Module 2 Process Control and various controllers

Introduction to process control
PID controller and tuning
Various control configurations such as cascade control, feedforward control, split range control, ratio control, override control, selective control

Concept of FEEDBACK Control

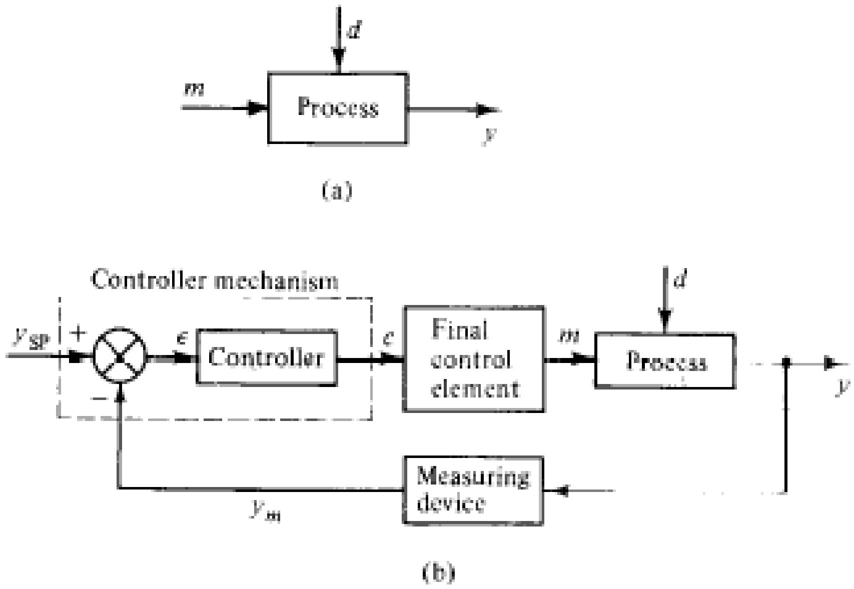
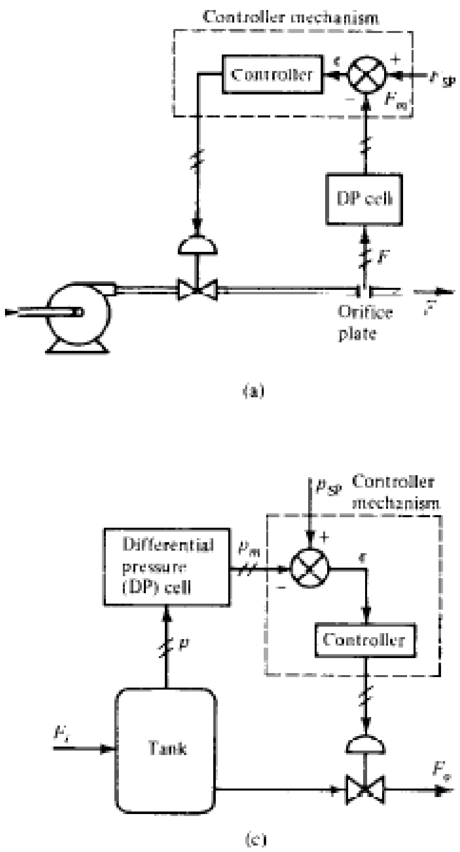


Figure 13.1 (a) process and (b) corresponding feedback loop.



