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Implementation of Governor Control Logic in Steam Turbine Simulator

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1. Introduction

Recently, the steam turbine controls the steam control valve by a distributed control system more safely and accurately. It is interfaced between the DCS and the governor that controls the speed or the output of the synchronous generator by controlling the amount of steam in inlet of the steam turbine.

Control methods of the Steam turbine are becoming more advanced and these have evolved into DEHC (Digital Electrical Hydraulic Control) governors through MHC (Mechanical Hydraulic Control) and EHC (Electrical Hydraulic Control).

Among the governors, EHC refers to a governor that electrically generates a control signal and amplifies it into a hydraulic signal. In the DEHC, the speed input unit, the setting unit, and a part performing each function are processed by software. The high performance microprocessor performs the operation and determines the function as a governor[1]. This is necessary because DEHC is an interface for controlling and protecting steam control valves.

In this paper, the control logics of the DEHC system of MHPS were implemented to simulate the steam turbine, and the result of trends was similar to the design data.

2. Implementation and Simulation

2.1. Simulator

The simulator includes process models that simulate power plant processes, control models simulating control systems, instructor controls that enable Malfunction / Remote functions, operation models that adjust power output in conjunction with process models, control models, and process variables. It consists of a soft/hard panel that can be monitored and partially operated.

It can be classified into four types of simulators, stimulated, virtual, hybrid, emulated, depending on the implementation method of the operator console and control model[2]. In this paper, the logic interfaced with DCS by emulating DEHC model, which is composed of different hardware from DCS system.

2.2. Governor Control with DEH Control

The MHPS steam control valve is controlled by the DEHC governor system. That controls turbine speed and HP, IP and LP pressure. And it controls the speed of the turbine, slowly increasing the amount of steam at the beginning of operation. When the turbine speed reaches 3600rpm, it synchronizes and controls the power generation output through pressure control.

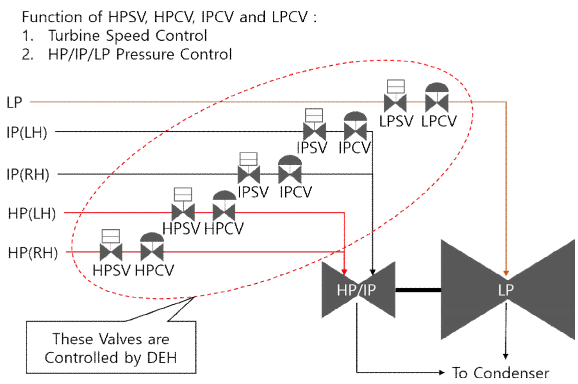


Fig. 1. Valve Control by DEHC

DEHC consists of EOST (Electrical Over Speed Trip), OPC (Over Speed Protection Controller), TCL (Turbine Valves Closing Logic) and SVL (Servo Valve interface module LVDT (Linear Variable Differential. Transformer)) parts.

- EOST - EOST receives electrical signals from the turbine rotor, generates over-speed signals, and delivers them to the steam turbine protection system.
- OPC - When turbine speed exceeds 107% of rated speed or load-unbalance between required generator output and turbine-input (IP turbine inlet steam pressure – Generator current), OPC is actuated to prevent the over speed trip.
- TCL
  - Closing of turbine valves in high speed
  - Interface with SVL and OPC modules
- SVL – DEH Electric signal module is converted to Hydraulic signal by Servo Valve

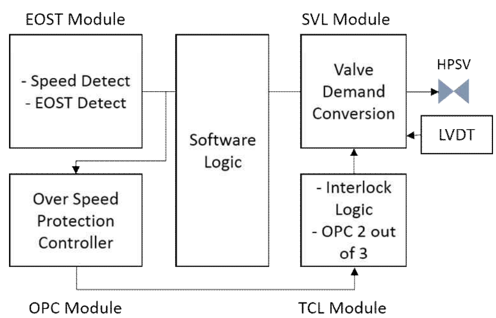


Fig. 2. DEHC of Steam Turbine

DEHC initiates pressure control by controlling the valves of the steam turbine and allows HPSV (High Pressure Shut up Valve) and HPCV (High Pressure Control Valve) to be valve transferred.

Among the DEHC functions, the following functions are interfaced.

(1) Speed control

Speed control is controlled by HPSV until synchronization. It receives turbine speed from EOST Module and transfers the value to SVL module by applying current setting value and speed ratio. The HPSV opening amount is determined by comparing with the value input from LVDT.

