Bab 5. Actuator

Dr. Yeffry Handoko Putra, S.T, M.T

Session Outlines & Objectives

Outlines

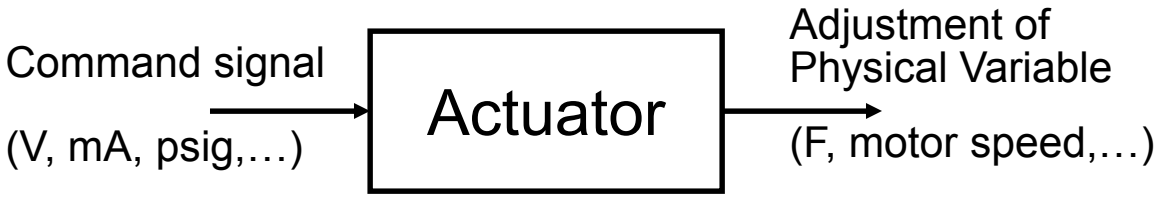
- Control valve
- Other actuators

Objectives

- Know various type of actuators and their application in the process control area
- Know the characteristics of actuators

Introduction

- What is actuator?
  - Actuator converts the command signal from controllers into physical adjustment in adjustable process variable



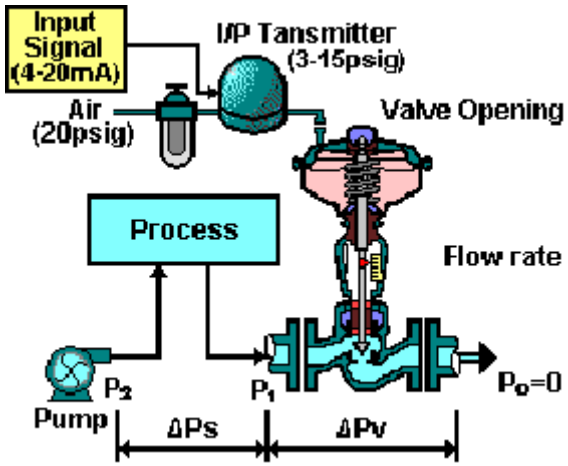
- Actuator types
  - Control valve: pneumatic, electric, hydraulic
  - Electric heater output: thyristor
  - Pump/Motor speed: inverter
  - Displacement: pneumatic, electric, hydraulic

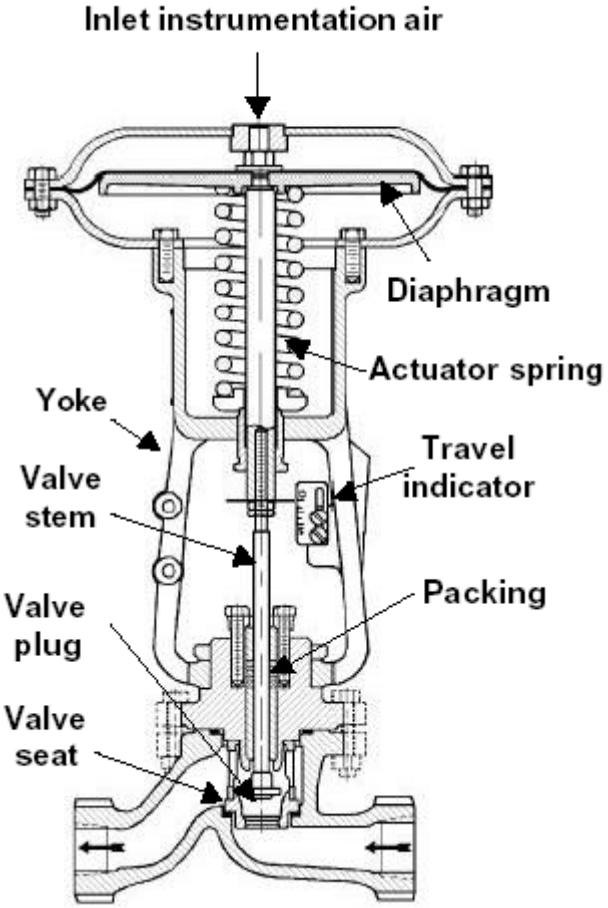
Industrial Actuator

- Actuator
  - Convert the industrial standard signal to action such as valve opening, power level, displacement
- Actuator power
  - Pneumatic
    - Simple, low cost, fast, low torque, hysteresis
  - Electric
    - Motor and gear box, high torque, slow
  - Hydraulic
    - High torque, fast, expensive

