Implementation of gain scheduling controller(s) for a water level and temperature control

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Abstract: The aim of this study is to control the water level and the temperature of the first tank at the same time. Control of the level and temperature is first conducted by separate proportional plus integral PI controllers. Gain-scheduled PI controller(s) are also implemented and tested in this tank system. Gain scheduling is a popular engineering method used to design controllers for nonlinear and linear parameter varying systems. In this study we use three operating points which cover the range of the plant's dynamics. The scheduling variable is taken from the control signal. Tuning parameters are specified for each region. The PI settings are switched automatically when the process moves into a different region. To prevent abrupt changes to PI settings and subsequent process bumps, the gain scheduler uses an interpolation range between regions to provide smooth transitions. Within the interpolation range, the PI settings are calculated using the linear interpolation of the configured settings for the adjacent regions. Control strategies are realized in the DeltaV automation system, which is used to control the process.

The results of the experiments in laboratory show that the gain-scheduled water level controller provides a significant improvement in performance than the conventional PI water level controller. In this case, the temperature controller is conducted with conventional PI controller. The temperature control is more complex than the level control. The difficulty comes from the dependence of the water level in the first tank. The experiments in laboratory show that the conventional PI temperature control provides better results than the gain-scheduled temperature controller. The results of the experiments show also that the gain-scheduled water level and the conventional PI temperature controllers provide improvement in transient performance than using two gain-scheduled controllers.

Keywords: Gain scheduling, nonlinear design, automation system.