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Creating durable seals in glass-lined steel equipment

EQUIPMENT made of glass-lined steel is used when manufacturing or processing aggressive chemicals such as aniline derivatives and sulphuric or hydrochloric acid. The Achilles heel of such systems is the gaskets needed to seal the joints between components. Exposure to aggressive media causes the seals to degrade overtime, resulting in damage to equipment and posing a health risk to operators. Replacing the seals costs a great deal of time and effort, with a corresponding drop in production output.

A newly developed gasket tape made of ePTFE (expanded polytetrafluorethylene) is specifically designed to address the challenges of creating reliable seals in large glass-lined steel equipment.

Operators of chemical plants choose sealing materials according to a wide range of criteria such as process medium, flange type, sealing performance, pressure and heat resistance, cost and longevity. Other important selection criteria include time required for installation and inventory management. And, of course, a plant operations prior gasket experience weighs in as well. Gaskets for glass-lined-steel equipment are safety-relevant parts because their failure can endanger human lives and/or harm the environment, but they are often treated for administrative purposes as C-class items, that is, parts of minor significance.

This classification doesn't reflect the true importance of these sealants. There is a need for more explicit regulations to supplement the general legislation pertaining to occupational health and safety and the handling of hazardous substances. The introduction of a European-wide regulatory basis for establishing detailed, standard processes would be welcome, for instance with respect to approval procedures and safety. As things stand today, companies are obliged to find their own compromise between varying sets of requirements. These include compliance with EU-wide and national directives concerning environmental protection and occupational health and safety. At the same time, companies are making efforts to augment the reliability of their products, simplify inventory management and installation processes, and reduce downtime and overall costs. An added factor in both cases is specific process requirements with respect to temperature, pressure and media.

Glass-lined sealants ... reliable

GLS-vessel

SEALING CHALLENGES

One particular challenge is that of choosing the right sealant for glass-lined steel systems, because these involve the use of aggressive media such as aniline derivatives and sulphuric or hydrochloric acid under demanding conditions. Glass-lined steel presents the advantage of being highly resistant to corrosive and/or abrasive media. Other characteristic features of this material are its smooth surface, which is easy to clean due to its low adhesion properties, and its biologic and catalytic inert behaviour. Nonetheless, it can be difficult to achieve reliable seals in glass-lined steel equipment. This is because the glass lining is more brittle than the metal, and can therefore split or splinter if handled incorrectly. As a result, the gasket load that can be applied to the seal is lower than that for an all-steel flange. Consequently, care must be taken to limit the pressure applied when installing gaskets between interconnecting parts of the system.

Another problem is that of achieving a reliable seal if the flange surface is uneven or has surface deviations. Once the glass lining has fused, its surface cannot be reworked. The challenges posed by these characteristics of glass-lined steel, combined with the exposure to aggressive chemicals and high temperatures, must be met by the chosen sealant. In practice, these difficult conditions often lead to premature sealing failure and a greater risk of corrosion. The further consequences of sealing failure include leaks and uncontrolled emissions, damage to equipment, high replacement and repair costs, production losses, unplanned maintenance and downtime, and potential risks to employees' health and safety.

RESISTANT SEALING MATERIAL

On account of its high chemical resistance, polytetrafluorethylene (PTFE) is often used as a gasket in applications involving highly aggressive media. It resists attack by almost all media (pH range 0-14), with the exception of molten or dissolved alkali metals and elemental fluorine, and supports an extremely wide range of temperatures, from -269-degC to +315-degC. The non-ageing material is weather- and UV-resistant, has a low coefficient of friction, is physiologically harmless, and is suitable for a wide range of different applications.

The molecular structure of PTFE consists of a chain or backbone of carbon atoms saturated with fluorine atoms. The strong covalent bonds between the fluorine and carbon atoms explain this polymer's quasi-inert reactivity to other chemicals. This is the reason why it is used in sealants. On the other hand, its low reactivity means that unlike certain elastomers PTFE is unable to form molecular networks. As a result, PTFE gaskets have a pronounced tendency to "creep" under stress due to alternating hot and cold temperatures.

