Overview

Three factors to consider when selecting a lubricant for high pressure, reciprocating compressors in hydrogen service include impact on compressor downtime (Mean Time Between Outages or MTBO), the effect of oil carryover to downstream processes, and cost.
Compressor Downtime (MBTO)

Due to high costs and low resources, today’s industry has seen a strong shift to increasing reliability of plant operations to extend plant outages. If we apply this reliability focus to reciprocating compressors we must first look at what tends to fail more readily. Valve replacement, excessive ring wear and excessive packing wear are some of the major reasons of unplanned shutdowns for horizontal reciprocating compressors in hydrogen service. This is typically caused by one or a combination of gas absorption, lubrication absorption, improper ISO selection, and improper feed rates. Synthetic lubricants help to minimize unplanned shutdowns and increase the Mean Time Between Outages (MTBO) interval. This is especially true where ISO 320 and higher viscosity petroleum oils have traditionally been used.

Petroleum based lubricants are more easily absorbed by hydrogen gas at higher pressures (typically seen in the final stages of compression). Feed rates have to be increased to these high pressure cylinders to compensate for this effect, incurring higher costs and also a risk of washout (excess of lubrication that washes away any existing lubrication currently on the cylinder walls). Due to their chemistry, petroleum based lubricants also absorb hydrogen gas at higher pressures, which results in a reduction in viscosity. In order to accommodate for this inevitability, the initial starting viscosity has to be increased allowing for viscosity dilution. Since a petroleum-based lubricant is normally selected based on the conditions of the final stage of compression, the compressor starts with oil that is too thick for proper flow and lubrication in the earlier stage cylinders. This leads to excessive wear on the cylinder rings and packing, especially during startup of the compressor.

Increasing feed rates also lead to excessive oil, which leads to “stiction” of the valve plates and premature valve failure. Stiction occurs when the oil film between the valve plates and valve seats is increased. As the valve opens, it passes through a larger volume of oil which means it has to work harder to break the film strength making the valve less efficient while also throwing off the valve timing (which is important in compressor applications). Excessive lubricant feed rates also lead to excessive carbon forming tendencies at higher temperatures and more oil carry over to downstream components. The efficiency of the compressor is compromised because of poor valve operation, leading to complete failure.

The selection of the right synthetic lubricant can eliminate the issues caused by the use of petroleum based oils. Synthetics have a lower absorption rate into the gas stream. This means feed rates can be reduced significantly compared to mineral based lubricants, resulting in less downstream contamination, a lower possibility of valve “stiction,” and lower carbon forming tendency. Synthetics also have a lower tendency to absorb hydrogen gas. This means an ISO 150 synthetic may be used in place of an ISO 320 or heavier petroleum based lubricant. This results in better lubrication for cylinders (both high pressure and low pressure) and packing because of the lower viscosity lubricant’s ability to flow more readily around the cylinder walls. Synthetics also offer better metal wetting ability so they adhere to the metal surface of the cylinders and provide superior film strength.
Effect of Oil Carryover Downstream

Downstream processes may also benefit from the use of synthetic-based lubricants. Petroleum-based oils naturally contain elements that may bond to downstream catalysts. This process is commonly known as catalyst “poisoning.” Synthetic base stocks are free of such contaminants. If formulated correctly, synthetic lubricants may be verified as being safe for use with such catalysts. Examples are UOP platforming catalysts.

If lubricant is allowed to carryover downstream of the compressor to the platforming catalyst, poisoning of the catalyst may occur. A reduction in efficiency of 1 percent in the catalyst would result in a $10,000/day loss in a $1,000,000/day process. Carbon forming tendencies of the lubricant should be considered as well. Oil carryover to a high temperature catalyst may result in carbon coating the catalyst and further reducing its efficiency and the gas flow rates.

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Weigh the Cost

Cost is a matter of perspective. Too often we compare the price of one lubricant to another in terms of price per gallon. When comparing petroleum based oils to synthetic oils, the question should be what is my cost of using petroleum compared to my cost for using synthetics?

Reduced feed rates, improved compressor run-time and efficiency, longer component life, extended MTBOs, and improved catalyst efficiency are all factors which must be considered when determining if petroleum or synthetic is the more costly choice.

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