COMPRESSOR VALVES

Questions and Answers About Compressor Valves

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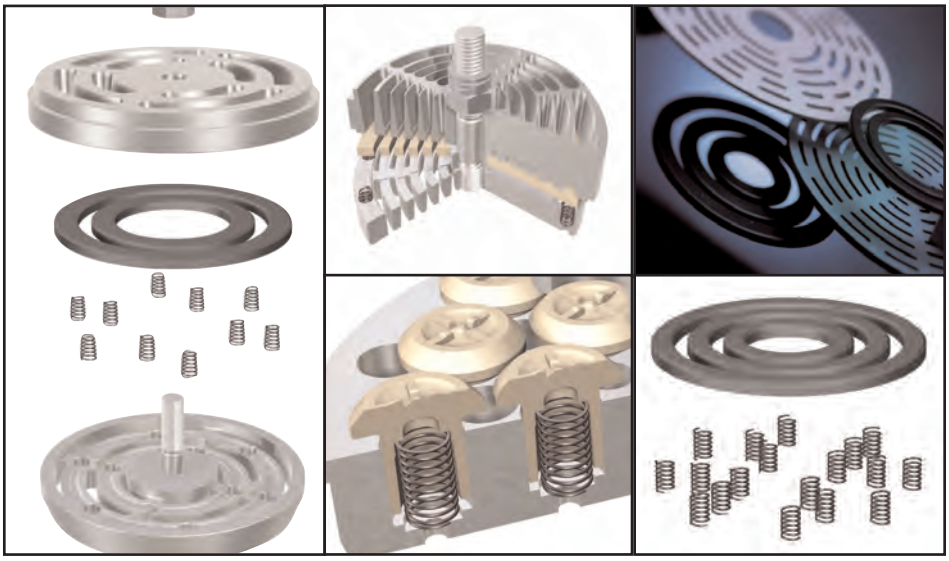
You have valve questions
We have answers

A compressor valve is a device that controls the inward flow of lower pressure and the outward flow of higher pressure gas from a reciprocating compressor cylinder. Normally these valves open and close automatically, solely governed by the pressure differential in the cylinder compared to the suction or discharge line pressure.



What are the basic components of a compressor valve?

Most valves have five basic components:

- Seat
- Guard (guard, stop plate, buffer, plate, etc.
- Sealing element (valve plate or valve ring, channel, poppet, feather strip, ball, etc.)
- Damping element (coil springs, cushion plates,spring plates, damping plates, etc.)
- Assembly element (bolts, nuts, retainer ring, etc.)

Are there different kinds of compressor valves?

There are several different kinds of compressor valves: plate valves, ring valves, channel valves, feather valves, poppet valves, ball valves, reed and concentric valves. Each design has specific criteria with regard to the sealing element and all the other components are designed accordingly.

Is there any such thing as an "all purpose valve"?

Not really, each valve is designed for a certain application and is best used in the range of operating conditions for which it was designed.

What does a compressor valve do?

A compressor valve regulates the flow of air or gas in a compressor cylinder. There is at least one suction valve and one discharge valve for every compression chamber. Each valve opens and closes with every cycle of the piston. For example, a valve used in a compressor operating at 1200 r.p.m. for 24 hours a day and 365 days a year, opens an closes:

- 72,000 times per hour, or
- 1,728,00 times per day, or
- 630,720,000 times per year!

What must a compressor valve do?

Compressor operators typically expect the valve to be:

- efficient
- durable
- quiet

Efficiency demands include aerodynamic flow efficiency and the volumetric efficiency.
A durable valve should provide maintenance free operation over several thousand hours plus relative ease in servicing and repair.

How can I compare two valves of equal size, but different design?

Examine the basic requirements a valve should fulfill, compare the efficiency and durability of both valve designs. Price should not always be of highest priority. Remember, what may look like a bargain may cost much more to operate. Also consider the cost of reconditioning each valve design. A simple machined surface (lapped or ground flat) is less costly to refurbish than a more complex contoured sealing surface.

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Can a valve comparison be made without running an actual test and total instrumentation of the compression cylinder?

There are two phases in analyzing valves:

1 Comparing design criteria and data without actual tests. This can go as far as computer simulated performance diagrams, based on experimental data gathered in actual tests.
2 Installation of valves in the cylinder and complete analysis of the results combined with a subsequent life test.

I am interested in pre-analysis. How do I go about it?

