

Feedforward and ratio control

In class activities

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Activities

1. Consider a boiler drum as shown in the figure below

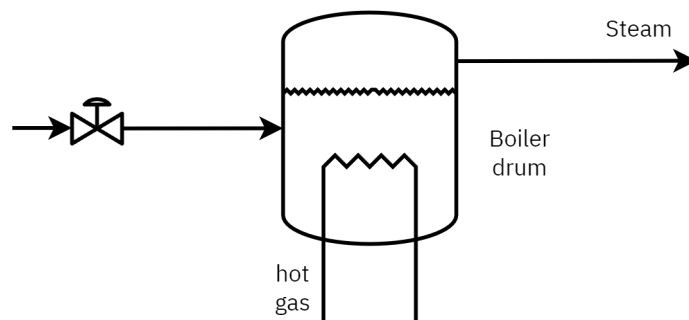


Figure 1: Boiler drum

- a. Identify controlled variable, manipulated variable and disturbance
- b. Draw a conventional feedback control to maintain liquid level in the boiler.
- c. What are the drawbacks of this system?

2. Consider the operation of heat exchanger to demonstrate the application of feedforward control strategy. Identify all disturbances and the target disturbance to be remove using the feedforward control strategy

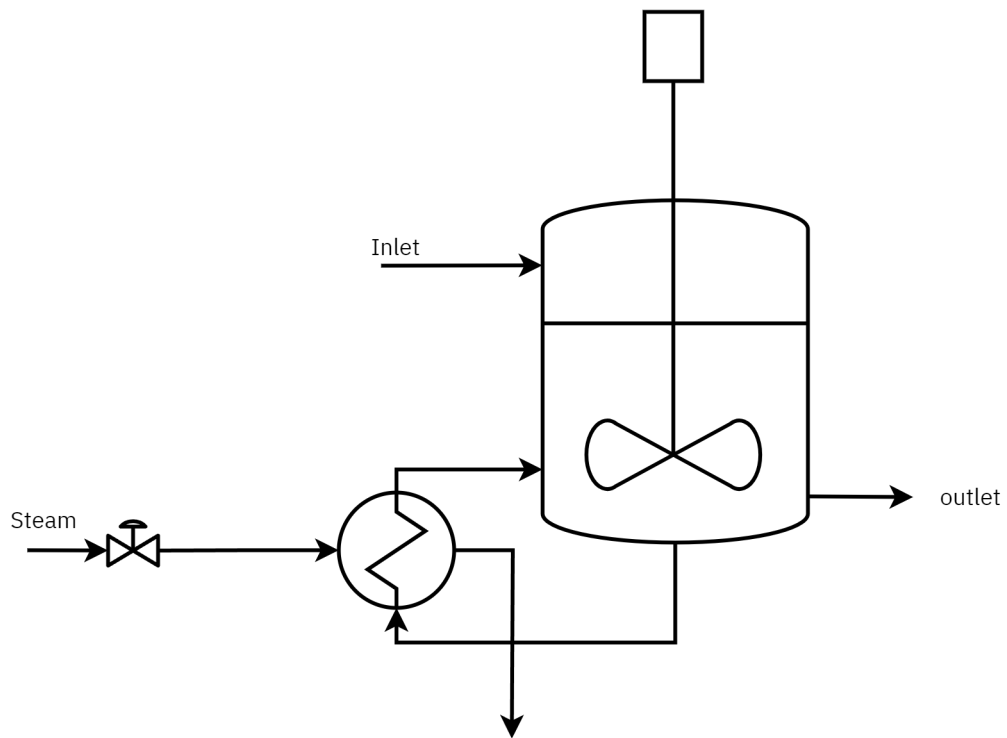


Figure 2: Heat exchanger

3. For the blending system shown in Figure 3

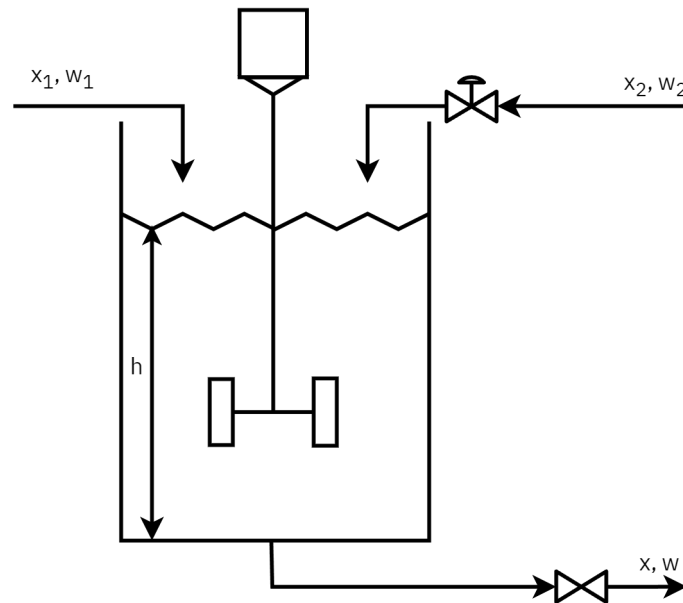


Figure 3: Blending system

- Identify controlled variable
- Manipulated variable
- Disturbance
- Propose a feedforward strategy to control outlet composition
- Propose a strategy to control composition when inlet flowrate w_2 is fluctuating
- propose a feedforward feedback control strategy

4. The process, and disturbance transfer functions for problem 1 are given by

$$G_p(s) = \frac{0.1e^{-s}}{2.5s + 1} \quad (1)$$

$$G_d(s) = \frac{0.5e^{-s}}{2.5s + 1} \quad (2)$$

use PID tuner app to tune a PID controller for this process.

