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Temperature control of pressurised gas cylinders in industrial processes - the safety and quality challenges

A wide range of production processes such as hermetic sealing, sintering or annealing and curing are carried out under controlled atmospheric conditions. The same applies to quality controls. A constant supply of gases from one or more gas cylinders ensures a constant level. The gas fractions are generally carefully dosed and the atmospheric condition parameters strictly controlled, as end product quality can greatly depend on the consistency and stability of the atmospheric conditions.

Consistent temperature control for pressurised gas cylinders

Flow rates can be maintained at a constant level by various means. However when accuracy is critical, strict control is needed across all process steps to ensure optimum quality and yield. A process gas supply normally uses reusable gas cylinders, where the contents are kept in a liquid state under pressure.
When the liquid exits the supply line, the liquid level in the cylinder drops, which also reduces the basic pressure available for the distribution of the gas. There is often a requirement to keep pressurised gas cylinders at a constant temperature, generally higher than the normal operating temperature. The consequent increase in pressure in the gas cylinder then helps keep the flow conditions constant. At relatively high flow rates additional problems may occur, which affect the stability of the flow. Without countermeasures, air/gas separation may occur or condensation may form on the outside of the gas cylinder, below the level of the liquid surface. When the pressurised liquid changes into a lower-pressure gas the latent heat of evaporation is used to change the liquid to a gas, which lowers the temperature of the cylinder wall. If the volume of gas flow is high enough, this temperature drop can cause atmospheric water vapour to condense and then freeze on the cylinder wall, even when the ambient temperature is above 0°C. In extreme cases, when the atmospheric temperature is relatively low, the pressure control valve can ice up.

This is a major problem, for example when using highly pure gas mixtures for calibration purposes.

Heating jackets ensure continuous supply of gas

A reliable solution for avoiding variations in the gas supply is to keep the surface of the gas cylinder warm using an insulated, temperature-controlled heating jacket. This also provides additional heat energy for the change of state. Specialists in work safety such as DENIOS supply heating jackets for all current industrial gas cylinders (Ø approx. 230 mm) for indoor and outdoor use. Most series production facilities and test centres use gas cylinders from third parties, which are stored and used in a vertical position. The heating jackets are quick to remove and fit to the next gas cylinder by simply releasing the strap and clips. Large-scale production facilities have fixed installations of horizontal pressurised gas cylinders, which are filled from neighbouring plant or directly from a tanker.
In these types of arrangements, the heating jackets are normally left on the cylinders permanently and are secured between the supports. New users often think that installations around gas cylinders need to be ATEX certified, as the gas inside the cylinders is explosive. This is not the case, since the heating jacket does not produce potentially explosive gases, unless there is a serious fault (where gas could escape from the cylinder or the supply line).

