Introduction to process control

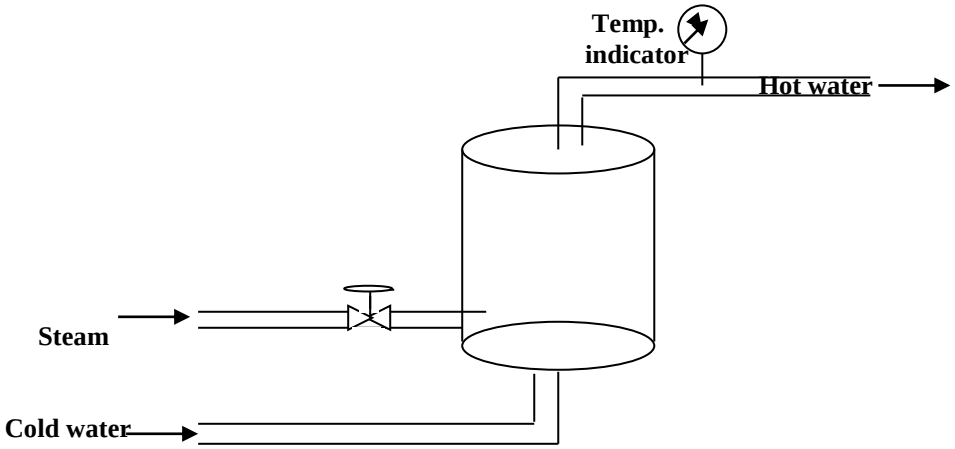


Figure (1) Open loop system

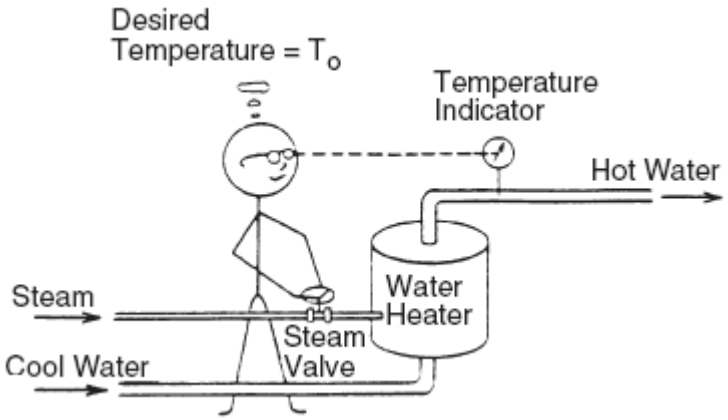


Figure (2) Manual Control system

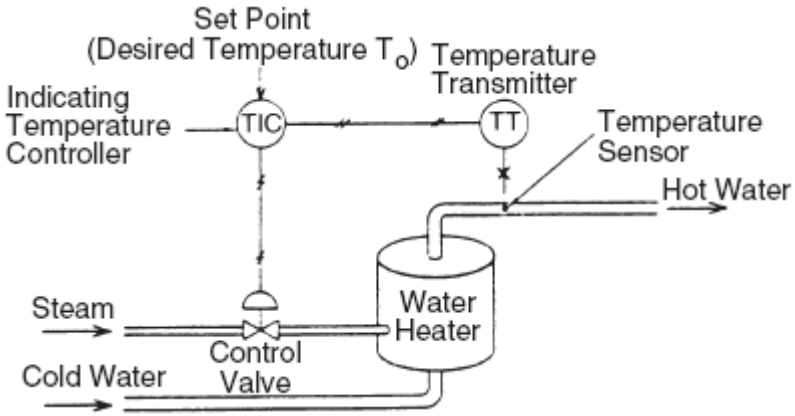


Figure (3) Automatic Control system (Closed Loop)

Control System Objectives

- Economic Incentive
- Safety
- Equipment Protection
- Reduce variability
- Increase efficiency
- Ensure the stability of a process
- Elimination of routine

Definitions:

System: it is a combination of components that act together and perform a certain objective.

Plant: it is the machine of which a particular quantity or condition is to be controlled.

Process: is defined as the changing or refining of raw materials that pass through or remain in a liquid, gaseous, or slurry state to create end products.

Control: in process industries refers to the regulation of all aspects of the process. Precise control of level, pH, oxygen, foam, nutrient, temperature, pressure and flow is important in many process applications.

Sensor: a measuring instrument, the most common measurements are of flow (F), temperature (T), pressure (P), level (L), pH and composition (A, for analyzer).The sensor will detect the value of the measured variable as a function of time.

Set point: The value at which the controlled parameter is to be maintained.

Controller: A device which receives a measurement of the process variable, compares with a set point representing the desired control point, and adjusts its output to minimize the error between the measurement and the set point.

Error Signal: The signal resulting from the difference between the set point reference signal and the process variable feedback signal in a controller.