Control Valve

- A work-horse of process control
- Actuator + valve
  - Valve opening is adjusted by an actuator
- Pneumatic control valve
  - Usually 3 – 15 psig signal is provided
  - I/P transmitter converts 4 – 20 mA signal to 3 – 15 psig pneumatic signal via 20 psig air supply





Major Classifications (1)

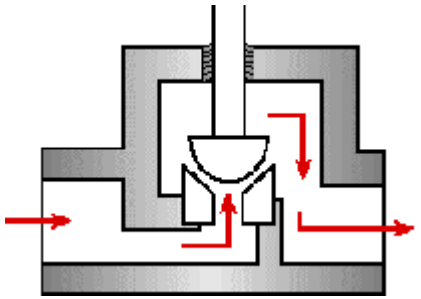
- Based on motion
  - Linear
    - Globe
    - Diaphragm
    - Pinch or clamp
    - Gate
  - Rotary
    - Eccentric plug
    - Butterfly
    - Ball
- Based on the event of a loss of signal or power (fail-safe mode)
  - Fail Open (FO)/Air-to-Open (ATO)
  - Fail Closed (FC)/Air-to-Closed (ATC)

Major Classifications (2)

- Based on type of power signal
  - Pneumatic
  - Electric
  - Hydraulic
- Based on valve trim (plug) types
  - Equal-percentage
  - Linear
  - Quick opening

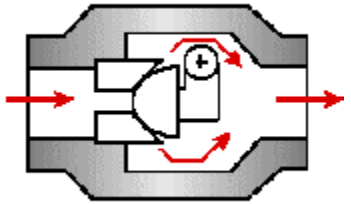
The Motions (1)

Linear



- Tortuous flow path
- Low recovery
- Can throttle small flow rates
- Offers variety of special trim designs
- Suited to high-pressure application
- Usually flanged or threaded
- Separable bonnet

Rotary



- Streamlined flow path
- High recovery
- More capacity
- Less packing wear
- Can handle slurry and abrasives
- Flangeless
- Integral bonnet
- High rangeability

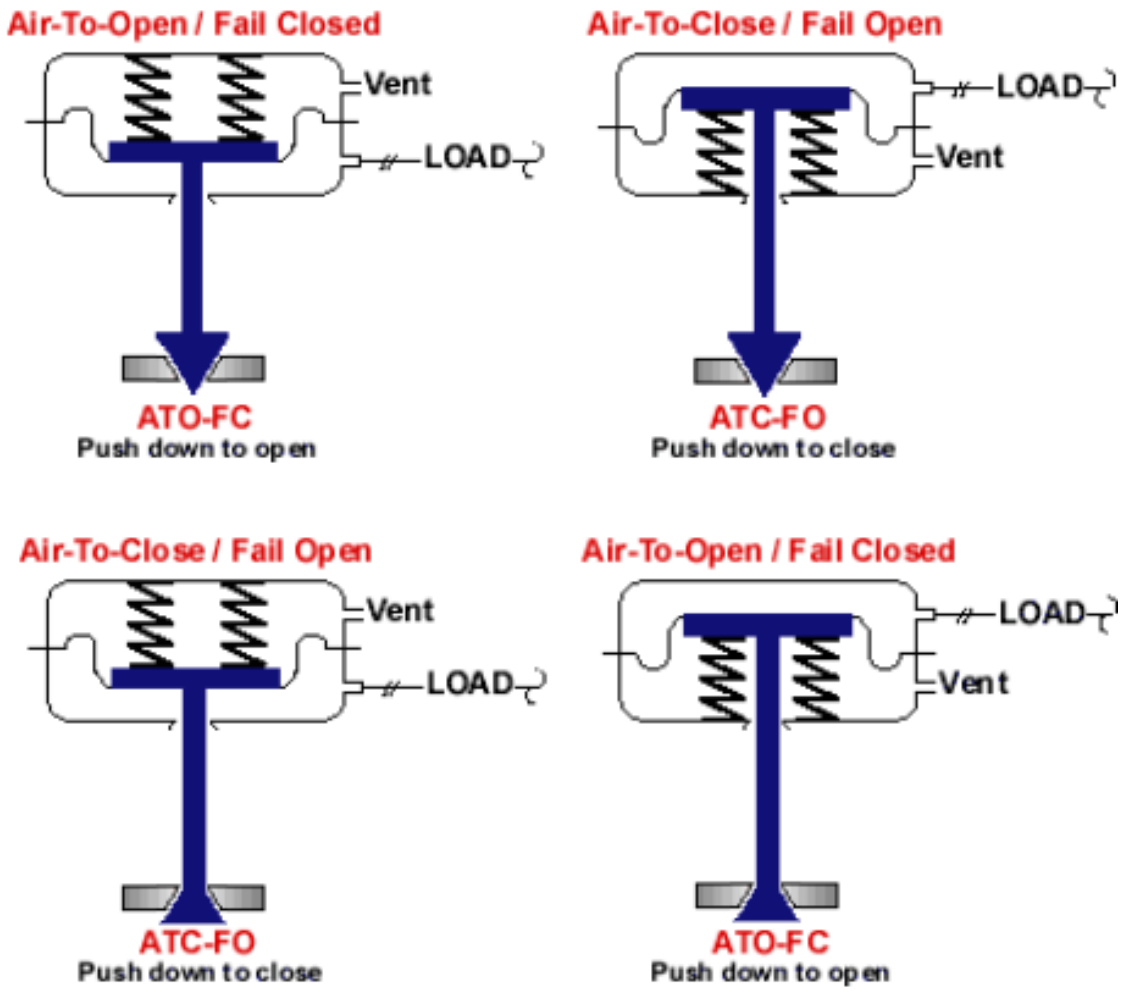
The Motion (2)