Concept of Feedforward Control

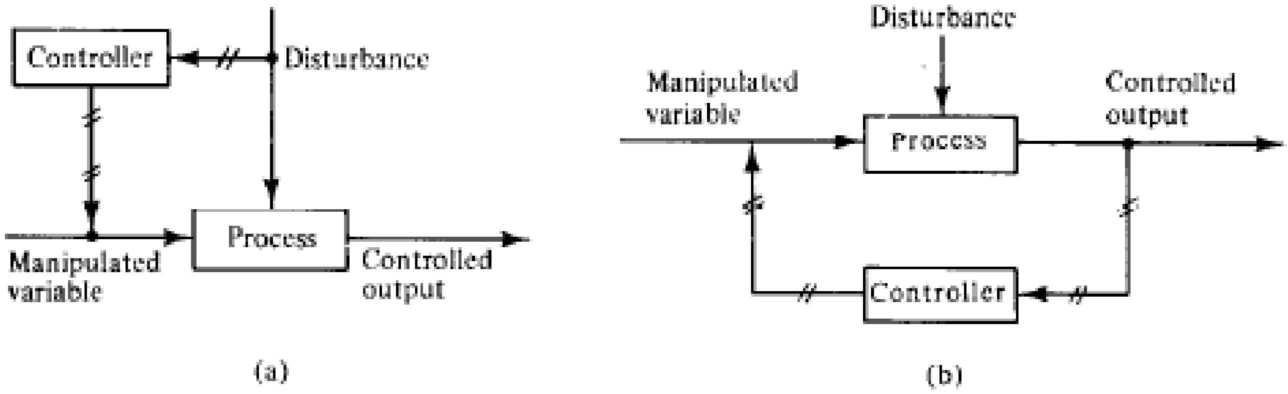
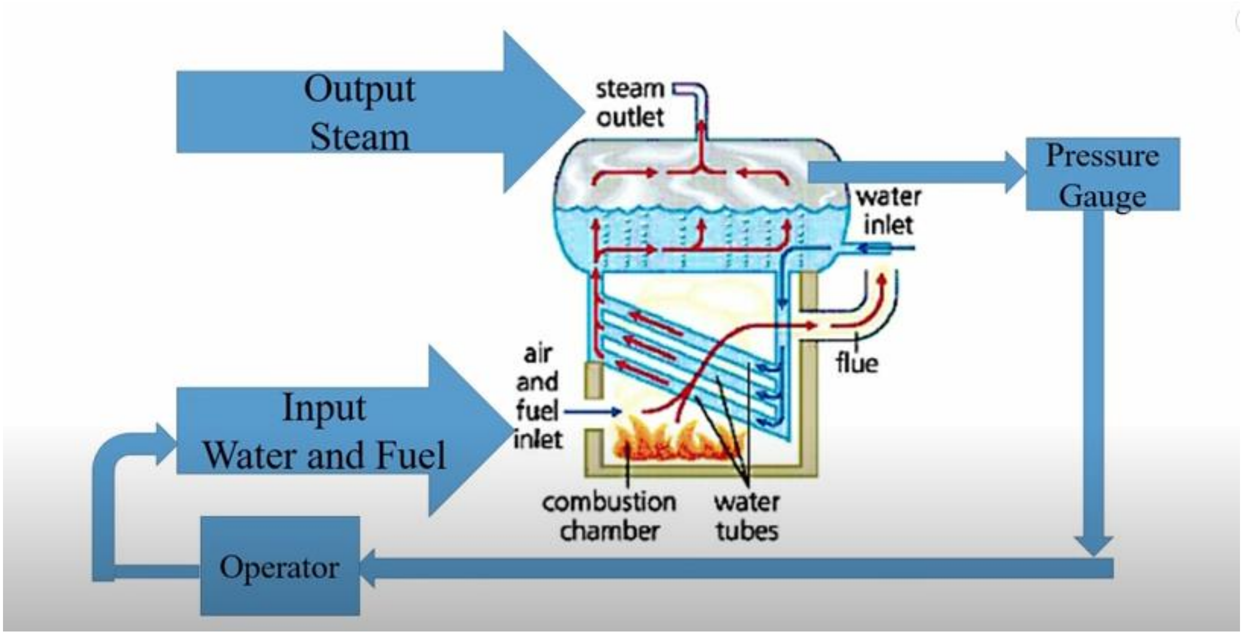
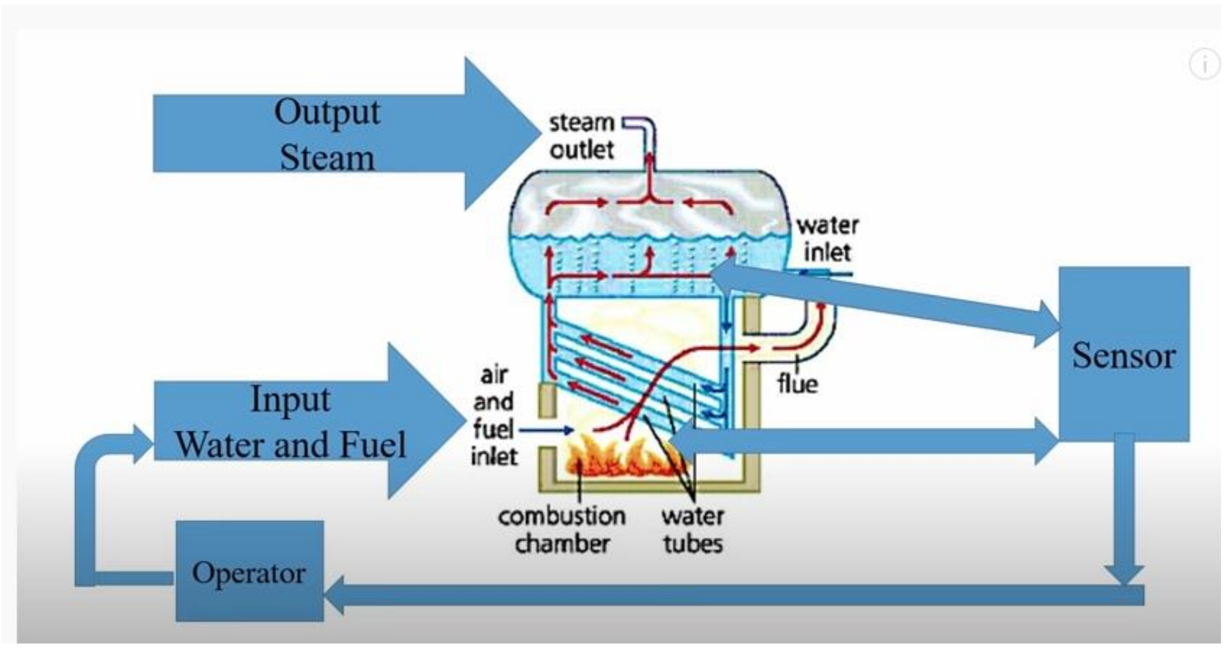


