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Simulation and Analysis of Main Steam Control System Based on Heat Transfer Calculation

Zhenqun HUANG[1], Ruyan LI[1], Zhongbao FENG[1], Songhan Wang[1],

Wenbo LI[2,a],Jiwei CHENG[2,A], Yingai JIN[2]

[1] *Jilin Province Electric Power Science Research Institute Co., Ltd, Changchun , 130021,China*
[2]*College of Automotive Engineering, Jilin University, Changchun, Jilin, 130022, China*
a)Corresponding author:694833871@qq.com
a)Corresponding author:13194357717

Abstract: In this paper, after thermal power plant 300MW boiler was studied, matlab was used to write calculation program about heat transfer process between the main steam and boiler flue gas and a mount of water was calculated to ensure the main steam temperature keeping in target temperature. Then heat transfer calculation program was introduced into simulink simulation platform based on control system multiple models switching and heat transfer calculation. The results show that multiple models switching control system based on heat transfer calculation not only overcome the large inertia of main steam temperature, a large hysteresis characteristic of main steam temperature, but also adapted to the boiler load changing.

Key words: main steam; target temperature; heat transfer calculation

INTRODUCTION

The main object of this paper is comparing the advantages and disadvantages of two methods of controlling main steam temperature. The first method is named PID, PID controller is proportion、integration、 differentiation controller. The second method is J-PID, which is the traditional PID controller based on heat transfer calculation. The overall simulation scheme is as follows: the first step of the simulation is calculating two control systems PID and J-PID under different load conditions, then the simulation results are compared. We have given the basis of choosing J-PID control system instead of PID control in this paper. At last, we took on the simulation under three typical conditions.

SYSTEM DIAGRAMS AND TRANSFER FUNCTION OF PID

The simulation model of PID main steam temperature control system is set up under the load of thirty percent boiler and the control objects are the functions of anterior region and inert zone. The system was put at last of the paper as figure 1 and 2.

The following is the optimal parameters of the optimized PID controller, including the rise time, overshoot, peak time, adjustment time.

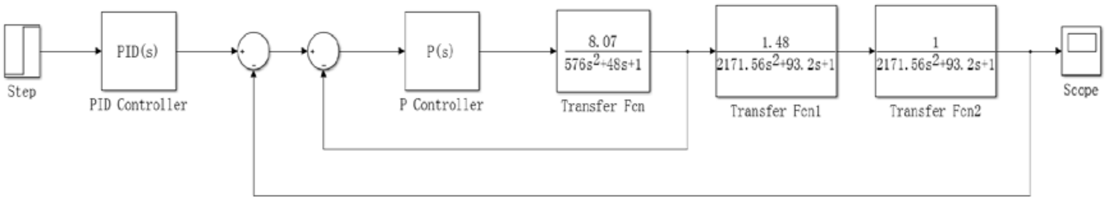

Fig.1 PID control system of main steam temperature under 30% load condition

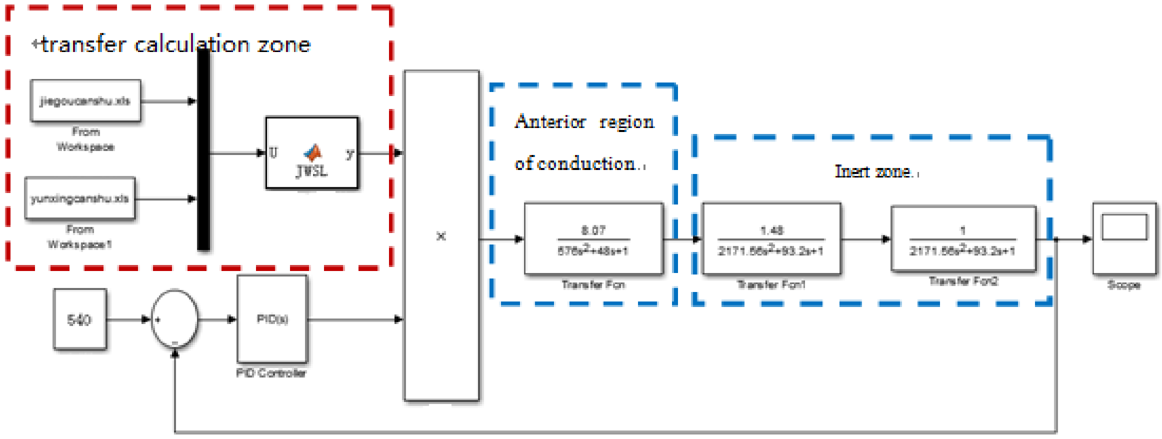

Fig.2 Main steam temperature control system based on heat transfer calculation under 30% load condition