- Globe valve
  - Rugged, usually the most expensive, particularly in the larger sizes, accurate and repeatable control, high pressure drop
- Gate valve
  - Sliding disc (gate), ideal for high pressure drip and high temperature application where operation is infrequent, multi-turn or long stroke pneumatic and electro-hydraulic actuators are needed, poor control
- Ball valve
  - Damper valve, most economical valves, high torque required
- Diaphragm valve
  - Simplest, tight shutoff, isolated, ideal for corrosive, slurry and sanitary services

Air-To-Open vs. Air-To-Close

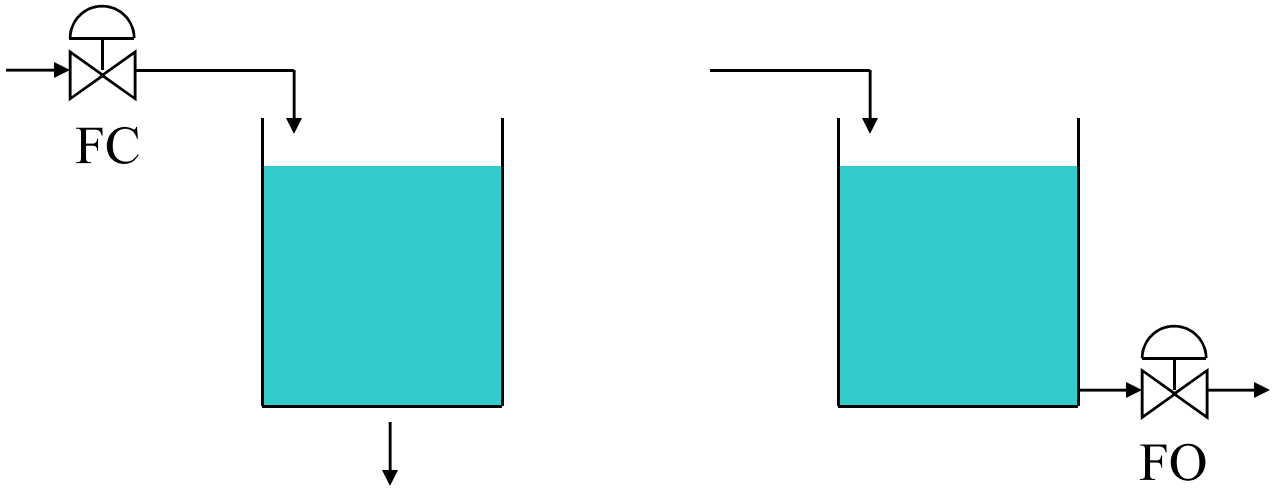
- Air-to-Open (+ gain)
  - More air → larger opening ⇒ No air → Valve closes.
- Air-to-Close (- gain)
  - More air → smaller opening ⇒ No air → Valve open completely.
- Proper type to use is determined from safety considerations
  - Air-to-close: Coolant valve in an exothermic reactor or in a condenser of a distillation column.
  - Air-to-open: Steam valve in a reactor, inlet flow valve to a tank.

