Permeation of Teflon Flowtube Liners and Installation Techniques to Reduce the Rate of Permeation

KEY POINTS

- Background
- Ways to Reduce Permeation including Liner Quality, Liner Thickness, and Temperature
- Solution to the Challenge

APPLICATION

Magnetic Flowmeter Permeation of Teflon Liners

BACKGROUND

Permeation can occasionally affect Teflon lined flowtubes in high temperature applications and result in reduced length of service. Permeation is the molecular diffusion of a fluid or vapor through a material, PTFE Teflon in this case of Rosemount flow tubes. It is characterized by bubbles forming underneath the liner sleeve. The rate of permeation through the Teflon liner is dependent on the following factors: process fluid chemistry, temperature, pressure, quality of the liner, and liner thickness.

Different process fluids will permeate at different rates depending on the molecular size of the process fluid. A process fluid with a smaller molecular size will permeate faster than a larger molecule. Higher process temperatures and pressures can increase the rate of permeation. Higher pressures will work to force the movement of molecules. Higher temperatures can create a temperature differential between the process and the environment which can create heat transfer dynamics that exasperate permeation. Rarely, if ever, do we see permeation in lower temperature applications. The quality of the liner, defined by the% crystallinity can have a significant impact on permeation. Liner thickness can also have a dramatic effect with regards to permeation. A thicker liner will result in a more permeation resistant lining.

CHALLENGE

Ways to Reduce Permeation

Liner Quality

One method to reduce the permeation rate in PTFE is to increase the crystallinity, or % of polymer with a crystalline structure, of the polymer. Since PTFE is not melt-processable, special processing techniques are used to form raw PTFE into usable articles. The primary technique used to process PTFE is compression molding. Compression molding is performed by compressing PTFE powder into a shape and then baking it at high temperatures to set the polymer structure. This processing technique may leave small voids in the material, when done improperly, that allow a process fluid to migrate through it. Rosemount has worked extensively with its PTFE sleeve processor's manufacturing process and quality control. In doing this, we ensure that we will obtain the highest level of permeation resistance possible. This may not be the case in other manufacturers' PTFE liners.

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Liner Thickness

The thickness of the PTFE sleeve is another important factor regarding permeation. A process fluid will migrate through a thicker liner much slower than a thinner liner. In addition, the relationship is non-linear. For instance, as the thickness of the liner increases, its permeation resistance increases at a faster rate. For example, the permeation rate of a .250" thick liner is four times lower than for a .125" thick liner. Rosemount uses thicker liners compared to some other manufacturers. This enables the Rosemount magmeter to be more resistant to permeation.

Temperature

Temperature affects permeation by the fact that the higher the temperature difference between the process fluid and ambient temperature, the higher the permeation rate. The use of insulation around a magmeter with a highly permeable process fluid can reduce the rate of permeation. By reducing the temperature gradient across the liner, the driving force behind permeation can be reduced. In installations with process temperatures above 300F, insulating the flowmeter body will reduce permeation rates.

SOLUTION

Rosemount takes great care in working with its supplier in producing the highest quality sleeves available. This combined with a careful selection of thicknesses and proper installation of the magmeter in higher temperature applications greatly reduces the risk that permeation will be an issue with PTFE liners.

Applications where the process temperature is above 300°F, we would recommend that you should insulate your PTFE lined flowmeter to reduce the effects of permeation. In addition, any highly permeable process fluids such as hydrochloric acid, nitric acid, sodium hydroxide, or sodium formate should be insulated at process temperatures greater than 250°F.

A final consideration is that we have found that the Rosemount PFA solution is superior in these very hot applications and it should be considered as a premium solution to resolve permeation issues with PTFE liners.

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