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Review Article

Establishment of Valve characteristics in Pneumatics

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Abstract

The characteristics of pneumatic fluids can be controlled by using different control valves. One of the method uses flow control valve to control the flow of fluid. In the test rig non compensated variable restrictor type flow control valve is used. The two cylinder reciprocating air compressor is used to get the required pressure. Pneumatic has great importance in many industrial applications. To study the flow characteristics of air passing through flow control valve the test rig is designed according to Indian standard (IS 14740:1999). This is to know whether the fluid and flow control valve is suitable for required application.

Keywords: *pneumatic, control valve, air compressor*

1. Introduction

During last few decades various automation and rationalization has been introduced in the field of manufacturing in order to enhance overall industrial productivity. Application of compressed air as a means of factory automation has come to stay in modern engineering plants. Pneumatic system is cheap but very effective method of automation technique and hence found extensive use all over the world in robotics and pick and place devices. Certain characteristics of compressed air have made this medium quite suitable for use in modern manufacturing and production plant.

1.1 Description of flow control valves

The purpose of flow control in a system is to regulate speed. All the devices discussed here control the speed of an actuator by regulating the flow rate. Flow rate also determines rate of energy transfer at any given pressure. The two are related in that the actuator force multiplied by the distance through which it moves (stroke) equals the work done on the load. The energy transferred must also equal the work done. Actuator speed determines the rate of energy transfer (i.e., horsepower), and speed is thus a function of flow rat

1.2 Different types of flow measurement

Controlling flow of a fluid-power system does not necessarily mean regulating volume per unit of time from a valve. Flow rate can be specified three different ways, so it is important to be aware of how flow is to be specified or measured: Volumetric flow rate, Qv, expressed in units of in.3/sec or min - or cc/sec or cc/min in SI metric measure - is used to calculate the linear speeds of piston rods or rotational speeds of motor shafts.Weight flow rate, Qw, expressed in units of lb/sec or lb/min, is used to calculate power using English units of measure.Mass flow rate, Qg, expressed in units of slugs/sec or slugs/min for English measure - or kg/sec or kg/min in SI metric measure - is used to calculate inertia forces during periods of acceleration and deceleration. Because they control the quantity of fluid that flows through the valve per unit of time, the same control valves are used for all three types of flow rates.

1.3 Valve characteristics of flow control valve

1.3.1 Typical representation of mass flow rate against pressure ratio

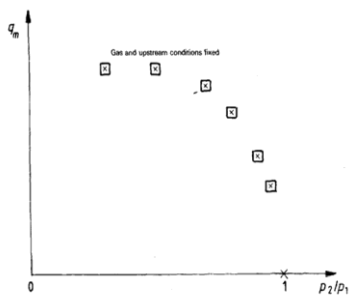

Fig.1 Typical representation of mass flow rate against pressure ratio

When, for constant absolute upstream pressure and temperature, the mass flow rate of compressible fluid

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through a component is measured as a function of the ratio of the downstream and upstream pressures, and the data points are plotted, a typical graph as in figure.

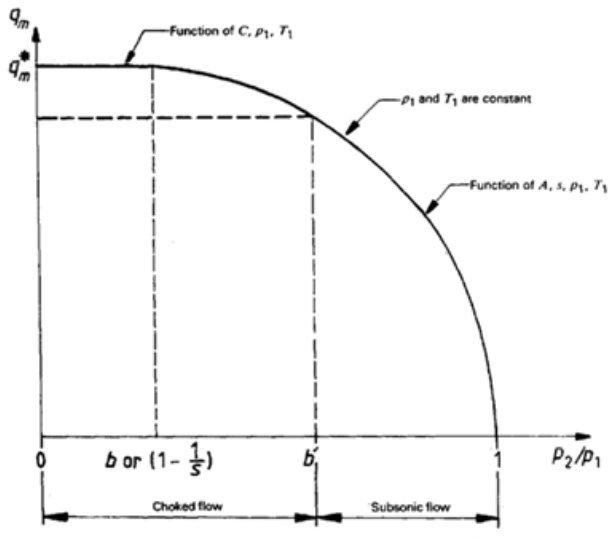
2. General representation of mass flow rate against pressure ratio

The results are more useful if an analytical curve is fitted through the points and if the coefficients are related to the upstream conditions and the nature of the gas. The accuracy of the representation becomes better when the number of independent coefficients used increases, but the difficulty of use also increases.

3. Method of presentation used in international standard

Using a simplified model of the components and the general laws of thermodynamics, it is possible to derive adequate theoretical equations for such a curve using only two independent coefficients. After calculating the coefficients from experimental data, the curves may be fitted to the points plotted from the graph.

It has been shown that when the velocity at some part of a pneumatic component becomes sonic, the flow remains nearly constant with constant upstream pressure and when the velocity is smaller, the curve qm = f (P2/P1) is nearly elliptical. The general representation used in this International Standard is given in figure below.



Moreover, it has been found experimentally that for most of the components used in pneumatic fluid power practice, or when the accuracy of the measurements is not very high, the model can be further simplified. It is then assumed that the relationship between mass flow rate and pressure ratio can be approximately described by a quarter of an ellipse, which smoothly joins the horizontal part of the curve, as shown in figure 8.3. This representation corresponds to the method of measurement adopted in this International Standard.

3. Experimental setup

Fig Test rig of flow control valve in pneumatics

Set up is as per I S 14740:1999 from “Pneumatics fluid power – components using compressible fluids – Determination of flow rate characteristics”.

3..1 Purpose

Whenever a flow control valve is used in circuits, it leads to pressure changes. Pressure drop across this valve must be considered while designing a circuit. In short valve characteristics must be known.

Consider a meter in type circuit. Here, power available to full bore end of the cylinder becomes important. Normally, it is pgQH Also power=P*Q. if at full bore end this required pressure "P" is not maintained cylinder may malfunction. Thus if characteristics & equation of the same is known, pressure drop can be taken care off while designing the circuit.

In this project using Indian Standard Specification, one such test rig for flow control valve is developed.

In general recommended pressure is 8 bars. That means if compressor develops 8 bars, actual pressure available at cylinder bore will be less than that. It becomes thus mandatory to have pressure drop in between all components which are installed in between compressor & cylinder. In this project emphasis is given on flow control valves.

Conclusion

1. The obtained characteristic of the flow control valve is compatible with the standard characteristics.
2. The choke flow condition however was not obtained as per standard characteristics due to compressor limitations.

3. From the characteristics the performance of the component can be predicted and compared, either in the form of a) and b) or the form of a) or b).

a) Sonic conductance (c) and critical pressure ratio (b); b) Effective area (A)

4. If the required characteristics of any pneumatic application are similar to the obtained characteristics then this flow control valve can be directly selected.

5. Using the test rig different type of flow control valves & their characteristics can be obtained.

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