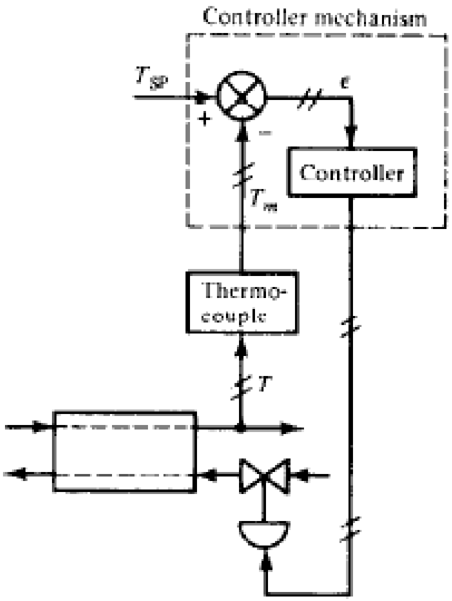
Figure 21.1 Structure of (a) feedforward, and (b) feedback control schemes.





Temperature control

Heat Exchanger:Aim to maintain exit temp. of stream constant



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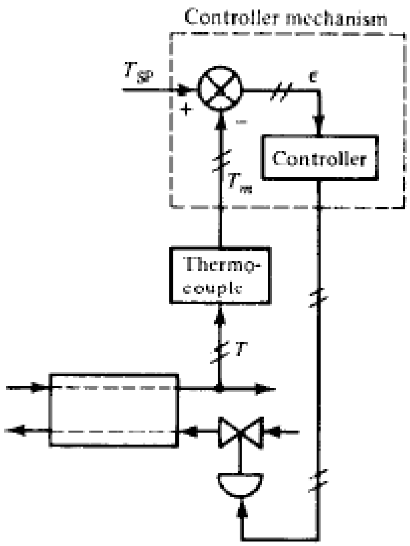


(f)

RELATIVE ADVANTAGES AND DISADVANTAGES OF FEEDFORWARD AND FEEDBACK CONTROL

Advantages	Disadvantages
Feedforward	
1. Acts before the effect of a disturbance has been felt by the system.	1. Requires identification of all possible disturbances and their direct measurement.
2. Is good for slow systems (multicapacity) or with significant dead time.	2. Cannot cope with unmeasured disturbances.
3. It does not introduce instability in the closed-loop response.	3. Sensitive to process parameter variations.
	4. Requires good knowledge of the process model.
Feedback	
1. It does not require identification and measurement of any disturbance.	1. It waits until the effect of the disturbances has been felt by the system, before control action is taken.
2. It is insensitive to modeling errors.	2. It is unsatisfactory for slow processes or with significant dead time.
3. It is insensitive to parameter changes.	3. It may create instability in the closed-loop response.

Cascade Control

Cascade control of jacketed CSTR

The reaction is exothermic and the heat generated is removed by the coolent, which flows in the jacket around the tank.

Control Objective- To keep T(temp. of the reacting mixture) constant.

