Roll-Gap Adaptive PID Control System of Twin Roll Strip Caster

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Abstract

In this paper, a roll gap PID controller about twin roll caster is established and the control parameters are determined by test data. On the basis of analysis about the hydraulic servo working principle, a roll-gap adaptive PID control system is presented to get better control performance.

Keywords

Roll-Gap, PID Control, Twin Roll Strip Caster.

1. Brief Introduction about Twin Roll Caster

The strip casting process is a new strip production method, which combines two processes of continuous casting and hot rolling. The molten liquid metal is directly poured into the space consisted of two rotating rolls and side dams. In the process, solidification of molten metal is completed rapidly and the process window is in a narrow range. Small variation of the process parameters lead to severe defects of the casting strip, even leak of molten steel and break of the strip. When roll gap is small or casting speed is slow, the molten pool level is high and the casting force is high, the result is heat cracking of strip. Vice versa, the strip quality is inferior because of breakout and oxidation. Only when the solidification final point is formed at the roll exit and the strip quality is satisfactory. Therefore, the measurement and control of process parameters are required to stabilize the casting process, to produce casting strip with good quality and to realize the industrial application.

2. Roll Gap PID Control System on AGC

A pilot twin roll caster has been developed with hydraulic servo auto gauge control system. And the strip is fabricated continuously at thickness from 2 to 4mm under casting speed 20 to 60 m/min. The schematic view of the main caster system is shown as Fig.1. A PID closed-loop control is used in the roll-gap controller, in which the displacement of moved roll is regarded as an objective of regulation and hydraulic servo-valve opening act as the control mean. Hydraulic servo AGC is the key of roll gap controller, which working principle diagram is shown as Fig.2, and it is a single-degree-freedom system which consists of three-way servo valve, three-way pressure reducing valve, elastic load, viscous friction load and quality load. The roll gap control system close-loop transfer function is got as Eq.1.

$$G(s) = (K + K_I \frac{1}{s} + K_d s)\widehat{G}(s) \tag{1}$$

Here, $\widehat{G}(s)$ is transfer function of the caster system. The aim of roll gap control is to choose appropriate parameters of K, Kicked to make the system adjusted time be shorter and overshoot be medium. Those parameters are determined by test data, K is changed from 1 to 8, the step is 1 and the value Ki is 0, 0.01, 0.1, 1, 10 and the value Kd is 1,e-4,e-8,e-12,e-15. Then system adjusted time and overshoot trends are shown as Fig.3 when x axis is K, Y axis is Ki. Analyzed on Fig.3, the PID control result is best when K=5.5, Ki=0.01, Kid =0.0067.

3. Roll Gap Adaptive PID Control System

The trends as Fig.3 are shown when the set-point of gap is from 5mm to 4mm. According to the control parameters got by Fig.3, when the sep-point of gap changes from 4mm to 5mm, the control performance is worse. Shown on Fig.2, when gap becomes small, the servo valve forwardly takes action, verse, the pressure reducing valve play the important role. So the transfer function of the caster system $\hat{G}(s)$ is different on above two conditions. To get better control performance comprehensively, an adaptive control chart is established shown as Fig.4. On the condition of the gap set-point become small, K=5.5, Ki=0.01, KD=0.0033, vice versa, K'=6.2, Ki'=0.02, KD'=0.0067