The Fail-safe Modes (1)

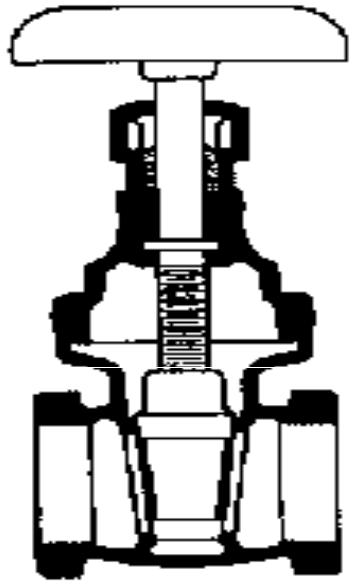


The Fail-safe Modes (2)

- Choose an air-to-open for applications for which it is desired to have the valve fail closed
- Choose an air-to-close for applications for which it is desired to have the valve fail open



Gate Valve



Gate Valve

Best Suited Control: Quick Opening

Recommended Uses:

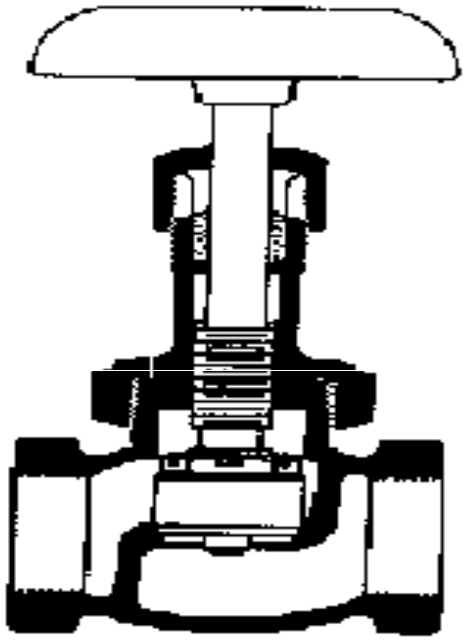
1. Fully open/closed, non-throttling
2. Infrequent operation
3. Minimal fluid trapping in line

Applications: Oil, gas, air, slurries, heavy liquids, steam, noncondensing gases, and corrosive liquids

Advantages:

1. High capacity
2. Tight shutoff
3. Low cost
4. Little resistance to flow

Globe Valve



Globe Valve

Best Suited Control: Linear and Equal percentage

Recommended Uses:

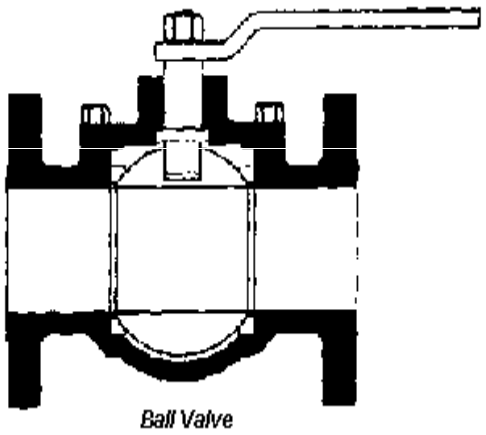
1. Throttling service/flow regulation
2. Frequent operation

Applications: Liquids, vapors, gases, corrosive substances, slurries

Advantages:

1. Efficient throttling
2. Accurate flow control
3. Available in multiple ports

Ball Valve


Ball Valve

Best Suited Control: Quick opening, linear

Recommended Uses:

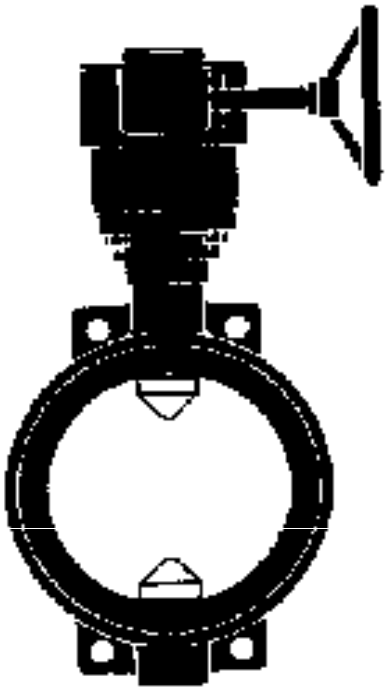
1. Fully open/closed, limited-throttling
2. Higher temperature fluids

