TEST RESULTS

DLC coated graphite ring trial resaults

Introduction

Pure graphite rings have been a proven solution used for sealing difficult media in demanding environments for many years. In addition to the many advantages graphite offers, unfortunately there are also properties that are drawbacks when using graphite rings.
In addition to the excellent sealing properties and media resistance against almost all media (except oxidising media) over a temperature range from -270°C to +450°C (and beyond), graphite can also be used at high pressures. The reason for this is quite simply that graphite is pure carbon, which unfortunately has a tendency to adhere to steel - particularly stainless steel.

The problem

If graphite seals are installed and not moved for a longer period of time, then they adhere to steel surfaces. This is known when graphite seals have to be replaced after years of successful service on flanged connections. The sometimes stubborn areas of adhesion on flanges often have to be removed mechanically and so there's a risk of damaging the flange surfaces. This behaviour is also known in fittings. In the case of stem seals with graphite rings, the graphite "sticks" to the stem of the valve. In order to actuate them, a certain "breakaway torque" has to be applied, and it can be uncomfortably high depending on the spindle diameter and the tightening torque applied on the screws. This behaviour is also known as the "stick-slip effect".

The challenge

Many different attempts have been made to prevent graphite from sticking. Often a lubricant was used to reduce the friction on the spindle, or a coating was applied to prevent the graphite from coming into contact with the steel (or stainless steel). However this caused additional problems. For example, the use of oils and greases is not permissible in oxygen applications, or the application range was limited to temperatures under 300°C. The challenge was to find a way to reduce the stick-slip effect without compromising the properties of the sealing element.

The solution

In surface technology, a carbon coating with the name DLC (diamond-like carbon) has been used for several years. In this case a carbon layer is applied to the surface of the element. When applied to shafts, a reduction in friction can be observed. At the same time, the service life of the coating is high due to good adhesion.
A similar trial has now been carried out on gaskets made of graphite and pure graphite rings.
A 15-month long-term trial was carried out by KLINGER Bartsch GmbH.

Trial apparatus:

The apparatus for the trial consists of a cylindrical chamber with a screwed bottom, a screwed inner mandrel and a pressure plate that is connected to the cylindrical chamber using four M10 Allen screws.

Trial procedure:

Three DLC-coated rings each with the dimensions 46.00 x 30.00 x 8.00 mm and a density of 1.6 g/ccm were inserted into the device and compressed by the pressure plate. For this purpose, the screws were tightened with a torque of 30 Nm. These test assemblies were then stored in a room at ambient conditions. The long-term trial started on 17 July 2019 and ended on 14 October 2020 when the fifth test fixture was opened.

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KLINGER Bartsch

Trial remarks of 14 October 2020
Fifth interim results
The fifth test arrangement with DLC coated rings was opened on 14 October 2020. A check of the screw force was not conducted because no change was expected compared to the first trial.

Observations:
Compared to the fourth trial, less deposits were observed in the test chamber. The deposits were approximately at the same level as in the second and third trials. The rings could be removed without damage in this trial as well. Adhesion to the inner mandrel and in the chamber could be removed without problems simply by wiping.

Summary
A long-term trial showed that DLC-coated pure graphite rings do not tend to stick to stainless steel even after having been under pressure a longer period of time.Therefore after a longer period of valve non-actuation, it can be expected that no stick-slip effect or "caking" of the graphite seal will lead to a higher actuating torque.

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