Measured Variable- actual temperature of tank

Disturbances- feed temperature Ti, coolant temperature Tc

Manipulated variable- Coolant flow rate Fc

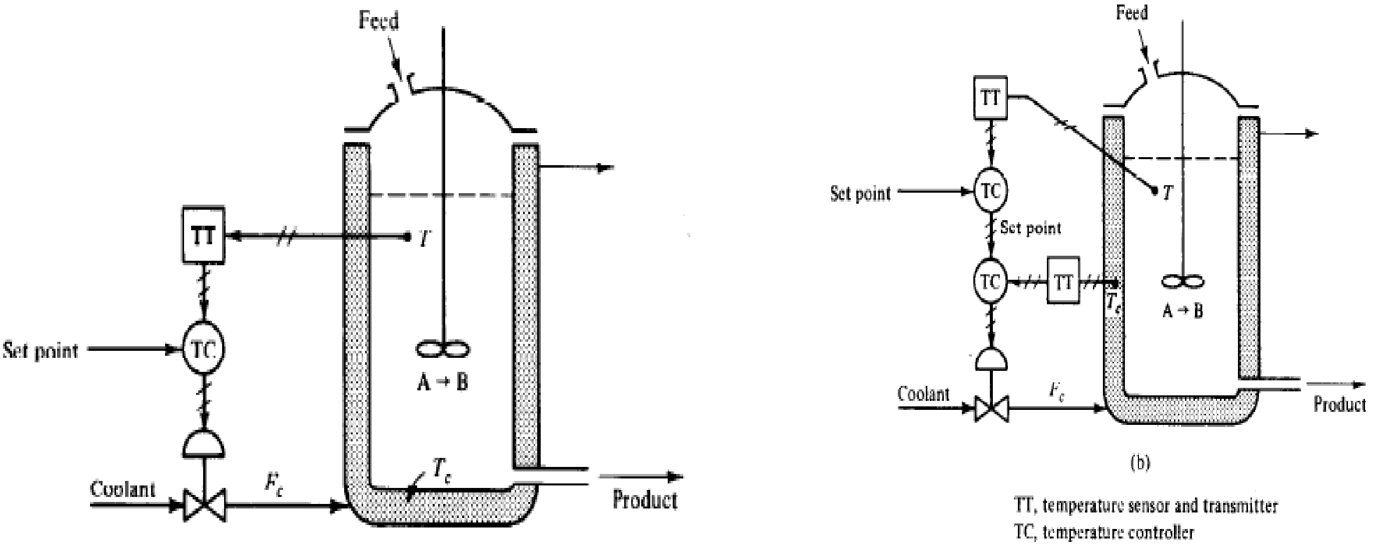
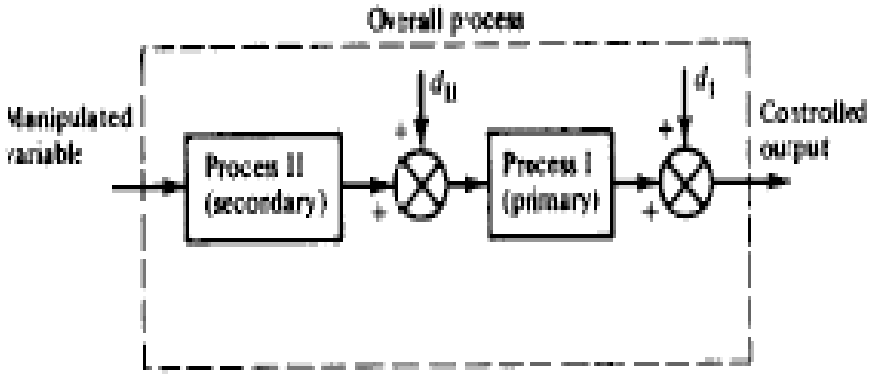
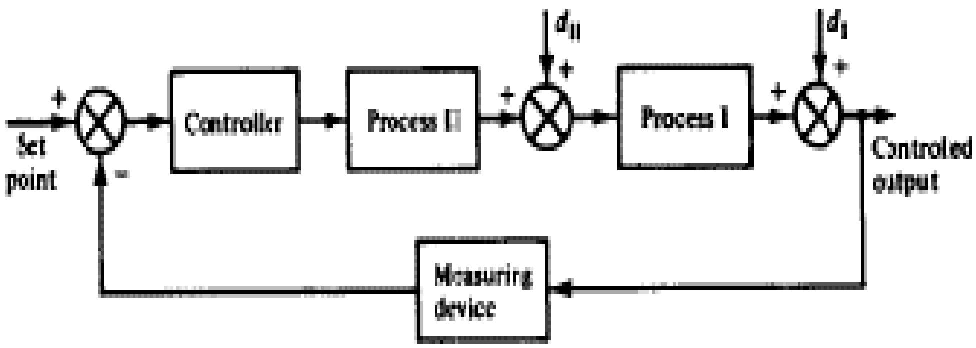


Figure 20.1 Temperature control of jacketed CSTR: (a) conventional feedback; (b) cascade.



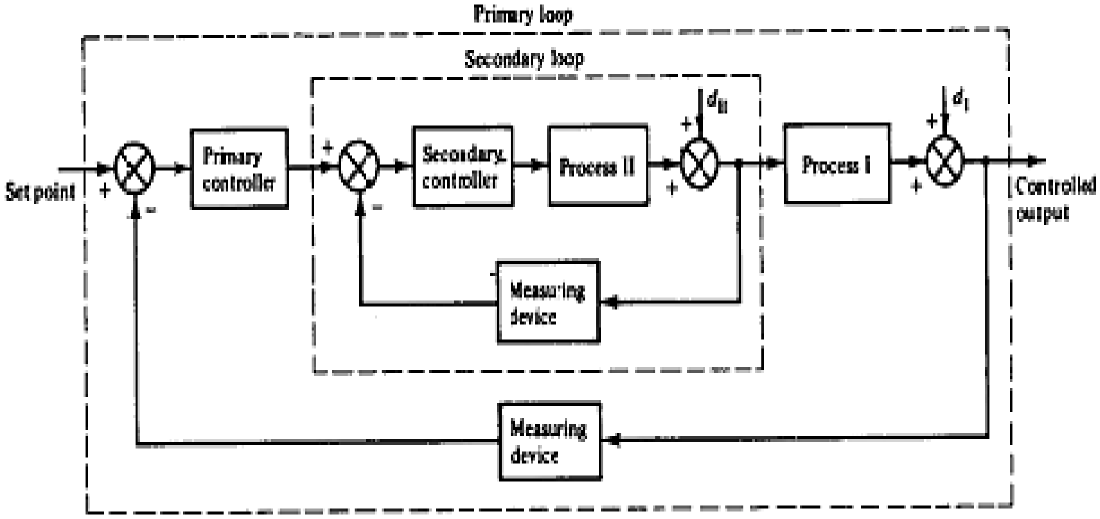
(a)