5. Propose a feedforward control system for Figure 1. Explain how a feedforward control can improve disturbance rejection or regulatory control performance.
6. Calculate ideal feedforward compensator for Problem 2 and implement pure feedforward control scheme in simulink.
7. Draw a combined feedforward-feedback PID for Figure 1. Implement feedforward-feedback system in simulink.
8. Consider the following process and disturbance transfer functions:

$$\text{Process: } G_p(s) = \frac{2 \exp(-4s)}{15s + 1} \quad (3)$$

$$\text{Disturbance: } G_d(s) = \frac{5 \exp(-2s)}{30s + 1} \quad (4)$$

Do the following:

- i. For the process given above, can an idealized feedforward controller be used to reject the disturbance.
 - ii. Obtain a feedforward controller and PID controller for the process above using the unified feedforward-feedback control method.
9. [Ratio control for ammonia synthesis reactor.](#)

10. Furnace ratio control Figure 4

Draw the schematic of a ratio control strategy. What is the target disturbance? What is the manipulated variable? What is the controlled variable?

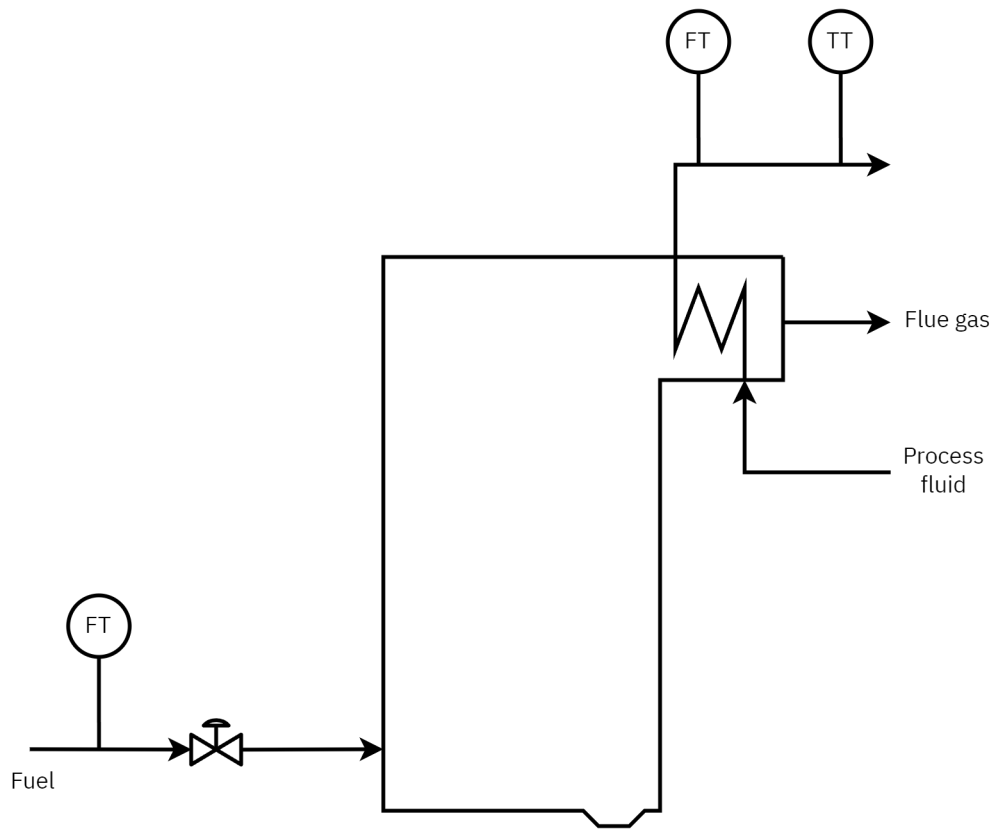


Figure 4: Furnace

11. Wastewater pH neutralization Figure 5

Devise a ratio control strategy to provide desired flow rate of NaOH solution to maintain the pH of the effluent.

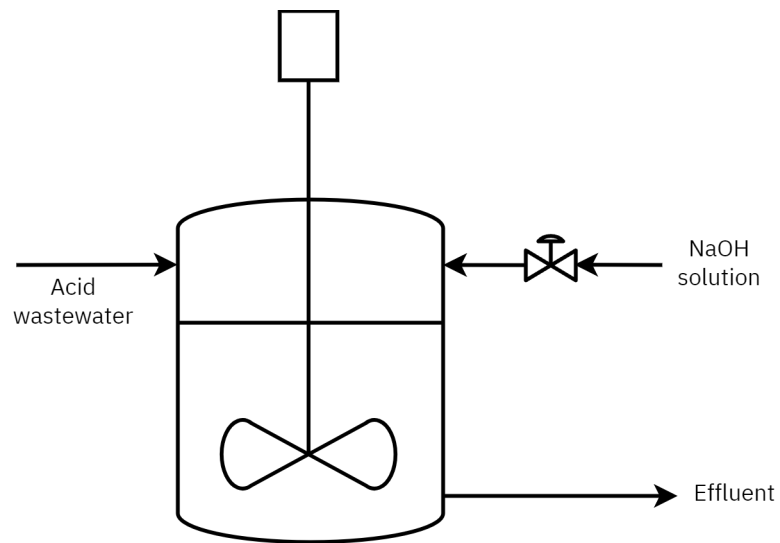


Figure 5: Wastewater treatment tank