CHBE 470 Introduction to Process Control (Ch. 1)

Most Chemical Engineering Coursework assumes that processes are at steady-state - however, most processes are NOT at steady state in the real world.

We need tools and an approach for dealing with dynamic processes

Examples of dynamic processes.

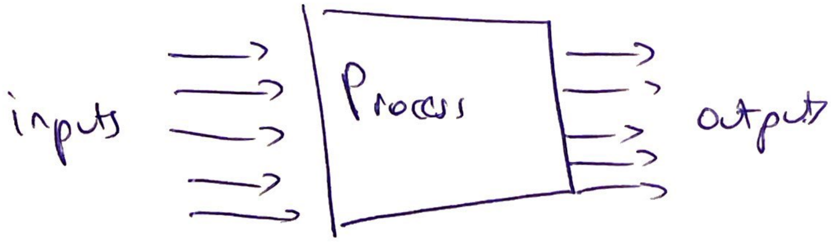
- reactor with variable feed
- temperature in a building
- steam power plant where temperature of condenser changes
- our bodies - metabolic regulation, heart rate, etc.

This course is about methods for <u>automated</u>, <u>feedback control</u>

We will study:

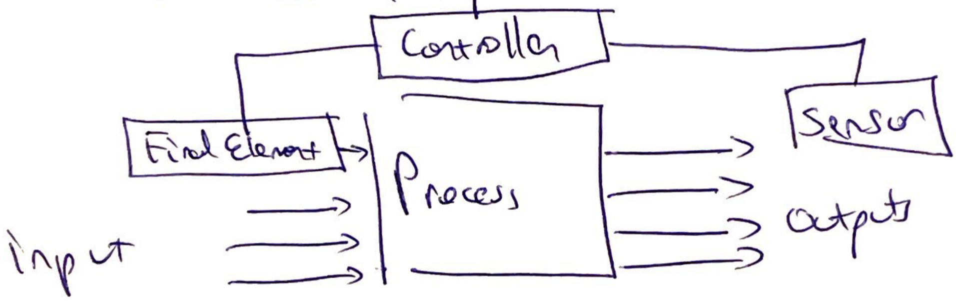
- Process Dynamics
- Process Control
- Stability - most of the processes we will look at are stable, but they can easily be made unstable using an improperly designed feedback control system

General Process Schematic



reactor, liquid mixing tank, building, cell, chemical plant, city, or the entire planet

Feedback Control systems use an output to change or influence an input



Sensor - provides a real-time measurement

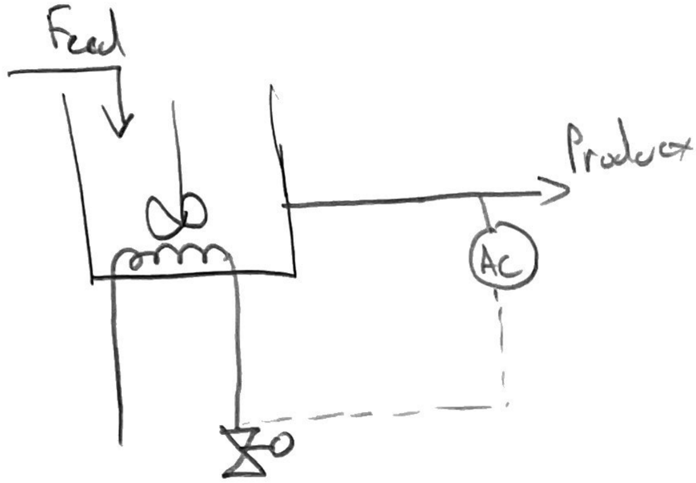
final element - equipment that influences the input

Controller - uses the measurement to adjust the final element

Criteria for feedback control

1) measured controlled variable.
2) adjustable manipulated variable
3) causal effect from manipulated to controlled variable

Example:



A: analyzer
C: controller

Reasons for feedback control
1) Disturbances
2) Changes to desired output
3) Model mismatch.

