

Pressure Reducing Valves

Introduction

The use of 300 bar cylinders and bundles has increased over the past 20 years. When such cylinders/bundles are connected to a stationary installation (of the end user), the change of working pressure (from historically 200 bar in Europe) to 300 bar have led to either:

- a change in the equipment used downstream the cylinder/bundle e.g. by using a 300 bar pressure regulator as per EN ISO 2503 [1], or
- the use of a pressure reduction function on the cylinders/bundles e.g. by using a pressure reducing valve, also known as step down valve, which intends to supply to the end user a pressure reduced below the service pressure of the existing equipment. Such a solution is noteworthy popular to avoid the re-design of a customer installation.

Both options are known to lead to equivalent levels of safety.

The use of pressure relief valves for such situations intends to protect the customer installation by releasing pressure in case of overpressure.

The pressure and flow characteristics of the pressure reducing valve is usually impacted by the pressure reducing mechanism. These characteristics should be taken into account to not prevent the existing equipment downstream delivering the required pressure and flow for the good functioning of the customer installation.

Pressure reducing valves have a built-in, pre-set, pressure reducer that intends to reduce pressure inside the cylinder/bundle (here 300 bar) to an outlet pressure of several dozens of bars (here less than 200 bar), the reduced pressure value depends on its design. This outlet pressure is a fixed value or may vary during the depletion of the cylinder/bundle.

Pressure reducing valves typically include additional functions such as:

- a closure device compliant with specific standards like EN ISO 10297 [2];
- a residual pressure device;
- a pressure relief device

Pressure reducing valves are not to be confused with VIPRs (Valve Integrated Pressure Regulators). VIPRs are valves that integrate a pressure regulating system and are used in several industrial or medical applications to reduce the cylinder/bundle pressure to a lower pressure suitable for end use processes. They are mainly adjustable inbuilt regulator, but in most cases is the outlet pressure not more than typically 10bar. VIPRs incorporate the basic functionality of a primary valve operating mechanism, with the additional capacity to regulate the pressure and/or flow at the valve outlet and, therefore, the end user does not need to use an additional regulator to have the gas at a given pressure/flow compatible with its equipment.

VIPRs are covered by EN ISO 22435 [3] (industrial VIPRs) or EN ISO 10524-3 [4] (medical VIPRs).

Present situation

Pressure reducing valves or their pressure reduction function are not covered by International or European standards. The design requirements are typically defined in technical specifications.

When a pressure reduction function, e.g. main valve with integrated step down, is embedded in the cylinder/bundle, such a function is not part of the customer installation and therefore is not covered by the regulatory requirements for stationary equipment (e.g. Pressure Equipment Directive [5]).

Nevertheless, malfunction of the pressure reduction may have consequences for the installation.

Standards covering industrial and medical VIPRs or pressure regulators, even if not applicable to such pressure reducing valves, have been often used to verify the performance of the pressure relief device.

Indeed, both standards define tests which intend to demonstrate that a pressure relief device integrated in a VIPR or a pressure regulator provides sufficient protection to the low pressure side of the VIPR in case of pressure regulating system default. Table 1 summarizes such test methods.

Table 1. Test examples to demonstrate that the low-pressure chamber will not fail in case of pressure regulator default

| Application | Reference standard | Test |
|------------------|---|--|
| Industrial gases | EN ISO 2503:2009 [1], Clause 9.7.2.2 | Pressure retention test of the low-pressure side of the pressure regulator |
| Industrial gases | EN ISO 7291:2010 [6], Clause 9.4.2.2 | Pressure retention test of the low-pressure side |
| Industrial gases | ISO/DIS 22435:2022 [3], Clause 6.9 | Pressure resistance test of the low pressure chamber |
| Medical gases | EN ISO 10524-3:2019 [4], Clause 8.6.2.3 | Resistance of the low-pressure side to P ₁ |

In those tests, a major default of the pressure regulating system is simulated by holding the pressure regulating system permanently open. A sample of the pressure reducing valve accordingly prepared is submitted to an inlet pressure up to either test pressure (EN ISO 22435 [3] and EN ISO 10524-3[4]) or nominal pressure (EN ISO 2503 [1] or EN ISO 7291 [6]).

As an example, a pressure reducing valve aiming to reduce pressure from a 300 bar cylinder down to a pressure below 200 bar should have a pressure relief device discharging enough gas to limit pressure inside the low pressure chamber below 200 bar in case of default of the pressure reducing unit.

NOTE: The pressure relief device is commonly a pressure relief valve, or a bursting disk.

Conclusion

The low-pressure side of the pressure reducing valves should be equipped with a pressure relief device designed similarly to the once used in VIPR's to provide the same level of safety.

Pressure reducing valves following the above can be used on 300 bar cylinders/bundles connected to a 200 bar stationary installation to supply to the end user a pressure reduced below the service pressure of the existing equipment.

References

- [1] EN ISO 2503, Gas welding equipment — Pressure regulators and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (30 MPa), www.cen.org
- [2] EN ISO 10297, Gas cylinders — Cylinder valves — Specification and type testing, www.cen.org
- [3] EN ISO 22435, Gas cylinders — Cylinder valves with integrated pressure regulators — Specification and type testing, www.cen.org
- [4] EN ISO 10524-3, Pressure regulators for use with medical gases — Part 3: Pressure regulators integrated with cylinder valves (VIPRs), www.cen.org
- [5] Pressure Equipment Directive - Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonization of the laws of the Member States relating to the making available on the market of pressure equipment.
- [6] EN ISO 7291, Gas welding equipment - Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar)

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