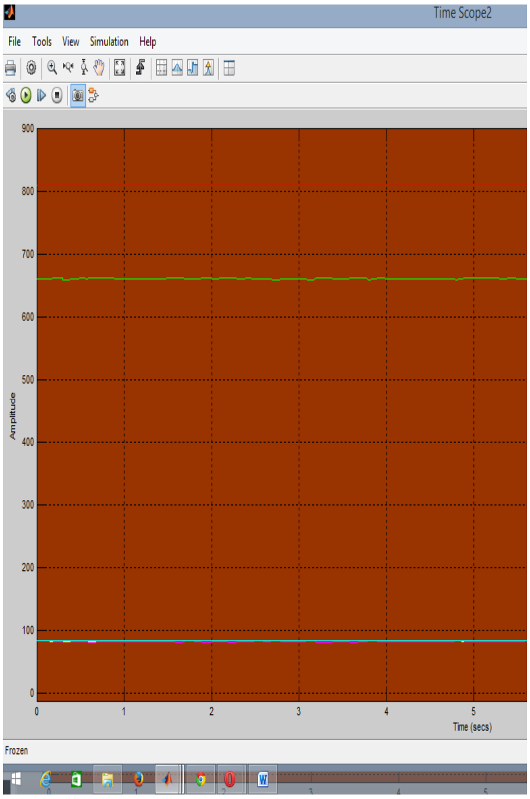

Fig 4.3: Scope output of cmc

5. CONCLUSION

Hence, With the help of CMC Philosophy we can control the entire operation with single set point.

The responses of plant with new coordinated control were compared with the real plant responses over a wide range of operations, where the real system has a conventional turbine-follower control strategy. In this project , a nonlinear coordinated control concept is presented in order to improve the flexibility and the performance of a once-through power plant. .The control system was consisting of a model-based feedforward controller, which generated the boiler demand and turbine references with respect to desired load.

Simulation results indicate the performance of proposed control system during load changes. In addition, the performance of the proposed control system was compared with the turbine-follower CC strategy.

The results showed that the new model-based CC concept could significantly enhance the maneuverability and load following capability of the power plant over a wide range of operation.

Balance is achieved between steam generation and steam consumption proper coordination between boiler control and turbine control.

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