EPFL, LAMS
« Industrial Automation » course

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Solution Sheet 2

Question 1
A PI-controller is used for controlling the heating of a batch in a chemical reactor to the operating temperature. The batch is always too cold when it is poured into the reactor and only heating is applied. However, the colder the batch is when the heating is started, the higher the final temperature goes. What is probably the causing this problem? Explain the mechanism and suggest solutions both for the cases that the controller design can and cannot be modified.

Hint: Consider the table on Slide 55

The process experiences an overshoot (probably due to the integral term responding to accumulated errors from the past). If the controller can be modified one could add a derivative term or the integrator value could be limited. If the controller can't be modified we can make the integral rising action slower (decreasing Ti) and thus reduce the overshoot. Another option is to increase the heating power so that the control signal never reaches the limit. Probably costly but might give a better behaviour of the process.

Question 2
A sensitive liquid flow is heated by an inductive heater in a section of the tube where it is flowing. The disturbance from the current in the heater makes it impossible to place a temperature sensor close to the heating point. Instead the sensor is placed a significant around 5m downstream. Now it becomes difficult to control the temperature with the intended PID-controller. What is the problem? How can you solve it? Suggest as many possible methods as you can think of. The flow is constant and will not change.

Since there is a significant delay introduced between control action and the measurement of the temperature the control becomes difficult. This could be handled by very moderate parameters in the tuning of the PID-controller but this is often not an acceptable method since the control quality is bad. To use a more complex controller where we use a model for the heating process that can be used to predict the reaction is one option (advanced control) . A practical modification of the process might also be possible. If the pressure conditions allow it, one could use a thinner tube between the heater and the sensor. In this case the speed of the liquid becomes higher with a smaller cross-section and the delay is reduced.

Question 1
Under what circumstances can we use feed-forward control?

- we must have a model on how the disturbance affects the plant
- we must be able to measure the disturbance before it hits the plant
- we must be able to compensate for the disturbance before it has affected the plant