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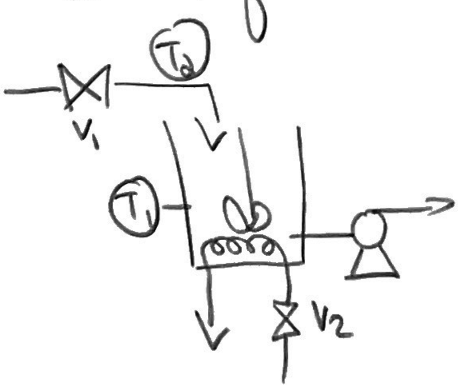
which of these is feedback control?

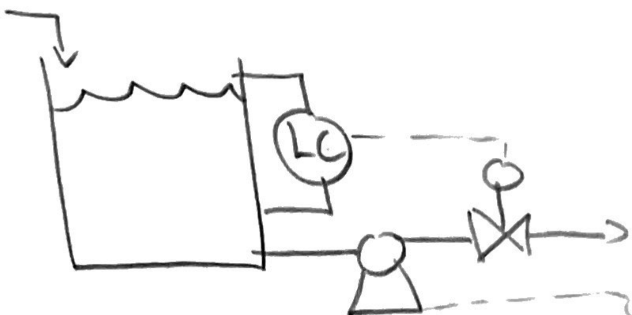


1) Control T_1 by adjusting V_2
2) Control T_1 by adjusting V_1
3) Control T_1 by measuring T_2 and adjusting V_2 to compensate.
4) Someone manually changing V_1 to control T_1

Other types of controllers

"F" flowrate

"C" controller



"L": level of liquid

"C": controller

See Fig. 1.8 in book for more typical layout

In fig 1.8, can the following be controlled by feedback control?

L2 Flash Drum Level

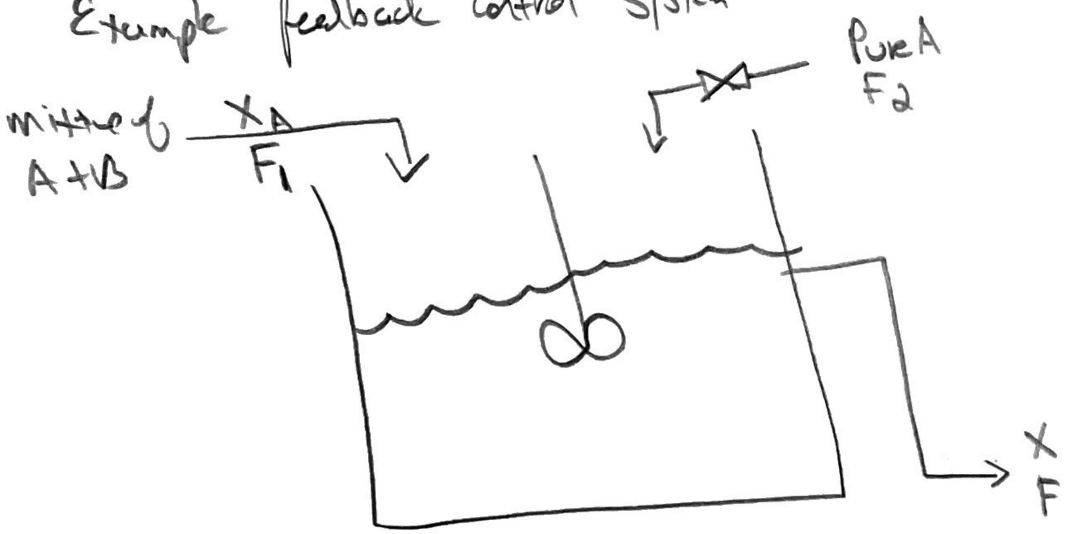
T5 Reactor Temperature.

P1 Flash Drum Pressure.

Ch. 2 Major Control Objectives

1) Safety
2) Environmental Protection
3) Equipment Protection
4) Smooth Operation + Production
5) Product Quality
6) Profit
7) Monitoring + Diagnosis

Example feedback control system



What is the correct value of F_2 needed to achieve a desired value of X_{sp}?

$$\left.\begin{aligned} F_1 + F_2 &= F \\ X_A F_1 + F_2 &= X_{sp} F \end{aligned}\right\} \quad F_2 = F_1 \frac{X_{sp} - X_A}{1 - X_{sp}}$$

What if X_1 varies with time. How do we adjust F_2 to maintain a desired value of $X = X_{sp}$?

$$F_2 = F_{20} + K_c[X_{sp} - X]$$

Proportional control