There are two objectives...efficiency and durability.
The aerodynamic flow efficiency depends greatly on the restrictions in the valve. The gas must pass through the seat area around the fully opened valve plate (free lift area) and escape through the guard. On most valves, the minimum flow area is the free lift area and this is the area most frequently compared in valve analysis. It takes into account that the valve is fully open.

A general rule: the higher the valve lift area the more efficient the valve.

A more meaningful comparison is the free lift area of two valves at equal lift. A higher valve lift may mean higher area, but also means less durability.

Lower lift valves are typically more durable.

The flow resistance is further influenced by other factors such as surface friction, directional changes in the gas flow, turbulence within the valve, springload, etc.
Seats with cast slots are not as good as milled slots tapered and properly deburred. Slotted seats, in general, are better than seats with drilled holes, particularly if the seats are made with a few drilled holes of large diameter. Hanging or open guards are often better than safety guards with respect to aerodynamic flow.
Most valve manufacturers will supply design information such as valve lift, free lift area, and seat and guard area for comparison. In some instances, theoretically calculated valve losses can be quoted. Empirical derived values typically agree with actual test readings.

What is the equivalent area of a valve?

The equivalent area is the orifice area in square inches of a valve which also has a given pressure loss. The potential performance differences of two valve can be established by comparing their equivalent areas.

The higher the equivalent area, the better the flow efficiency.

What else should I consider when evaluating valve efficiency?

Volumetric efficiency. Volumetric efficiency (VE) of a compression cylinder may be influenced by a valve conversion. Clearance volume affects VE. Clearance volume is the volume in a cylinder end that is not swept by the movement of the piston. Depending on the size of the cylinder, clearance volume can range from 2% to as high as 60% of displacement, or more. It includes spaces between piston and head at the end of the stroke, space under the valves, and of course clearance within the piston side of the valve itself.

The higher the clearance the poorer the volumetric efficiency of the cylinder.

What does valve dynamics mean?

A compressor valve opens and closes with every compression cycle. The timing and pattern of these events are referred to as valve dynamics.
It is important that the valve opens and closes at the right time and does not flutter. Compressor valve dynamics influence valve life and compression efficiency. Springing and the mass of the moving components affect valve dynamics.
For proper performance, valves are designed for specific operating windows.

Do some cylinders have extra clearance built-in?

Yes. There are cases where the output is controlled by purposely adding clearance to a cylinder. In low compression ratios, the volumetric efficiency is of minor influence.

You mentioned compression ratio. What is it?

Compression ratio is the ratio of absolute discharge pressure to absolute inlet pressure.

Are ways to pre-analyze the valve efficiency?

Yes. An engineering analysis will determined or at least anticipate valve efficiency. Conducting a valve analysis prior to settling on a

product increases the likelihood that the valve will operate properly with expected efficiency and durability upon installation. Purchasing valves based solely on price or availability does not offer the same assurance.

We talked about efficiency. How about durability?

It is difficult, if not impossible, to predict how long a valve will work. There are, however, certain criteria that will increase the probability of lasting valve performance:

- lower r.p.m.
- lower valve lift

Sealing elements (plates, rings) with simple shape tend to have a higher fatigue resistance than parts of more intricate shape. Good mechanical cushioning and damping elements tend to minimize impact forces and definitely increase life. Air cushioned valves are not a mechanically controlled damping system. They depend solely on maintaining correct production tolerances, both in manufacture and after repair.

Most sealing elements are made from glass-fiber or carbon fiber-filled composite materials, such as nylon and PEEK. Steel plates and ring are less common.

These new materials have proved very effective in valve applications. Composites work better in difficult services enduring contaminants and liquids in the gas stream. Non-metallic sealing elements tend to leak more than steel plates when new. This condition typically corrects itself once the compressor is running for several hours and the valve has worn-in.

Remember that a valve opens and closes once for each compression cycle.

How can I separate good seals from poor ones?

The sealing element is subjected to constant movement and must survive through much abuse. The sealing element is certainly the vital part. An experienced engineer can separate good sealing elements from poor ones. They analyze the part's design, material and production process.

If a valve breaks prematurely, is it always due to improper design or inadequate production?

No, a compressor valve is an integral part of a larger piece of equipment. Often problems show up in the valve that are caused by outside factors. Carryover of foreign material can cause valve failure. Pulsations in the system can sometimes cause valve flutter. Changes in operational use from original design conditions are often the cause of frequent breakage. Improper valve repair and maintenance also cause short life. The list of possibilities is long.

Do I have to live with poor valve performance or durability?

No one should ever accept poor performance. Try to analyze the problem. Ask industry specialists for advice and consultation. Remember for every problem, there is normally a solution.

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