More Cascade Control

Review

- What is cascade control?
- Why use cascade control?
- What process dynamics are necessary?
- What types of controllers are used?
- How do you tune controllers?

Cascade Design

- Characteristics for selecting early warning PV2 include:
  - it must be measurable with a sensor
  - the same FCE (e.g., valve) used to manipulate PV1 also manipulates PV2
  - the same disturbances that are of concern for PV1 also disrupt PV2
  - PV2 responds before PV1 to disturbances of concern and to FCE manipulations

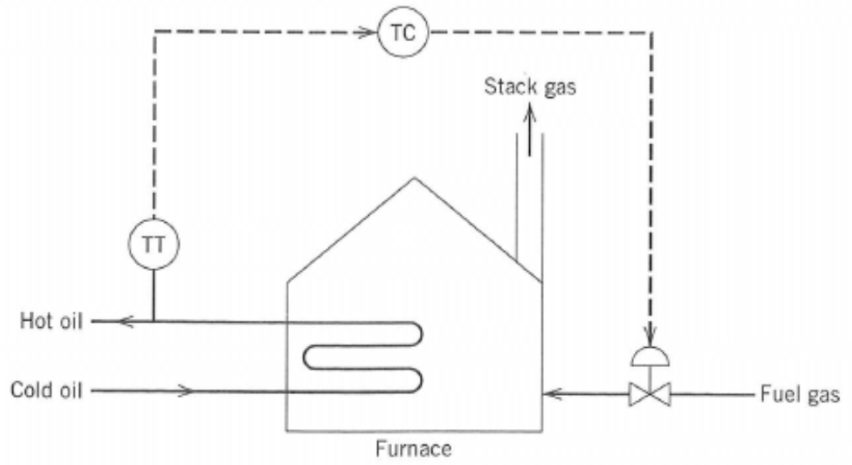
Misconceptions and Mis-Applications of Cascade Control

- Generally, adding a secondary controller does not make a feedback control system faster
- Secondary controllers are often more complicated, e.g., PI or PID, than they should be
- Cascade control is overused
  - Must be a disturbance to localize by secondary control
  - Often, system can be improved by removing cascade control (replace with simpler single-loop systems)

Misconceptions and Mis-Applications of Cascade Control

- A common form of a cascade controller is a valve positioner as a secondary controller
  - Electromechanical or pneumatic-mechanical, high gain controller mounted on the valve
  - Overcomes frictional effects
  - Minimizes hysteresis and deadband
- You are asking for trouble if the dynamics of the secondary loop are commensurate with (or slower than!) the dynamics of the primary loop

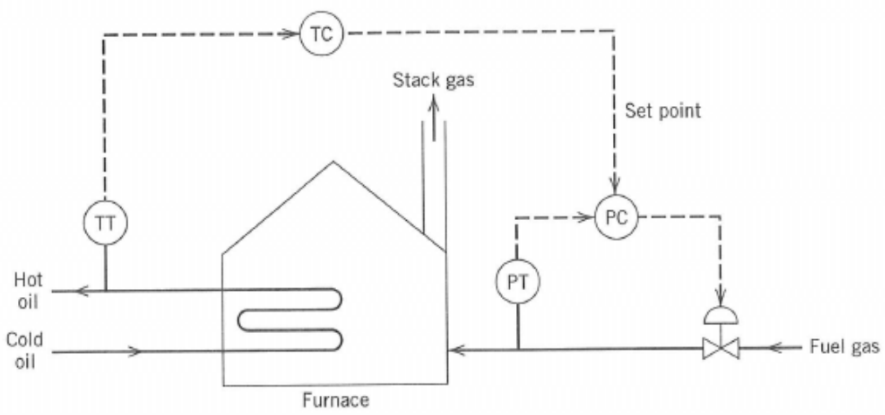
Example from Seborg et al.