EXISTING SOLUTIONS

The material Polytetrafluoroethylene (PTFE) is commonly chosen for its chemical resistance. However it lacks conformability and creep resistance. Thus, common seals, such as envelope gaskets or filled PTFE gaskets, attempt to overcome these weaknesses by incorporating compressible materials and or fillers.

However, envelope gaskets resolve only part of the problem. The envelope allows permeation or worst case can even have defects (porosity or small holes in the PTFE envelope) both resulting in degradation of the inside of the gasket over time.

High temperatures can lead to a loss in sealing effectivity with lower grade inlays, such as Compressed Synthetic Fibre (CSF) sheets. Those can get hard and brittle.

Moreover, the need to shim envelope gaskets can lead to costly delays.

Filled PTFE gaskets typically contain glass spheres or fibers to improve creep resistance. However this is not enough in all cases. High temperatures, especially cycling temperatures, combined with the low loads available in glass-lined-steel lead to gasket force loss (due to creep) resulting in higher leakage.

Extra complexity is added with large flanges (> DN600 / 24-inch) due to the need for offsite gasket fabrication. This often results in long lead times, shipping, handling and inventory challenges. Furthermore, inconsistent quality across manufacturers and product lines as well as time consuming and complex installation, may lead to troublesome and delayed start-up.

ALTERNATIVE SOLUTION

An alternative solution is to use expanded PTFE (ePTFE), a material that Bob Gore discovered back in 1969 while experimenting with ways of heating and stretching PTFE rods. The combination of heat and rapid expansion significantly improves the material's mechanical properties while at the same time preserving the original chemical properties of PTFE. The added mechanical advantages of ePTFE include: outstanding blowout performance; superior high-temperature performance; longer service life; good conformability resulting in tight seals, and high resistance to creep and cold flow.

Thanks to its conformability, ePTFE can be used to seal flange surfaces of different qualities. This is because the sealant is capable of adapting its shape to any surface irregularities on the flange without altering the tightness of the seal. The result is a reliable and long-lasting joint.

NOVEL GASKET TAPE

The Gore Gasket Tape Series 1000 was specifically designed to address the challenges of reliably sealing large, glass-lined-steel flanges (upward of DN 600). The tape contains a proprietary barrier core of compressed, high-density ePTFE, which provides effective protection against leakage.

This barrier core enables an area of very high density to be produced rapidly as the bolts are tightened. Thus, even when a relatively low contact pressure is applied, as it is the case with glass-lined steel reactors, an optimum seal can be achieved. With this technology, the resulting seal is more than ten times tighter than when using conventional gasket tapes without a barrier core. Moreover, it offers high creep resistance at equivalent bolt loads. The Gore Gasket Tape Series 1000 prevents the diffusion of highly volatile chemicals, providing reliable protection against such emissions across the entire width of the flange.

The tape is supplied in a convenient spool format that simplifies handling and reduces delivery lead times by facilitating rapid shipment. This format also significantly simplifies the task of applying the sealant during assembly. The length required is simply reeled off from the spool and fitted to the shape of the flange at the assembly station. The adhesive backing facilitates placement of the gasket on the flange, enabling it to be installed in one step by a single operator. De Dietrich Process Systems, for example, has endorsed the use of this gasket tape in its glass-lined steel reactors on account of these numerous advantages.

The new Gore Gasket Tape Series 1000 is specifically designed to meet the challenges of sealing flanges in large glass-lined reactors. It contains a barrier core of compressed ePTFE, which guarantees long-lasting, reliable sealed joints in glass-lined reactors, prevents the diffusion of highly volatile media, and provides reliable protection against chemical attack across the entire width of the flange. The tape is entirely fabricated from inert ePTFE. Specifically designed to offer high creep resistance without compromising bolt load, it allows full use of the specification range of the glass-lined steel equipment. This facilitates longer maintenance cycles, as demanded by leading operators of chemical plants.