Applications: Most liquids, high temperatures, slurries

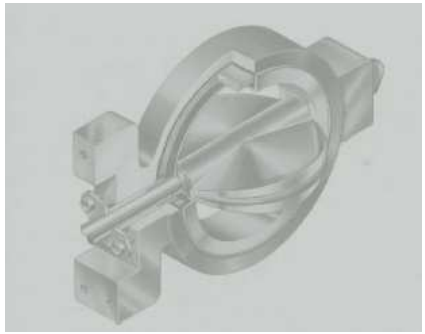
Advantages:

1. Low cost
2. High capacity
3. Low leakage
4. Tight sealing with low torque

Butterfly Valve



Butterfly Valve



Best Suited Control: Linear, Equal percentage

Recommended Uses:

1. Fully open/closed or throttling services
2. Frequent operation
3. Minimal fluid trapping in line

Applications: Liquids, gases, slurries, liquids with suspended solids

Advantages:

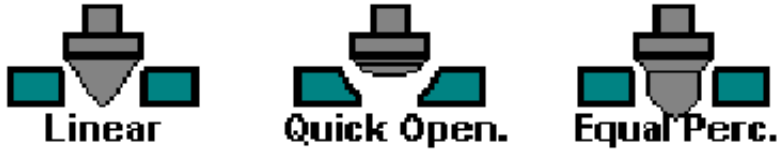
1. Low cost
2. High capacity
3. Good flow control
4. Low pressure drop

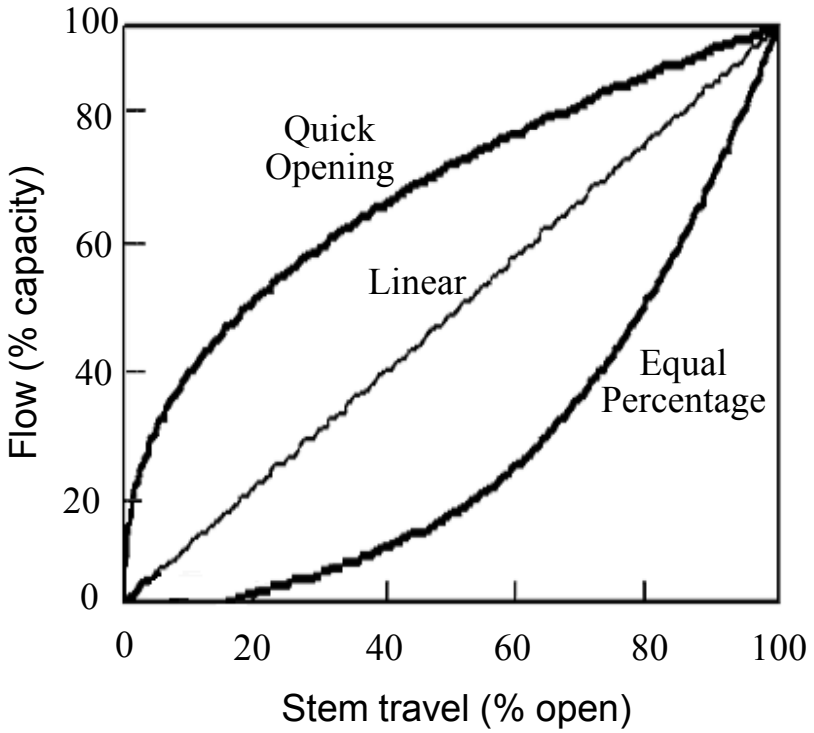
Other Valves

- Check valves are designed to restrict the flow to one direction. If the flow reverses direction, the check valve closes.
- Relief valves are used to regulate the operating pressure of incompressible flow.
- Safety valves are used to release excess pressure in gases or compressible fluids.

Valve Trim (Plug) Type

- Equal Percentage
  - Used for about 90% of control valve applications since it results in the most linear installed characteristics
  - Used where large pressure drop is expected
- Linear
  - Used when a relatively constant pressure drop is maintained across the valve
  - Used for liquid level or flow loop
- Quick Opening
  - Used for safety by-pass applications where quick opening is desired





Pressure Drop vs. Flow Rate