(b)

Process2- Jacket (disturbance is coolent temperature)

Process1- Exhothermic reaction (disturbance is incoming temperature)



(c)

Figure 20.2 Schematic representation of: (a) open-loop process; (b) conventional feedback; (c) cascade control.

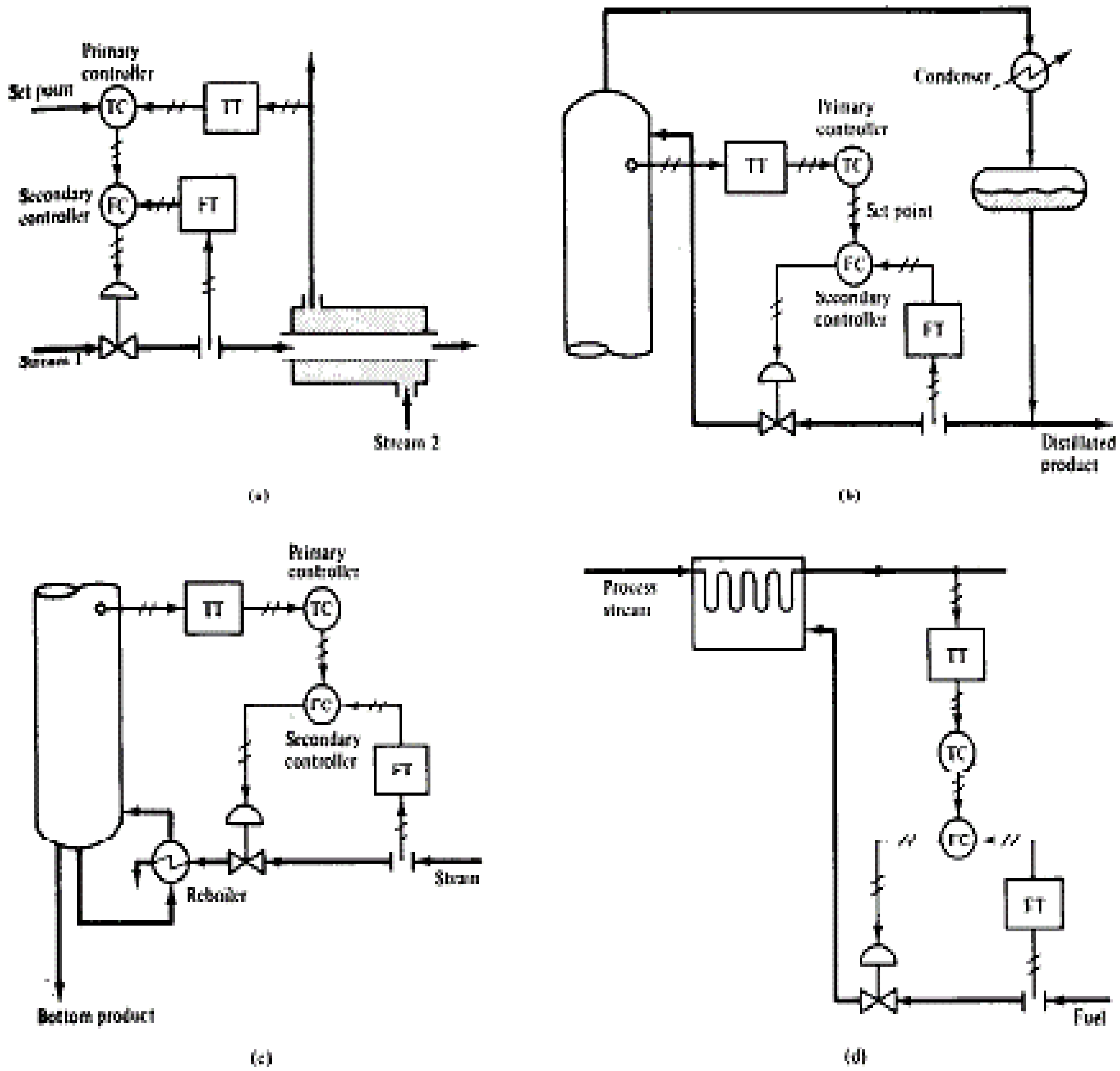


Figure 20.3 Examples of cascade control for: (a) heat exchanger; (b), (c) distillation column; (d) process furnace.

