Final control element

There are different types of final control elements:

1. Control valve
2. Sinoloid valve
3. Variable speed –pump
4. Pump, compressor, heater ,….etc.

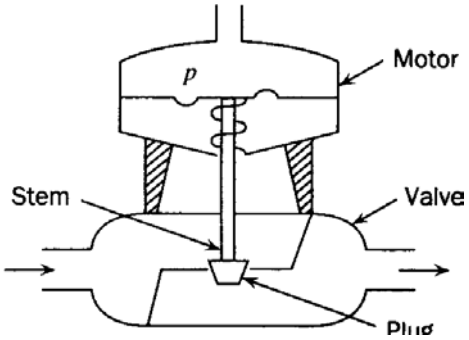

Fig.48 Pneumatic control valve

Action of the control valve

1. Air –to- close: failed open
2. Air –to- open: failed close

Valve characteristics

1. Rangeability
2. Turn down
3. Flow –lift –relationship

Selection of pneumatic control valve

1. Rangeability of process and maximum flowrate
2. Normal range of load
3. Pressure drop through the valve for minimum and maximum flowrate
4. Property of fluid
5. Determining size of valve
6. Characteristic coefficient

Characteristic coefficient= $\frac{pressuer\ \ drop\ \ throug\ h\ the\ valve\ \ at\ \ fully\ \ open}{pressuer\ \ drop\ \ throug\ h\ the\ valve\ \ at\ \ fully\ \ close}$

Control valve

A pneumatic valve always has some dynamic lag . The relationship between flow and valve pressure is:

$$G_v(s) = \frac{\theta(s)}{p(s)} = \frac{K_v}{\tau_v s + 1}$$

K_v :the steady state gain of valve

τ_v :time constant of valve

$\tau_v \approx small \rightarrow 0 \qquad \frac{\theta(s)}{p(s)} = K_v$

Control valve sizing

This is a procedure of calculating the valve flow coefficient C_v which is a factor associated which the valve capacity . The flowrate through the control valve depend on the following:

1. Valve size
2. Fluid density
3. Pressure drop
4. Valve stem position

In order to specify the size of a valve in the terms of its capacity to provide flow when fully open . The following equation is introduced which applies to the flow of an incompressible fluid through the fully open valve:

$$q = C_v \sqrt{\frac{\Delta P}{G}} . f(x)$$

q :flowrate, gpm

C_v :valve size coefficient

x :valve stem position (fraction of open)

f(x) :fraction of total flow ,f(x)=1,fully open =Q_{max} ,f(x)=0.1:Q_{min}

G :specific gravity

ΔP : pressure drop over the valve ,psi

$$f(x) = \frac{C_v}{C_{v\,max\,.}}$$

The curve of f(x) vs. x is called the inherent characteristic of the valve

f(x) :fraction of total flow

x: fraction of open