

Part - B (Actuators)

B6a

Objective : To study the inherent and installed characteristics of control valve

Theory : The control action taken by a controller is delivered by final control elements. One of the most frequently used final control elements is the control valve. A valve has 3 main components: Actuator, positioner and body. Control valves are automatic and are operated by electrical, hydraulic or pneumatic actuator. A piston and a cylinder are two main components of a pneumatic actuator. The valve stem which is connected to the internal components of the actuator, is moved by the piston, which is covered by a diaphragm, or seal, that allows air pressure to force the diaphragm and maintain the air inside the cylinder.

Inherent characteristics : All control valve have an inherent flow characteristic that define the relationship between valve opening and flow rate under constant pressure conditions.

The flow rate through a valve is expressed as follows:

$$Q = C f(x) \sqrt{\frac{\Delta P}{\rho}}$$

where,

$Q \equiv$ volumetric flow rate

$C \equiv$ Valve coefficient ; $x \equiv$ fractional valve opening

$\Delta P \equiv$ Pressure drop across the valve

$\rho \equiv$ Density of fluid

Depending upon the shape of the plug we get different valve characteristics. Three main type are:

Quick opening

$$\sqrt{x}$$

$$\leftarrow f(x)$$

Linear

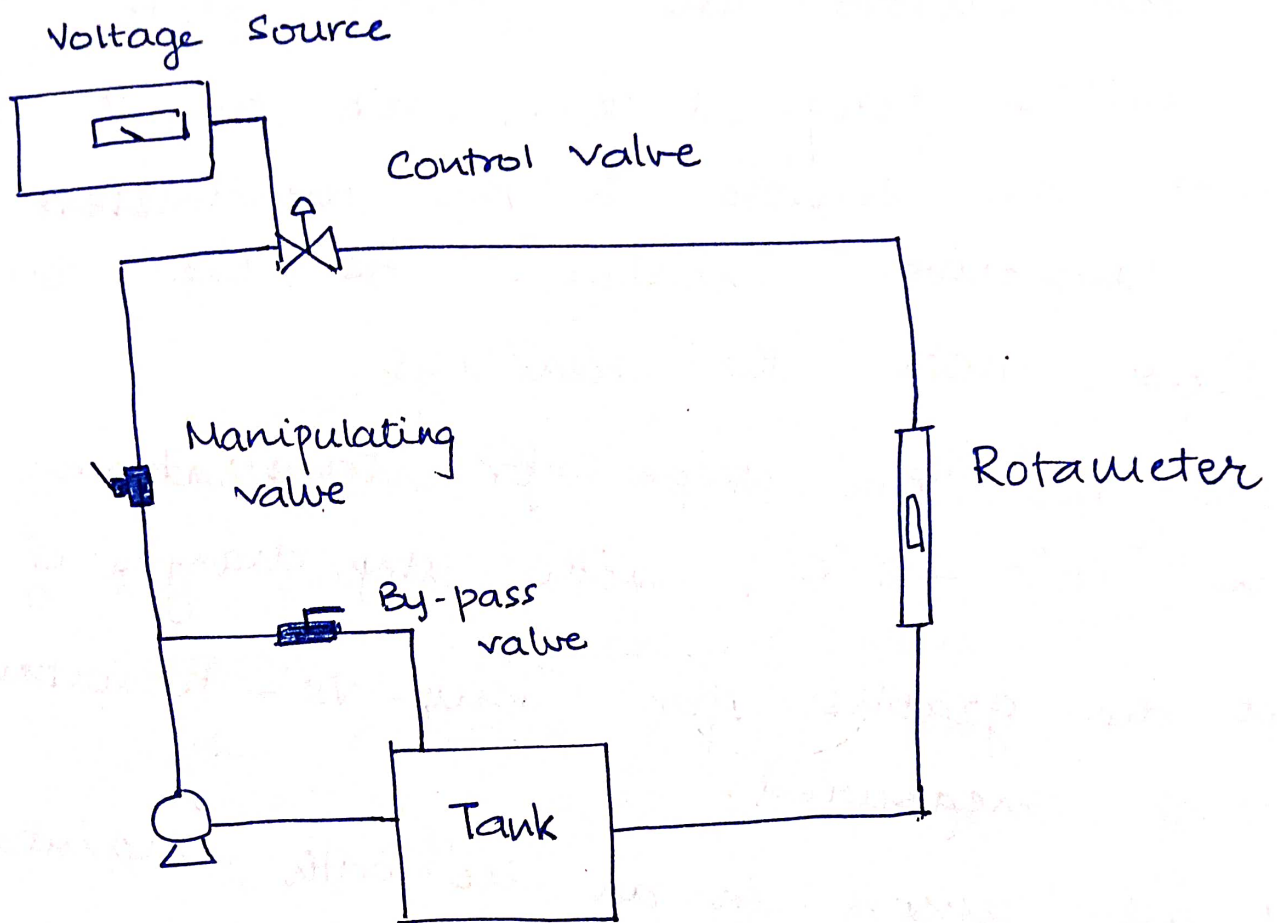
$$x$$

Equal percentage

$$a^{x-1}$$

Installed : When the valve is installed in a plant,
Characteristics it does not exhibit its inherent characteristics and we get installed characteristics. This is because there will be additional frictional losses in the system.

SCHEMATIC DIAGRAM :



APPARATUS :

- Air-to-open control valve
- Rotameter
- Mercury Manometer
- Ball valve
- Centrifugal pump.

Procedure

→ Inherent Characteristics :

- We closed the by-pass valve and used the manipulated valve to keep the pressure drop constant.
- Set the voltage to 5V and started the experiment with 28 mmHg pressure drop and noted the flow rate.
- Decreased the voltage with step change of 0.2 V. The manipulated valve is then slightly closed to bring ΔP back to 28 mmHg and report flow rate.
- The same procedure is repeated by changing voltage to 3V and back to 5V.

→ Installed characteristics :

- By-pass valve is completely closed and manipulating valve is kept completely open.
- Opening of control valve is controlling voltage supply.
- We changed the voltage with a step of -0.2V till 3V and then +0.2V till 5V.
- Flow rate and ΔP was measured at each step.