Controller Parameters

	Tuned	Block
P	1.0965	1.0965
I	0.0057136	0.0057136
D	51.9314	51.9314
N	1.1193	1.1193

Performance and Robustness

	Tuned	Block
Rise time	119 seconds	119 seconds
Settling time	549 seconds	549 seconds
Overshoot	0 %	0 %
Peak	0.998	0.998
Gain margin	11.6 dB @ 0.0311 rad/s	11.6 dB @ 0.0311 rad...
Phase margin	75 deg @ 0.00979 ra...	75 deg @ 0.00979 ra...
Closed-loop stability	Stable	Stable

Fig. 3 Optimal parameters and indexes of PID main steam temperature controller

SYSTEM DIAGRAMS AND TRANSFER FUNCTION OF J-PID

The following is the optimal parameters of the optimized J-PID controller, including the rise time, overshoot, peak time, adjustment time.

Controller Parameters

	Tuned	Block
P	1.3265	1.3265
I	0.0085317	0.0085317
D	51.0143	51.0143
N	1.4091	1.4091

Performance and Robustness

	Tuned	Block
Rise time	91.1 seconds	91.1 seconds
Settling time	461 seconds	461 seconds
Overshoot	15.1 %	15.1 %
Peak	1.15	1.15
Gain margin	9.76 dB @ 0.0282 rad/s	9.76 dB @ 0.0282 rad/s
Phase margin	54 deg @ 0.0123 rad/s	54 deg @ 0.0123 rad/s
Closed-loop stability	Stable	Stable

Fig. 4 Optimal parameters and indexes of J-PID main steam temperature controller

SIMULATION ANALYSIS

The simulation model of PID and J-PID main steam temperature control system under 30% load conditions is given in the above description. In this section, the simulation of two main steam temperature control systems under 3 typical load conditions is carried out. The results are as follows:

(1) The simulation results of the two control systems under 30% load conditions are as follows:

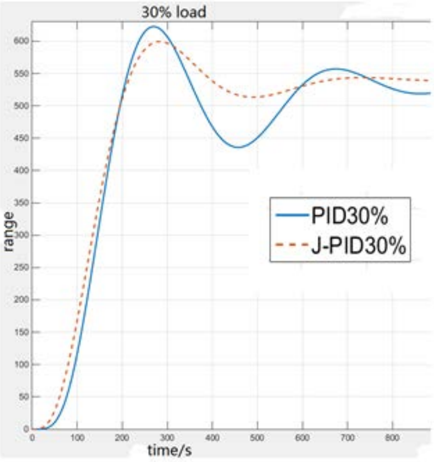

Fig.5 Comparison of control effects under 30% load conditions

(2) The simulation results of the two control systems under 100% load conditions are as follows:

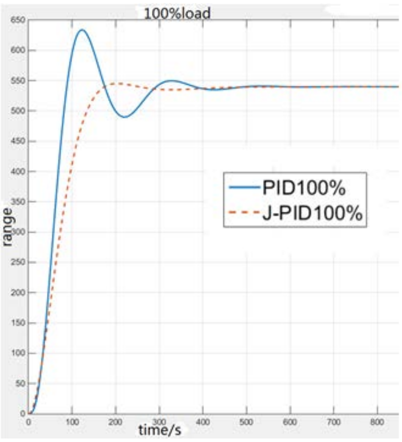

Fig.6 Comparison of control effects under 100% load conditions

The simulation curves show that when the boiler operates under 30% and 44% load conditions, the temperature of the main steam is realized as large inertia and large lag and the system has a large response time, so the main steam temperature takes a long time to reach a steady state. Compared with the PID control system, the overshoot of the J-PID control system is very small. What's more, the larger the load, the smaller the overshoot. At last when the boiler operates at 100% load, the J-PID has almost no overshoot.

CONCLUSIONS

The control effect of the main steam temperature control system based on heat transfer calculation is better than that of PID, the main reason is that the J-PID system can eliminate the disturbance of the system quickly (such as main steam flow, temperature, flue gas flow rate, temperature).

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