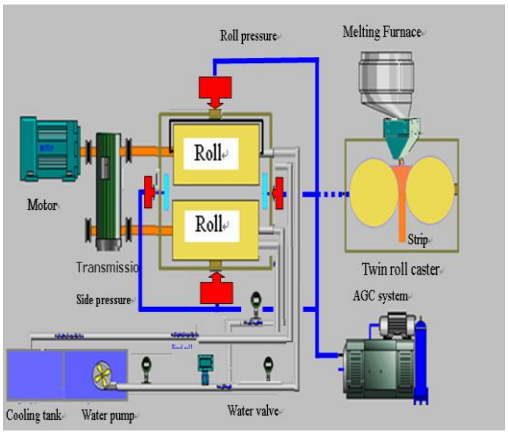


Fig 1. Schematic view of the main caster system

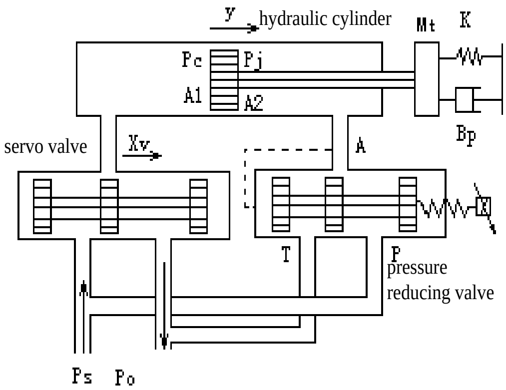
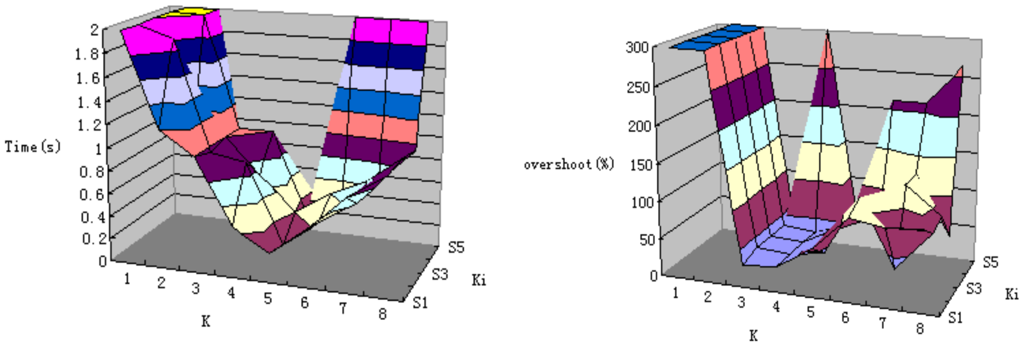


Fig 2. Working chart of hydraulic servo control



(a) Adjusted time trend (b) Overshoot trend

Fig 3. Control performance trends under various control parameters

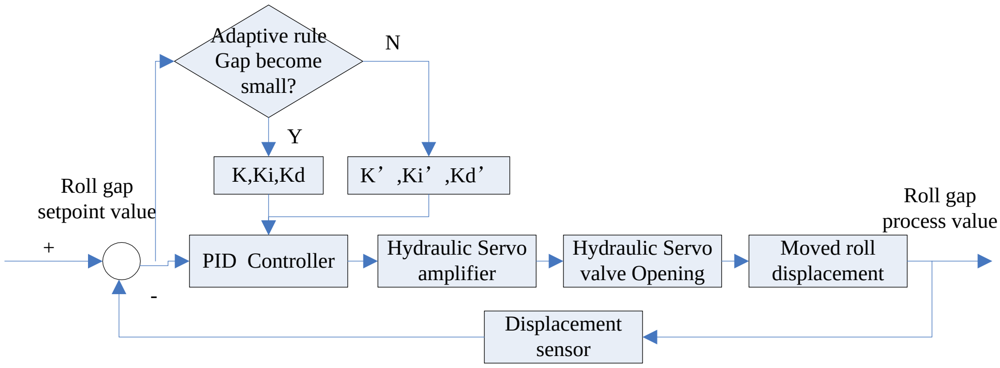


Fig 4. Adaptive control diagram of roll gap

4. Conclusion

It supplies the data and way in detail to establish the roll gap PID control system for the twin roll caster. Meanwhile, according to the work characteristic of hydraulic servo system, a adaptive PID roll gap controller is presented. The next job is to think over influencing factors about PID parameters in order to get more comprehensive adaptive rule for better control performance.

References

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