(Fig. 16.1)

- Goal:
  - Heat up oil stream
- Controlled variable
  - Temperature of oil out
- Manipulated variable:
  - Fuel gas flow rate
- Problem:
  - Fluctuating fuel gas pressure

Solution: Cascade Control



(Fig. 16.2)

- Primary loop:
  - Controls T_{out} of oil
  - Makes set point for secondary loop
- Secondary loop:
  - Measures and controls fuel gas pressure
  - Could use flow rate instead of pressure

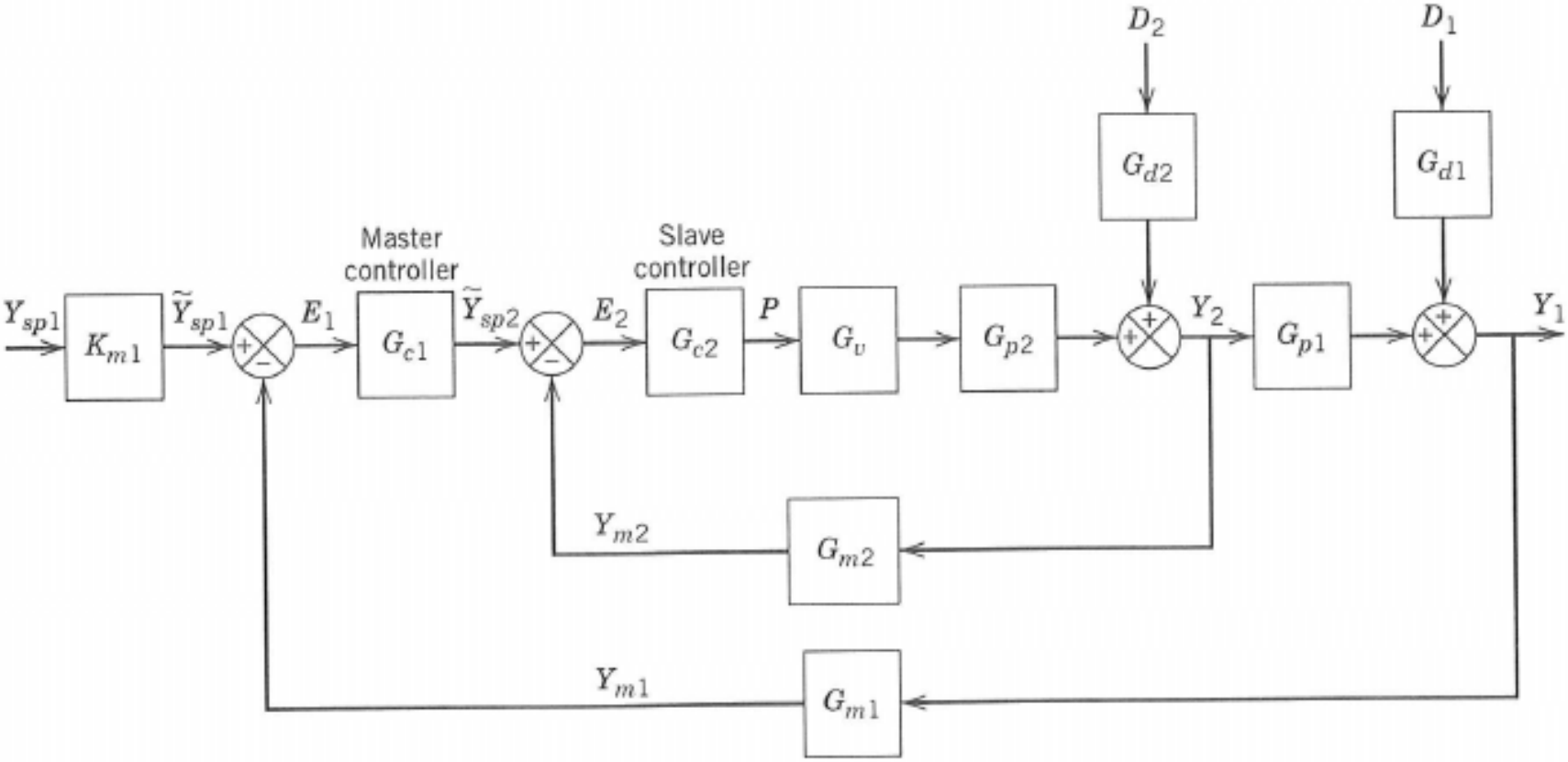
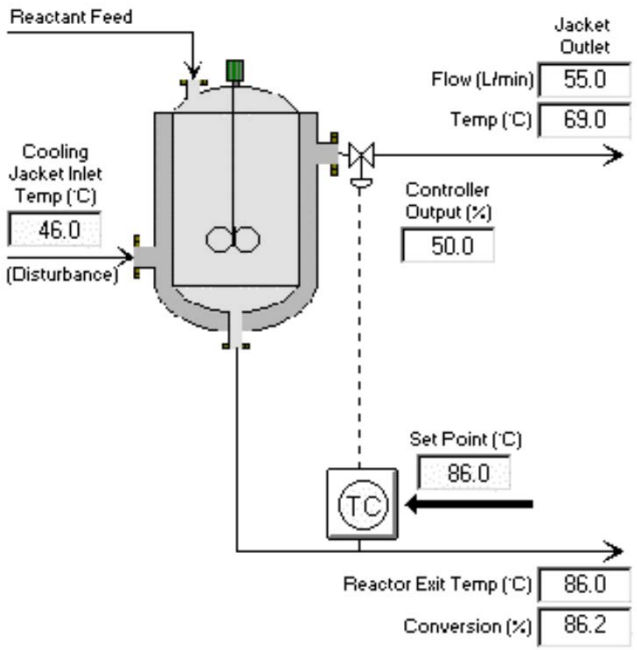


