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Design, Analysis & Construction of Manual Setting of Downstream Pressure for Regulator Considering Ergonomics

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Abstract – *A pressure regulator is a device which controls the pressure of liquids or gases (medium) by reducing a high input pressure to a controlled lower output pressure. They also work to maintain a constant output pressure even when there are fluctuations in the inlet pressure.*

Pressure regulators, in various forms, are used in many domestic and industrial applications, like regulating propane used in gas grills, to regulate oxygen in healthcare equipment, to supply compressed air in industrial applications, to regulate fuel in automotive engines and aerospace applications. The main aspect that is common across all these applications is pressure control – from a higher source pressure to a lower output pressure.

Pressure Regulators are found in many common home and industrial applications. For example, pressure regulators are used in gas grills to regulate propane, in home heating furnaces to regulate natural gases, in medical and dental equipment to regulate oxygen and anesthesia gases, in pneumatic automation systems to regulate compressed air, in engines to regulate fuel and in fuel cells to regulate hydrogen. As this partial list demonstrates there are numerous applications for regulators yet, in each of them, the pressure regulator provides the same function. Pressure regulators reduce a supply (or inlet) pressure to a lower outlet pressure and work to maintain this outlet pressure despite fluctuations in the inlet pressure. The reduction of the inlet pressure to a lower outlet pressure is the key characteristic of pressure regulators

When choosing a pressure regulator many factors must be considered. Important considerations include operating pressure ranges for the inlet and outlet, flow requirements, the fluid (Is it a gas, a liquid, toxic, or flammable), expected operating temperature range, material selection for the regulator components including seals, as well as size and weight constraints.

The chemical properties of the fluid should be considered before determining the best materials for your application. Each fluid will have its own unique characteristics so care must be taken to select the appropriate body and seal materials that will meet fluid. The parts of the regulator in contact with the fluid are known as the "wetted" components.

I- INTRODUCTION

Control Air offers three main categories of Air Pressure Regulators: Precision Regulators, Filter Regulators and General-Purpose Regulators. Precision Regulators offer accuracy and sensitivity while General Purpose Regulators offer greater economy and efficiency. Air Filter Regulators are considered a vital air preparation device when it comes to protecting your sensitive downstream equipment. Each category includes regulators in various sizes, materials, and pressure ranges.

A two-stage pressure regulator is ideal for applications with large variations in the flow rate, significant fluctuations in the inlet pressure, or decreasing inlet pressure such as occurs with gas supplied from a small storage tank or gas cylinder.

A three-stage regulator provides a stable outlet pressure like a two-stage regulator but with the added ability to handle a significantly higher maximum inlet pressure. three-stage regulator is rated to handle an inlet pressure as high as 3,000 psi and it will provide a stable outlet pressure (in the 0 to 30 psi range) despite changes to the supply pressure. A small and lightweight pressure regulator that can maintain a stable low output pressure despite an inlet pressure that will decrease over time from a high pressure is a critical component in many designs. Examples include portable analytical instruments, hydrogen fuel cells, UAVs, and medical devices powered by high pressure gas supplied from a gas cartridge or storage cylinder

The materials selected for the pressure regulator not only need to be compatible with the fluid but also must be able to function properly at the expected operating temperature. The primary concern is whether the elastomer chosen will function properly throughout the expected temperature range. Additionally, the operating temperature may affect flow capacity and/or the spring rate in extreme applications

II-METHODOLOGY

(1) Pressure Reducing Element (poppet valve)

Most commonly, regulators employ a spring loaded "poppet" valve as a restrictive element. The poppet includes an elastomeric seal or, in some high pressure designs a thermoplastic seal, which is configured to make a seal on a valve seat. When the spring force moves the seal away from the valve seat, fluid is allowed to flow from the inlet of the regulator to the outlet. As the outlet pressure rises, the force generated by the sensing element resists the force of the spring and the valve is closed. These two forces reach a balance point at the set point of the pressure regulator. When the downstream pressure drops below the set-point, the spring pushes the poppet away from the valve seat and additional fluid is allowed to flow from the inlet to the outlet until the force balance is restored.

(2) Sensing Element (piston or diaphragm)

Piston style designs are often used when higher outlet pressures are required, when ruggedness is a concern or when the outlet pressure does not have to be held to a tight tolerance. Piston designs tend to be sluggish, as compared to diaphragm designs, because of the friction between the piston seal and the regulator body.