Selective Control

Auctioneering control   Override control for protection of control equipment

Auctioneering Control

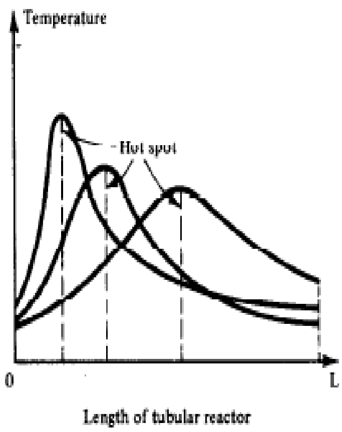


Figure 20.8 Temperature profiles in a tubular catalytic reactor.

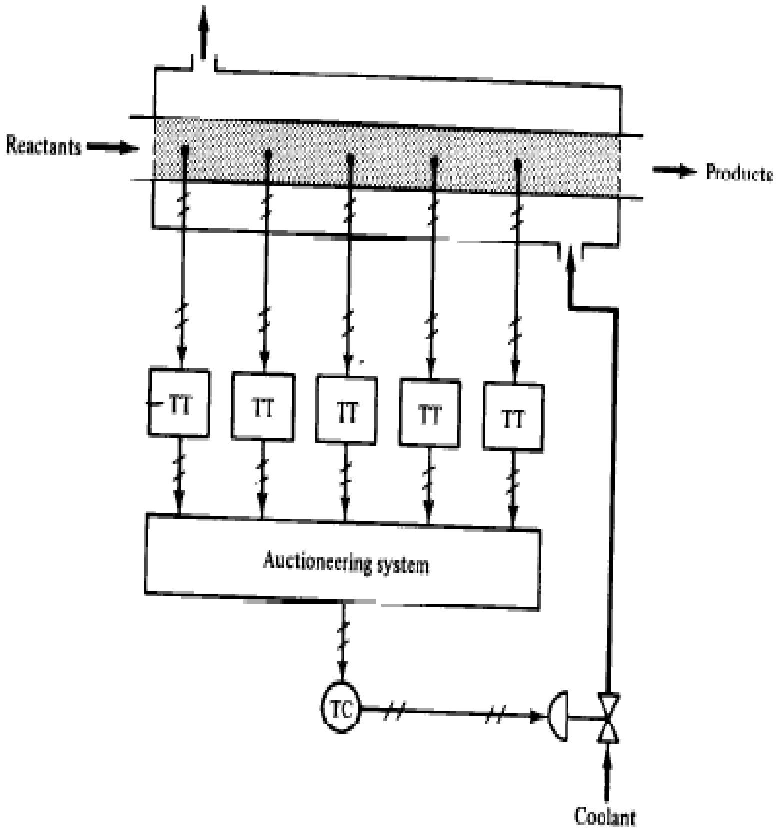


Figure 20.9 Auctioneering control system for a tubular catalytic reactor.

Override control

During the normal operation of a plant or during its startup or shutdown it is possible that dangerous situations may arise which may lead to destruction of equipment and operating personnel. In such cases it is necessary to change from the normal control action and attempt to prevent a process variable from exceeding an allowable upper or lower limit. This can be achieved through the use of special types of switches. The *high selector switch* (HSS) is used whenever a variable should not exceed an upper limit, and the *low selector switch* (LSS) is employed to prevent a process variable from exceeding a lower limit.

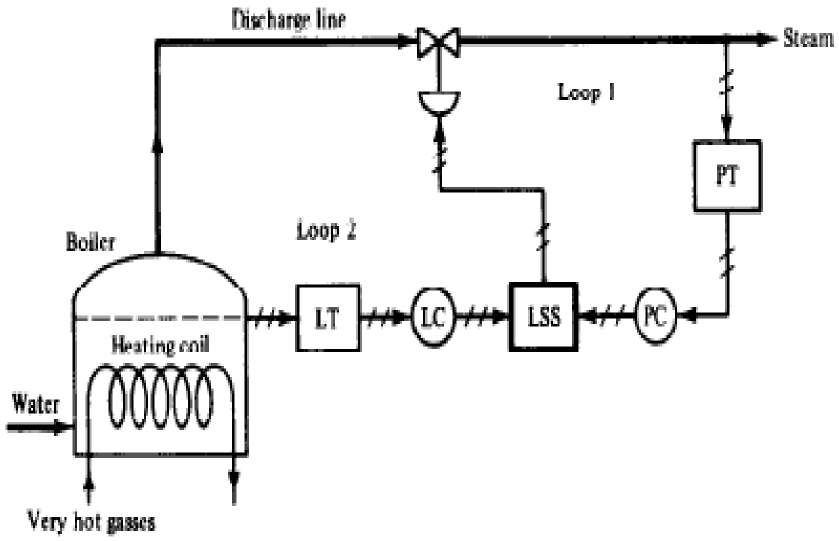


Figure 20.5 Override control to protect a boiler system.