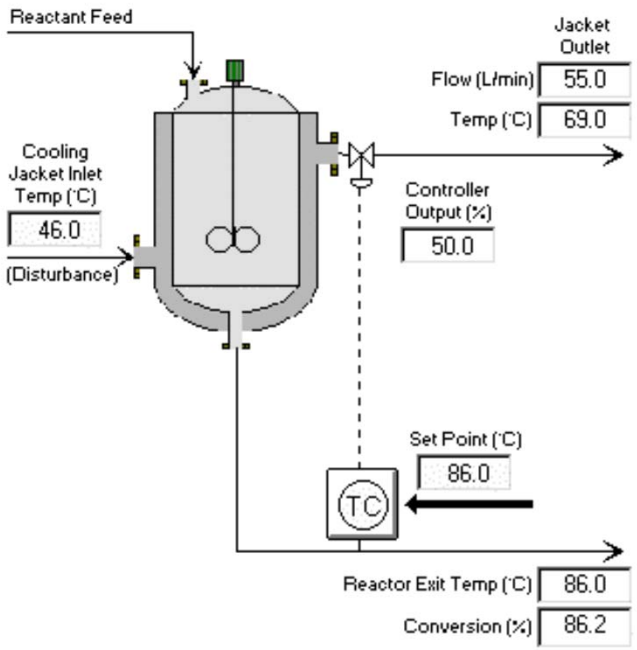
Figure 16.4 Block diagram of the cascade control system.

Safety Video



- Exothermic reaction
- Cooling jacket on batch reactor
- Operator-controlled cooling flow rate
- H_2 production in reactor
- CSB video
- Special Problem 14

Control Station Example



- Jacketed reactor with cascade control
- Initial conditions
  - Controller output = 50%
  - Inlet T_{jacket} = 46°C
- P-only control for the secondary loop
- Tune

Question

τ_p = 1.5 min for the inner loop
τ_p = 0.55 min for the outer loop

Does this violate our rules for implementing cascade control?

Next Class---- Feed Forward