Feedback Control: A type of control whereby the controller receives a feedback signal representing the condition of the controlled process variable, compares it to the set point, and adjusts the controller output accordingly.

Steady-State: The condition when all process properties are constant with time, transient responses having died out.

Transmitter: A device that converts a process measurement (pressure, flow, level, temperature, etc.) into an electrical or pneumatic signal suitable for use by an indicating or control system.

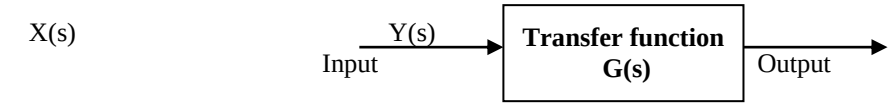
Controlled variable: process output which is to be maintained at a desired value by adjustment of a process input.

Manipulated variable: process input which is adjusted to maintain the controlled output at set point.

Disturbance: a process input (other than the manipulated parameter) which affects the controlled parameter.

Process Time Constant(τ): Amount of time counted from the moment the variable starts to respond that it takes the process variable to reach 63.2% of its total change.

Block diagram: it is relationship between the input and the output of the system.It is easier to visualize the control system in terms of a block diagram.

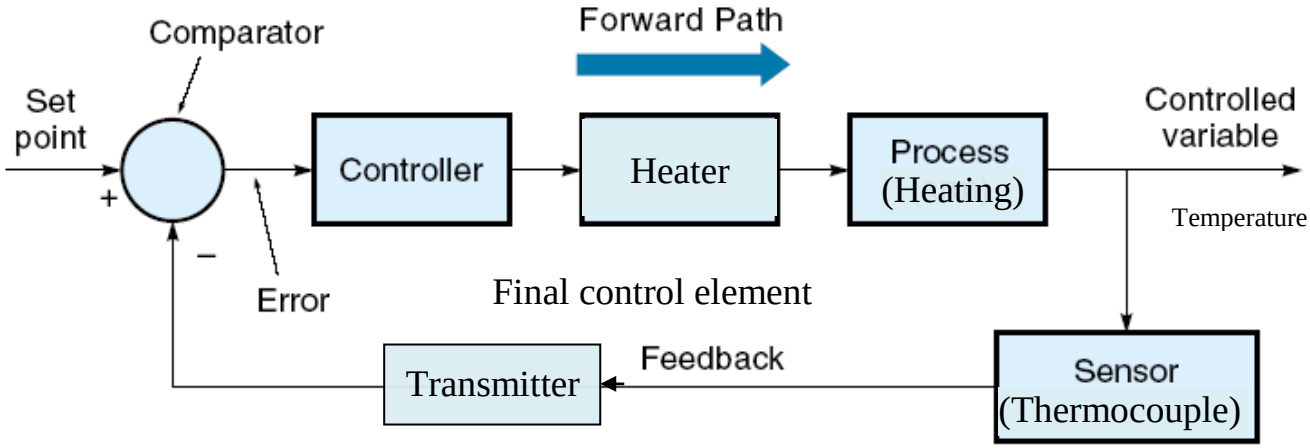


Block diagram

Transfer Function: it is the ratio of the Laplace transform of output (response function) to the Laplace transform of the input (driving force) under assumption that all initial conditions are zero unless that given another value.

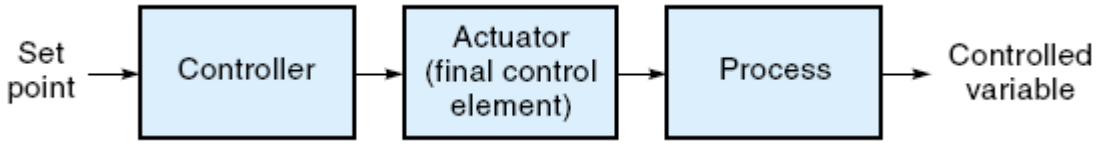
e.g. the transfer function of the above block diagram is G (s) = Y(s)/X(s)

Closed-loop control system: it is a feedback control system which the output signals has a direct effect upon the control action.



Advantage: more accurate than the open-loop control system.
Disadvantages: (1) Complex and expensive
(2) The stability is the major problem in closed-loop control system

Open-loop control system: it is a control system in which the output has no effect upon the control action. (The output is neither measured nor fed back for comparison with the input).



(Timer) Motor

Advantages:

(1) Simple construction and ease of maintenance.
(2) Less expensive than closed-loop control system.
(3) There is no stability problem.

Disadvantages:

(1) Disturbance and change in calibration cause errors; and output may be different from what is desired.

(2) To maintain the required quality in the output, recalibration is necessary from time to time

Note: any control system which operates on a time basis is open-loop control system, e.g. washing machine, traffic light …etc.