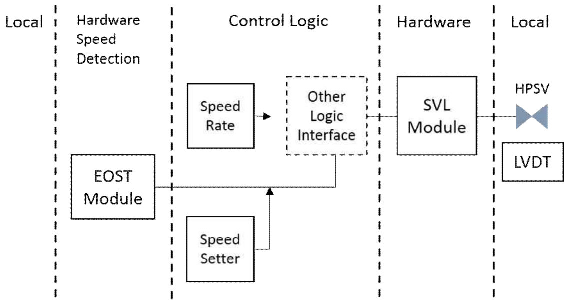


Fig. 3. Speed Control Logic

(2) Initial load control

Before the synchronization, speed up / down signals are delivered in addition to the automatic synchronization system (ASS) and speed control bias. The initial load set-point is added when the circuit breaker for synchronization is closed. This result is reflected in the HPSV valve opening demand value.

(3) Valve transfer (HPSV→HPCV)

After initial load completed, turbine control mode is transferred from "HPSV control mode" to "HPCV control mode"

(4) Pressure control

HPCV is closed to keep the pressure at the minimum set-point when in pressure control. As the pressure rises, HPCV opens completely at the end.

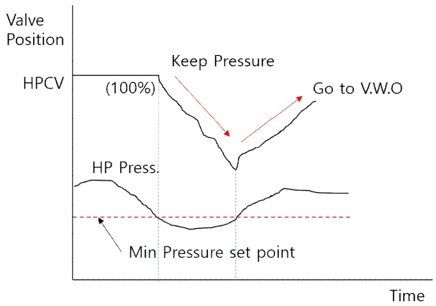


Fig. 4. Pressure Control

2.3. Implementation of Governor Control Logic

DEHC control logic delivers the opening and closing demands to each valve. In particular, EOST, OPC, TCL, and SVL are the intermediate interfaces that transfer the calculated value of control logic to the valve, so they must be implemented to control the valve.

The DCS control model of the simulator is implemented by S/W translation. This method increases the reliability of the simulator control model.

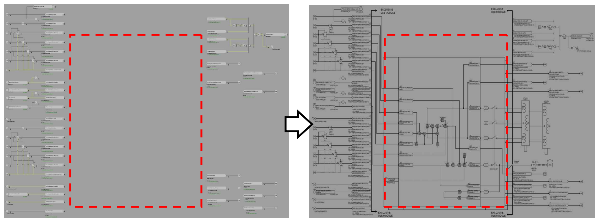


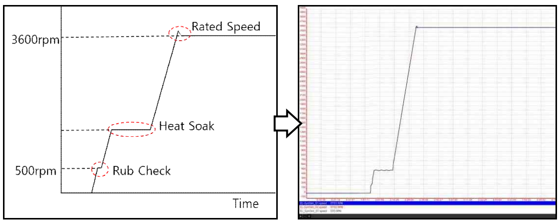
Fig. 5. Implementation of the DCS Control Logic

In this paper, the logic implemented with reference to the experience of manufacturing other simulators, the expert advice.

2.4. Simulation

In the simulator, it is easy to verify that the values are correctly transferred to the control valve. In particular, the value of the module is simplified and implemented in the simulator.

When comparing the design data and trends driving simulator results trends of the actual plant it can be found that work very closely.

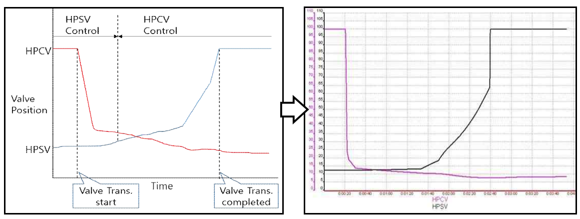


(a) Design Data (b) Simulation Result

Fig. 6. Speed Control Trends

As shown in the figure above, Speed Control has a process of Rub Check at 500rpm after the initial start. When synchronizing, it is shown to keep 3600rpm, and the simulation showed that the speed control graph is implemented the same.

The valve transfer can also be changed to the pressure control mode with the same operation in the simulator as shown below.



(a) Design Data (b) Simulation Result

Fig. 7. Valve Transfer Trends

The added logic calculates the value received from the DCS control logic and the valve request value delivered to the valve, and is applied to the actual valve control.

3. Conclusions

In this paper, the logic interfaced the EOST, TCL, SVL, and OPC logic of a DEHC system consisting of DCS logic and the other hardware for steam turbine valve control. The simulation result of speed control and valves transfer operation of HP, IP and LP control valves was similar to the design data.

REFERENCES

[1] Jaewon Engineering, "Small and medium capacity steam turbine generator digital simulator", SME Technology Innovation Development Project Final Report, pp.14-15, 2003
[2] Seung Hyun Byun, "Implementation of bypass system control for power plant simulator", The Korean Institute of Electrical Engineers summer annual conference, pp.1634-1635, 2009