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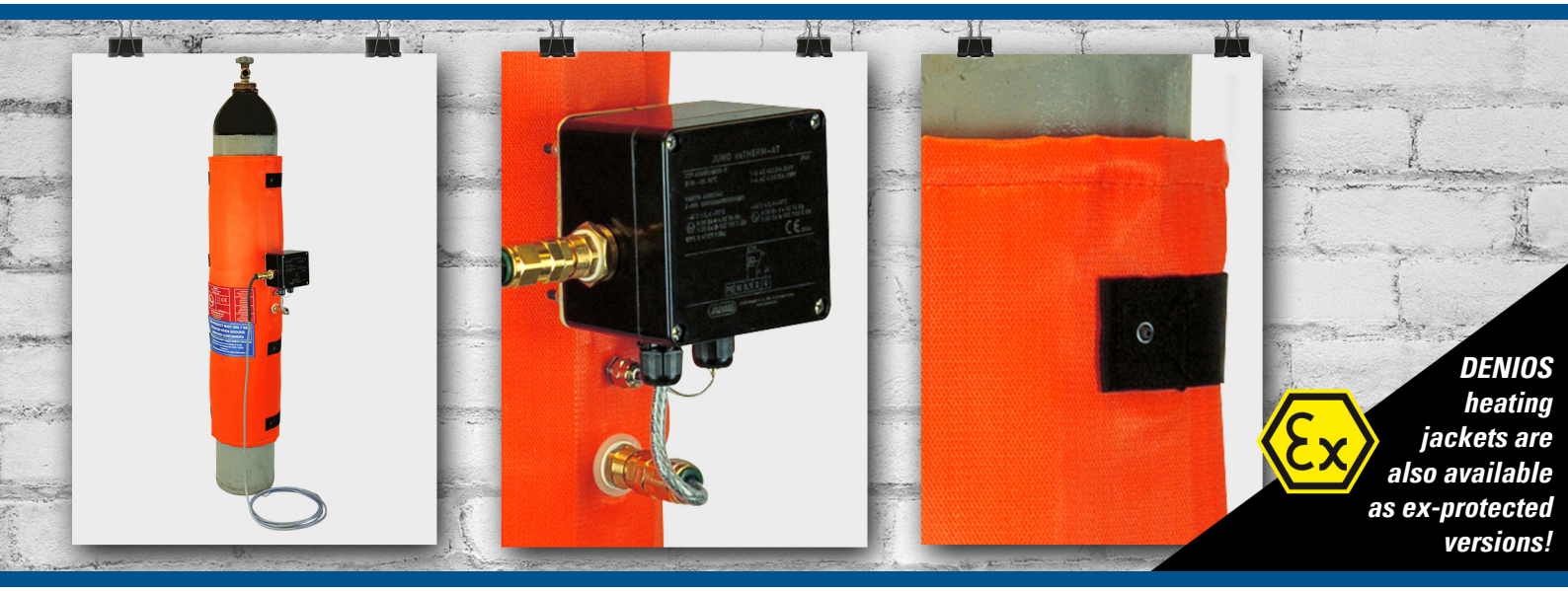

Specific points for Ex areas

New, especially strict requirements are imposed if the area around the gas cylinders is classified as potentially explosive, as electrical equipment then falls under the ATEX directive. This might be the case if an area is near a production site where other equipment emits gases, or when drums or containers are being used which may release explosive vapours in a nearby area. Ex-proof heating jackets from well-known manufacturers such as DENIOS are fully certified to the strict ATEX and IECEx regulations and the IEC 60079 standards for zone 1 and are therefore suitable for all Ex areas classified as zone 1 and 2. They are designed so that safe surface temperatures are automatically reached with "self-regulation", without needing an independent thermostat. The self-regulated temperature is always related to the AC voltage applied. Using a transformer in the central power supply (almost always a "safe" area due to the numerous power and circuit breakers) means that the voltage, and therefore the maximum temperature that can be reached, can be reduced, so a wide range of certified temperature classes can be offered. As an alternative option, a certified thermostat can be fitted if the temperature sensitivity of the medium requires temperature regulation below the self-limiting value of the heating jacket.

International standards for flexible heating

There are a range of statutory international standards which apply to all industrial flexible heating. The manufacturer's declaration of conformity must confirm that these standards are complied with or even exceeded, to protect personnel from unacceptable risks when using the product. The standards include protection from electric shock in accordance with IEC 60364-4-41:2005 and from the effects of heat in accordance with IEC 60364-4-42:2010. In addition, special safety requirements are to be observed for equipment with resistance heating in accordance with IEC 60512-2:2006, with general requirements given in IEC 60519-1:2010. Many see these standards as just a set of figures, but they have been compiled and published by experts, who understand every aspect and have checked the contents in fine detail. When comparing various quotes, a specialist buyer will ensure that the right standards have been used. When using electrical equipment which falls under the ATEX directive, there is a basic safety factor as the risk of explosion due to sparks or electric arcs has been removed. One method has always been to house electrical components inside pressure-tight, enclosed housings so that any ignition of gases in the housing cannot cause an explosion outside the housing. For flexible heating the basic principle of "improved safety" in IEC 60079-7 can be applied, to avoid the structural limitations inherent in the weight and construction of pressure-tight, enclosed solutions. All causes of faults and potential faults in normal operation are to be considered; the entire design must guarantee continual safety under these strict conditions. When such a product is developed for an explosive area in line with the ATEX standards it needs to be tested and certified by one of the independent organisations specified by the national authorities for quality standards. All manufacturing and test methods are strictly controlled and additional tests are required to ensure that no potentially faulty or badly manufactured products come onto the market. This high level of safety in manufacture, quality and reliability can be expected by any user who obtains his product from an approved, well-known manufacturer.