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Valve Sizing & Types

Abstract

Valves are an important component of every process system and it is cruical to select the right valve size to ensure that a process is successfully and reliably controlled. The aim of this poster is to illustrate the different types of valves that are used in process control and to explain how to calculate the right valve size based on the conditions of a system.

Introduction

Process plants consists of many control loops networked together to produce a desirable product. There are many variables such as temperature, pressure and flow rate in the system and control valves are used to ensure that all variables are at the specified level. There are different types and sizes of valves that are used in process control depending on the process. When sizing control valves, the flow coefficient (Cv) must be worked out which is the relationship between pressure drop and flow rate through a valve.

Ball Valves

Ball valves are a quick opening valves that give a tight shutoff and are simple example of a control valve. When fully open, a ball valve creates little turbulence or resistance to flow. The ball opening can be fully open or closed which allows it to be used in variety of chemical applications such as the flow of hyrdoflouric acid and dry chlorine [1].

Advantages:
- Low cost.
- High flow capacity and easy to automate.
- Low leakage and maintenance.

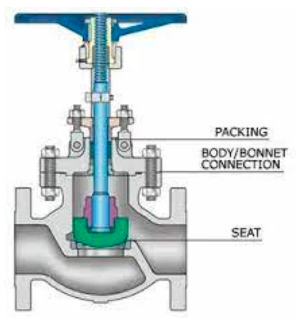
Disadvantages:
- Limited throttling characteristics.
- Prone to cavitation.
- Not suitable for slurry applications due to cavities around the ball.

Globe Valves

Globe valves consist of a movable disk-type element and a stationary ring seat in a generally spherical body. The valve stem moves a globe plug relative to the valve seat. The globe and seat construction gives the valve good flow regulation characteristics as the globe plug can be fully opened or closed. It is recommended that this valve is used for frequent and wide throttling operations, and it is suitable for most liquids, vapors, gases and corrosive substances [1].

Advantages:
- Accurate flow control.
- Efficient and precise throttling.

Disadvantages:
- More expensive than other valves.
- Low recovery and relatively low coefficient of flow (Cv).
- High pressure drop, higher pump capacity and system wear.



How to Calculate Valve Size

For sizing a control valve, a combination of theory and empirical data such as flow medium, construction material and temperature-pressure ratings must be known but most importantly the flow coefficient (Cv) must be calculated. The flow coefficient is defined as the flow rate per minute that will pass through a fully open valve with a pressure differential of 1 psi. When Cv is calculated, a valve must be chosen with the same Cv or slightly higher value to ensure the valve operates effectively [1].

For flowing liquids like water or oil the equation below can be used, where Cv= Flow coefficient, Q= Flow rate, S= Specific gravity of fluid relative to water, ΔP= Pressure change.

$$Cv = Q\sqrt{(S/\Delta P)}$$

For air and gaseous flow, the equation to calculate Cv is below and is a bit more complicated as you have to consider the low and high pressure drops because gasses are compressible fluids and their density changes with pressure. Therefore the equation below is used where Cv= Flow coefficient, Qa= Air or gas flow, T= Flowing air or gas temperature, ΔP= Pressure change and P2 = Outlet pressure at maximum flow.

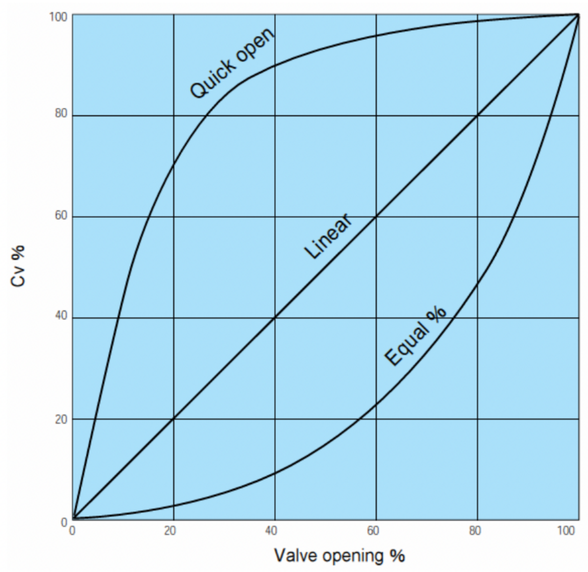
$$Cv = \frac{Qa\sqrt{G\,(T+460)}}{1360\sqrt{\Delta P (P_2)}}$$

Furthermore, another important aspect of valve sizing is to calculate the pipe diameter which can be done using the equation below, where d= diameter of pipe, Q max= maximum flow through the valve, v= velocity of flow [2].

$$d = \sqrt{\frac{4\,Q_{max}}{\pi v}}$$

Control Valve Characteristics

There are three common types of flow characteristics which are *Linear, Equal Percentage* and *Quick Opening.* Firstly, the linear valve characteristic provides a linear relationship between the valve position and the flowrate and when plotted on a graph this will be a straight line. Secondly, the equal percentage valve produces the same percentage change in flow per fixed increment of valve stroke. Lastly, A quick opening valve produces a large increase in flow for a small initial change in the positioning of the valve [3,4].



This graph shows the three most common types of observed flow characteristics types which are linear, Quick Open and Equal Percentage. Specifically, it shows that the Cv value changes when the valve positioning is varied.

Conclusion

There are many different types of valves that are used in process control systems. The effectiveness of any control system depends on the suitability of the control valve and so it is essential to choose the correct type and size. Sizing depends on many variables but it is vital to calculate the correct Flow Coefficent (Cv) value as it is the most important factor.

references

[1] A. Bhatia, Control Valve Basics: Sizing and Selection, 3-44.
[2] Sara Peters, 2016, How to Size A Control Valve and Why It's Important.
[3] Werner Sölken, 2012, Introduction to Control Valves.
[4] Karan Sotoodeh, Subsea Valves and Actuators for the Oil and Gas Industry, 1-10.