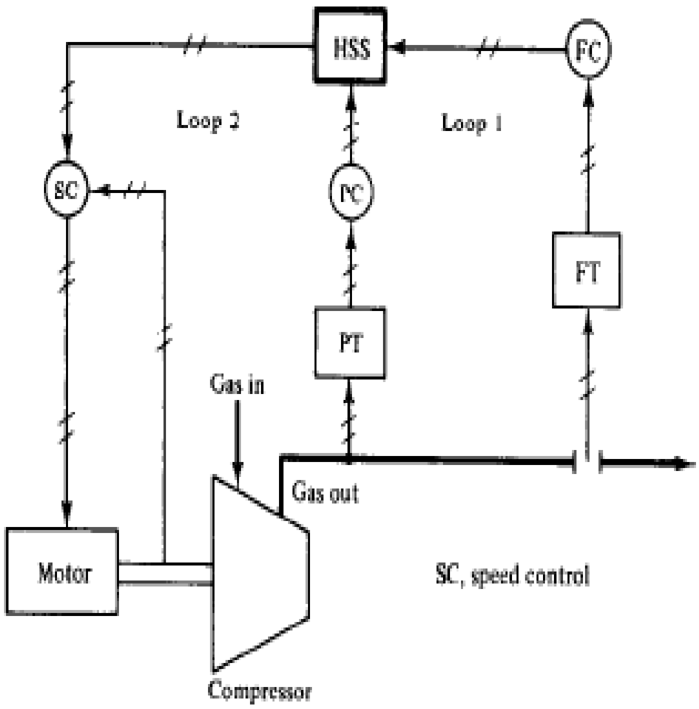


Figure 20.6 Override control to protect a compressor.

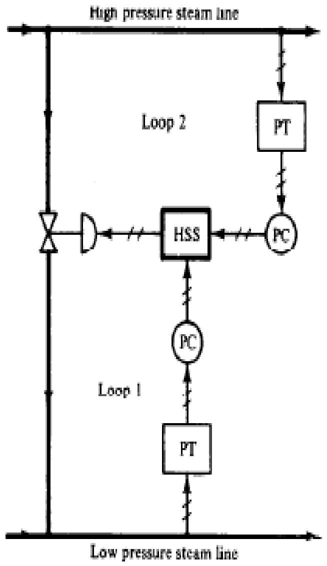


Figure 20.7 Override control for steam distribution system.

Split-Range Control

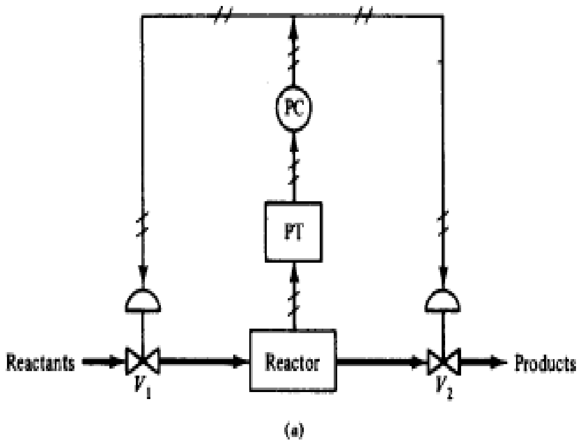
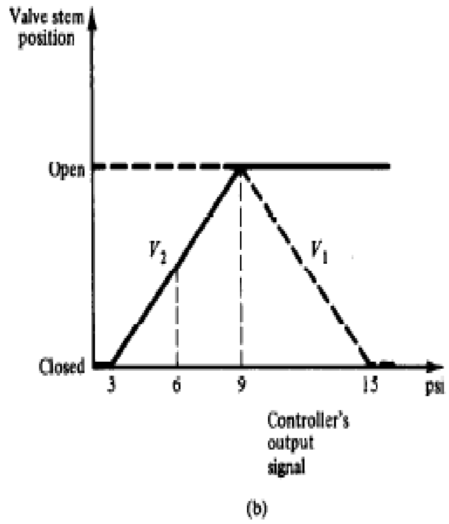


Figure 20.10 (a) Reactor system with split-range control; (b) action of two valves.