In low pressure applications, or when high accuracy is required, the diaphragm style is preferred. Diaphragm regulators employ a thin disc shaped element which is used to sense pressure changes. They are usually made of an elastomer; however, thin convoluted metal is used in special applications. Diaphragms essentially eliminate the friction inherent with piston style designs. Additionally, for a particular regulator size, it is often possible to provide a greater sensing area with a diaphragm design than would be feasible if a piston style design was employed.

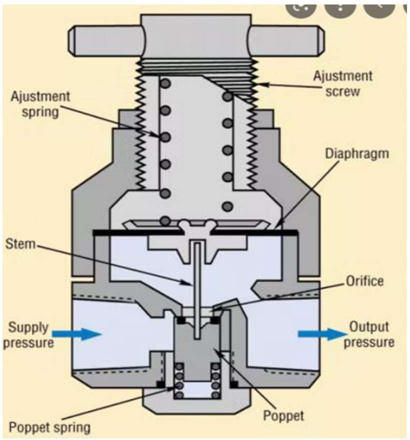

Fig. 1- fig shows the regulator cross section

III - DESIGN

Non-electrical equipment for use in potentially explosive atmospheres

European standard EN 13463-1 [22]

Maximum allowable Impact energies according to ATEX Non- electrical=500 J

3.6.1 Case: Full stroke Piston against Inlet block

Initial spring load = 264 N

dP spring = (Initial Spring Load ×Piston area)/9.81

= 1.01157 bar

Max. Spring load = 2640 N (after 10 mm stroke)

dP spring= (Max. Spring Load ×Piston area)/9.81

Inlet Pressure= 20 bar

Outlet pressure= 0 bar

Effective pressure= 14.99 bar

Maximum stroke (s)= 10 mm

Weight of Moving component = piston + stem
= 0.185 kg

Piston Diameter = 5.82 cm

Force (F)= pA = Effective pressure ×Piston area ×9.81

= 3912.772 N

Acceleration (a) = F/m = 21150.12 m/s2

Velocity (v)= √2as = 20.56702 m/s

Impact Energy =1/2 mv^2 = 39.12772 J

IV - CONCLUSION

Lot of work has already been done in the field of pressure regulator improvement in terms performance like accuracy, precision, repeatability

Most of the study & research are around the performance enhancement for better productivity Also work has been done to make regulators ore safe & to established it as a reliable device specially for hazardous locations like oil & gas applications

Regulators have been conventionally getting operated manually, by pilot pressure, electrically

Manual operation is quite difficult specially while operating regulator with higher pressure rating & flow requirements

User comfort has not been considered very well so far & all focus seeming to be around the performance

With all paper & literature review, it has been concluded that wok can be done in user comfort & changing some internal mechanism like diaphragm & adjusting pin.

REFERENCES

[1] *Dirk Hübner, Harald Ortwig, Linear Modeling, Simulation and Experimental Verification of a Pressure Regulator for CNG Injection Systems, ISSN: 1690-4*

[2] *ISO 10524-1:2018, Pressure regulators for use with medical gases — Part 1 Pressure regulators and pressure regulators with flow-metering devices*

[3] *Akash Singh Raikwar, Amit Jain,A Review Paper on Hydrodynamic Cavitation Volume 7 Issue No.4, IJESC April 2017*

[4] *F. Caupin, E. Herbert, C. R. Physique, Cavitation in water, science direct 2006*

[5] *E. P. Rood, Mechanisms of Cavitation Inception, Volume 113, Issue 2, ASME*

[6] *Sreedhar bk, Shaju K Albert, Aniruddha Bhalchandra Pandit, Cavitation Damage: Theory and Measurements, Research gate 2006.*

[7] *Adnan Maqsood, Dynamic Modeling and Analysis of a High-Pressure Regulator Research gate 2016*

[8] *M. G. Patil1, R. B. Barjibhe, Flow Analysis of Gas Pressure Regulator by Numerical & Experimental Method, IRJET, Volume: 05 Issue: 07 | July-2018*

[9] *hui wang,changshuai zhang,guochao zhao,yuning song,peng fu, Zhou guoqiang Parametric Analysis of the I-Stage Structure for a Dual-Stage Gas Pressure Reducing Regulator, , IEEE,2020*

[10] *Aishwarya Jadhav,Dr. S. G. Joshi,P. D. Maskar ,Sandip V. Patil, Design a New Pressure Regulating Valve for Fuel Injection Pump of Diesel Engine, IRJET,2020*

[11] *B.p. somerday,C. San marchi, Composite Pressure Vessel, science direct 2018.*

[12] *Pressure equipment directive (PED), 2014/68/EU*

[13] *American Society of Mechanical Engineers, Boiler & pressure vessel code ASME BPVC.*