Increasing process reliability with lubrication know-how

Taking reactions into account

Selection of the correct lubricant for oil-injected screw-type process gas compressors has a great impact on the reliability and profitability of the entire process plant. Thorough consulting is therefore important prior to purchasing a lubricating oil. Extensive and detailed chemical know-how, a great deal of practical experience and specially designed lubricating oils enable the effects of the gas flow on the lubricant to be predicted.

Process gas compressors are mainly used in the chemical and petrochemical industries – wherever gases are compressed and processed. Turbo, reciprocating and screw-type compressors are the three types most commonly found in industry.

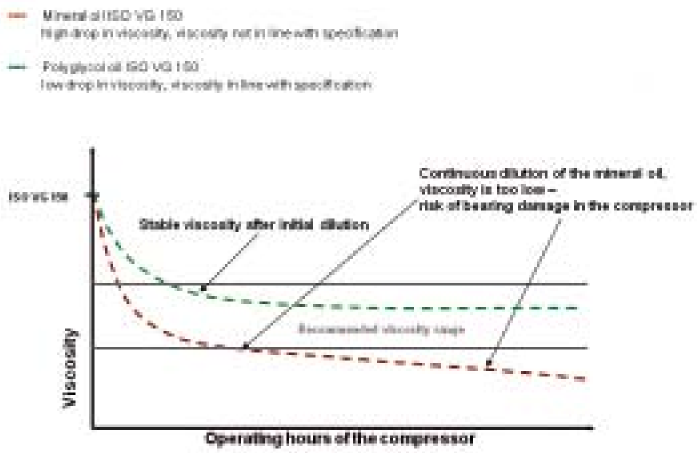
The lubrication of oil-injected screw-type and reciprocating compressors is particularly challenging. Here, the lubricating oil is injected directly into the compression chamber, sometimes under extreme operating conditions, in order to lubricate, seal and, above all, cool down the pistons or rotors. In screw-type compressors, in particular, the lubricating oil is in intense contact with the process gas. A long oil service life is a major requirement for this type of oil circulation system, as opposed to the total loss lubrication in reciprocating compressors. Due to these special constraints, this article will focus exclusively on oil-injected screw-type compressors.

Gas compressors, on the other hand, are used to compress a wide variety of different gases and gas mixtures, from inert gases such as hydrogen, nitrogen or helium through reactive gases such as ammonia, methyl chloride or hydrogen sulphide to hydrocarbon gases such as methane, propane or heptane. Some gas mixtures may include moisture or acid components such as hydrogen chloride or hydrogen sulphide.

These very specific and varying gas flows make lubricant selection a difficult task, as considerably more complex and far less predictable reactions can occur. Apart from chemical reactions between the gas and the lubricating oil and the oil's acidification, the solubility of the process gases in the oil needs to be observed, as this may considerably affect oil viscosity during operation.

These factors can lead to several problems for the operator: damaged bearings and rotors,

Refineries are a classic application for gas compressors



Schematic viscosity curve of a polyglycol oil compared to a mineral oil when a hydrocarbon/gas mixture is compressed

Oil container of a process gas compressor, covered with greenish sludge from reactions between the lubricating oil and the process gas

corrosion, solid or sludge-type deposits, shortened oil change intervals, high oil consumption, foam formation or even damage to downstream process catalysts, often resulting in lengthy and costly compressor downtime and subsequent standstill of the entire process plant.

Those are the problems – but what needs to be observed when selecting the correct lubricating oil for a gas compressor with a defined gas flow?

Correct viscosity is a must

Certain gases may dissolve in lubricating oils under pressure and thus reduce the oil's viscosity. This can lead to undesirable wear on compressor bearings and rotors.

This effect is explained quite clearly in the following example: carbon dioxide gas is dissolved in beer under pressure and escapes from the beer upon decompression – i. e. after the bottle has been opened – as foaming. In the same way, when pressure is applied, process gases are dissolved into the lubricating oil in a compressor and then separated from the oil once again as the pressure drops; this usually manifests itself through the formation of foam.

In this context, the following rule applies: the better the solubility of the gas in the lubricant, the more significant the viscosity reduction of the oil. The solubility of gases into lubricating oils depends largely on pressure, temperatures, the oil and gas polarity and the molecular weight of the gas.

A special calculation programme can be used to determine the solubility of each gas contained in the lubricating oil's gas flow, taking the aforementioned parameters into account. The benefit is a precise forecast of oil viscosity under operating conditions and, hence, a stable lubricating film as well as reassurance for the responsible operators when commissioning and operating the compressor.

The software for this complex calculation is only available from a specialist lubricant manufacturer. It is based on years of hands-on experience, extensive calculations and many online viscosity measurements on operational gas compressors.

A viscosity calculation under operating conditions is essential to ensure reliable long-term operation of a compressor. A lubricant specialist should therefore be consulted to assist with the selection of the correct lubricating oil.

Decreased oil consumption

Quite often, the oil itself is the reason for relatively high oil consumption. If the oil is injected into a screw-type compressor, it is not only used for lubrication but also for cooling the gas flow. Some lubricating oils evaporate at compressor operating temperatures, which may often be above 90 °C.

The oil vapour is carried along with the gas flow but – unlike the oil droplets – is not collected by the oil separator. Hence, oil consumption depends, amongst other things, on the evaporation stability of the lubricating oil. Compared to synthetic oils, conventional mineral oils are characterised by a higher vapour pressure – i. e. they evaporate more easily – and thus lead to higher oil consumption.

The oil absorption in the gas flow also plays an important role. Oil molecules may be absorbed by the compressed gas and entrained with the gas flow. Here, the following rule applies: homopolar oils are absorbed far more easily by homopolar gases than polar oils and vice versa. Once oil has been absorbed into the gas flow, it will not be collected by the oil separator.

The effects of absorption and evaporation show that specially designed compressor oils reduce the oil absorption into the gas flow and optimise its purity. Oil consumption decreases as a result while the reliability and long-term effectiveness of the entire process are increased.

Ensuring an oil-free gas flow

In many industrial processes there are catalysts downstream of the compressor which play an important role in the further processing of the gas flow. Traces of lubricating oil contained in the compressed gas flow may reduce the efficiency of these catalysts or even destroy them. This phenomenon is called "catalyst poisoning".

In order to avoid this, the amount of oil in the gas flow should be as low as possible and the oil formulation carefully selected, as both ingredients of mineral oils and some additives can damage the catalyst. The base oils and additives of the lubricants should therefore be compatible with the compressor materials.

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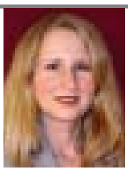

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