Output Signal and Valve Coordination

Controller's output signal	Valve V_1 stem position	Valve V_2 stem position
3 psig	Open	Closed
9 psig	Open	Open
15 psig	Closed	Open

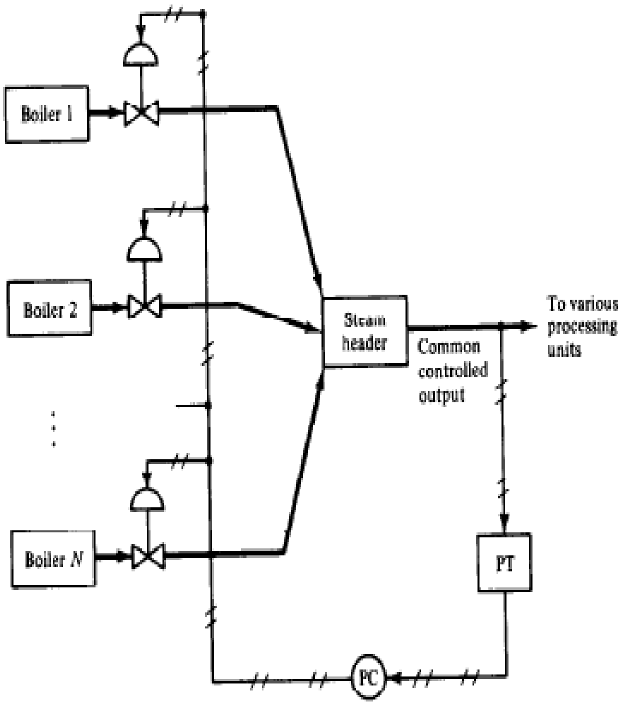
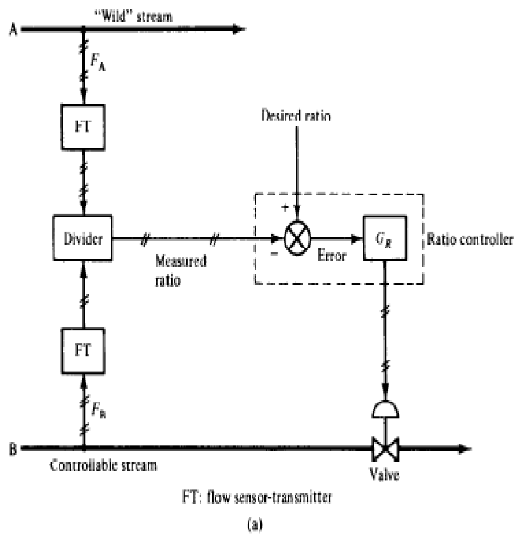
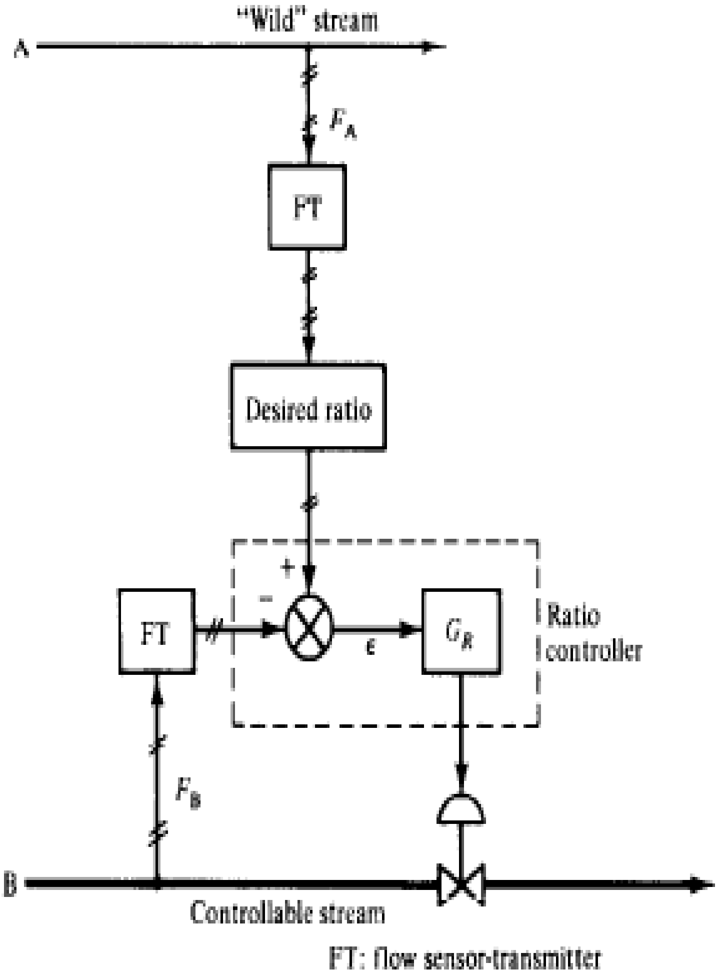


Figure 20.11 Steam header with split-range control.

Ratio Control





(b)

Figure 21.9 Alternative configurations of ratio control systems.