Figure 1. Gas supply panels are a complex mix of flow control valves, pressure regulators and safety devices.

SAFETY, SERVICE AND SECURITY

STEPHEN HARRISON, LINDE, GERMANY, EXPLAINS HOW THE SAFETY, QUALITY AND INTEGRITY OF GAS SUPPLY DEPENDS ON EQUIPMENT COMPETENCY.

Protecting the integrity of gas throughout the supply chain, from manufacture to end user, is an ongoing challenge, particularly as gases and gas mixtures become increasingly sophisticated to meet needs across the full spectrum of contemporary global industry.

Gas molecules are continually in motion, filling every corner of every space and capable of flowing through minute gaps. Gases stored within a container or in a gas supply system are constantly seeking ways to escape; simultaneously other gases present in the atmosphere have the ability to migrate into the container or system. Unintended gas mixtures and contamination could adversely affect production processes, damage the environment, cause safety risks or be harmful to human health.

Figure 2. Gas phase analytical sample collection for precision analysis is critical for quality assurance and process control in petrochemical processing.

Specialty gases applications are of particular concern. These are extremely sensitive high purity gases, often intentionally containing very low levels of trace components (in some cases as low as parts per trillion) which are used in equipment calibration and gas analysis. These trace components are easily compromised by a reaction with contaminant gases.

In response, leading gas manufacturers have developed increasingly hi tech cylinders, valves, regulators and supply systems, developed from new generation materials, to ensure that gas products remain pure and uncontaminated throughout their life cycle. This mitigates threats to the environment and human life, avoiding the exposure of all parties to the high cost of integrity failure.

Moving gas

When the intention is to deliver gas out of a cylinder, regulators are required to control pressure and valves to direct the flow rate. These are separate tasks and generally need multiple devices to achieve this successfully. Moving a gas or a gas mixture from a cylinder to the site of use requires a range of valves, regulators, piping and sometimes the inclusion of other gases and procedures, such as purge techniques, to achieve the correct result.

A guarantee needs to be in place to ensure that there are no leak points which could allow the product to move out into the environment or allow atmospheric gases to get in. The speed of flow from storage to point of use must also be controlled by a valve.

Furthermore, regulators are required to control the pressure of the gas. Many regularors store their gas products at high pressure to optimally fill their containers. However, consumers generally use the product at much lower pressures and therefore regulators are required to reduce the pressure to the application.

Industrial and technical applications

Gas can be utilised in a myraid of ways, the most basic of which are the industrial and technical gases used for applications such as welding and cutting in heavy industrial settings. The associated equipment is robust, high flow and tough because of the often physically demanding environment in which the equipment is used and also the high volumes of gas passing through it. In these applications, ball valves are often used for tight shut off and needle valves used for flow control.

Speciality application

Specialty gases are extremely high purity gases which can also be toxic or corrosive. Storing, handling and using these gases correctly is critical, thus there is a huge focus on the leak integrity of supply systems. In these applications, diaphragm valves are considered 'best in class' as process flow regulation devices, because they employ a flexible diaphragm to effectively control a process flow line either partially or completely as needed in order to regulate the transport of the gas stream and eliminate the possibility of contamination. 'Leak free' connections between these valves and other piping components are often achieved using national pipe tapered (NPT) thread.

Electronic and semi conductor applications

Gases related to electronic and semi conductor applications are ultra high purity and can be extremely toxic: in some cases, only a few parts per million could be fatal if leaked out. Furthermore, they are highly corrosive or pyrophoric, meaning that these gases ignite as soon as they come into contact with the air outside the system. Therefore the level of leak integrity must be absolute and as such, face seal fittings and welded connections are often used.

Design evolution

Several decades ago, specialty gas supply generally incorporated a gas cylinder featuring an on/off valve to which the customer would connect a regulator to drop the pressure to suit their system. More recently, such systems have evolved to include a first regulator to drop pressure to a mid level, then a series of other regulators to reduce the pressure down to the point of use. This approach provides much finer pressure and flow control.

In terms of piping, orbital welding is now commonly undertaken to seal connections and provide maximum system integrity. This involves rotating the welding arc mechanically through 360° around the pipe in a continuous motion to deliver a high integrity weld.

There is also a growing trend towards integrating the control equipment directly into the body of the cylinder: physically combining the valve and regulator into one unit to deliver accurate and precise low pressure flow control, which eliminates many traditional leak areas. An example of this is Linde's ECOCYL®. Additionally, the demand flow regulator (vacuum actuated) is designed for use with instruments that use a pump to draw calibration gas and provide the precise amount of gas required by the instrument pump. This simple, innovative regulator hastens calibration by eliminating the need for sample bags, flow meters or special operator training and is frequently supplied with Spectra protocol gases.

Integrated monoblocks are now being applied more often, particularly when conducting a purge. In this case, a system of three valves connected together is needed. One way to connect these three

valves is to screw them together with connections like national pipe threads or metal to metal face seals with electropolished surfaces. Another is to simply weld the three valves together, which is the most leak proof connection possible. However none of these methods are completely fail safe.

The monoblock, by contrast, offers the minimum possibilty of gas leakage. The metal is either cast as one single block, or machined to create one single piece of metal that incorporates three different valve mechanisms, thus reducing the number of potential leak points.

Recent developments over the past five years or so have normalised this approach and it is soon to be standardised, replacing the sequence of three valves joined together in the most sophisticated specialty gas supply systems. It is economically beneficial and at this level of gas usage such high quality equipment has become imperative in terms of human safety and environmental protection.

Conclusion

Essentially, a gas supply system is only as good as its weakest component: all components should be of compatible quality, as this is the only way gas users can guarantee the safety and purity of the products they use. Ideally, the gas that leaves the cylinder should be exactly the same as the gas that emerges at the point of use. Choosing a high quality valve for a system is pointless if the regulator incorporated is sub standard. The system must be designed to be appropriate for the application, including valves, regulators and piping, while the installation process remains important. Furthermore, the right connections must be selected and once the system is commissioned, it must be tested for pressure integrity and gas purity before the installer certifies the system as safe and ready for use.

Correct use of the system is another key factor. Purging is always recommended when pure or corrosive gases are being used, but incorrect or non-existant purging can allow the ingress of moisture or the damage and destruction of the entire supply system through corrosion. In some cases, additional cleaning with solvents must be undertaken. Regular maintenance is also important but must be defined according to best practice during use, until the close out of the system and its eventual scrapping when its use has expired.

The safety and quality of a gas supply system is also influenced by the choice of equipment construction materials, since gases can react with certain materials. At the heavy industry level of gas supply, materials such as plastic and rubber are commonly used for their cost effectiveness and flexibility. For the most critical gas applications stainless steel is the material of choice for supply systems, but different grades of stainless steel are suitable for different applications. For example, certain alloys are cheaper than others but are unsuitable for specific gas applications. Other alloys can be costly and difficult to work with, but are more corrosion resistant, such as grades 304 and 306 or the 'superalloy' Hastelloy. A variety of internal surface finishes are also available for specialty gases applications, with electropolished surfaces at the top end for use with very pure gases.

Thorough testing is required before equipment is shipped to a customer site: for example, leak testing using helium detectors or by monitoring pressure retention over a period of time. This is necessary because it allows gas suppliers to understand and assure the basic integrity of the system being supplied before it enters the market, thus providing totally integrated solutions to consumers. This involves utilising the most technologically advanced and appropriate valves and regulators, in addition to the designing and building supply systems that ensure the safety and quality of the gas at the point of use.