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TECH BRIEF: MECHANICAL VACUUM PUMP OILS FOR USE IN FREEZE DRYING SYSTEMS

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Introduction

In attempting to write a general engineering specification for vacuum pump oils to be used in Hull Company freeze drying equipment, many types of oils were encountered from many different manufacturers all claiming different things about what seemed to be the same oils. To help sort through this confusion, it was found useful to classify the oils into general categories. Below is a listening of these categories. It is hoped that this information will be helpful in determining which vacuum pump oil is correct for your application.

NOTE: It is recommended that the first choice of oil always be that of the manufacturer's specification, especially if the pump is still under warranty.

Some manufacturers specify their own brand of oil and will void their warranty if that particular brand of oil is not used. However, other manufacturers are only concerned that a high quality name-brand oil be used. It is suggested that one always contact the pump manufacturer before changing oil types.

Belt Drive Rotary Vane Pumps:
General Service

Fundamentally a very low-end oil designed for use specifically in small belt drive (only) rotary vane pumps. Viscosity at 100°F is approximately 200 SUS (Saybolt Universal Seconds). However, if you also own direct-drive type vane pumps, general service direct-drive oil (described below) can work as well.

Direct Drive Rotary Vane Pumps:
General Service

Manufacturers recommend this grade of oil as standard for non-chemical series vane pumps. This type of oil is also the grade most often used in rotary vane pumps on freeze drying systems since freeze drying most often involves only the removal of water vapor. This oil is usually molecularly distilled to remove light-end fractions, which results in a lower vapor pressure for the oil and therefore a more efficiently running pump. These oils are also applicable for use in some diffusion type vacuum pumps. Viscosities are typically between 220 and 250 SUS at 100°F.

Direct Drive Rotary Vane Pumps:
Chemical Service

This oil grade is actually standard diffusion pump oil but is recommended by rotary vane pump manufacturers as standard for their "chemical series" type pumps or for standard vane pumps used in processes involving corrosive or reactive gases. These oils go through a double molecular distillation process thus lowering the oil's vapor pressure an average of one order of magnitude (i.e., 1×10^{-5} Torr down to 1×10^{-6} Torr.) from that of the general service oil. One manufacturer has claimed that this oil will typically last 3 to 5 times longer than the general service oil. Viscosity at 100°F is usually between 250 and 350 SUS. This oil is also reclaimable, that is, can be re-purified after use and then used again at a fraction of the cost.

While oil of this grade is not usually required for vacuum pumps used in freeze drying, it is used occasionally when a potentially corrosive substance is dried. It can also be used if longer maintenance intervals are desired.

Direct Drive Rotary Vane Pumps:
Corrosive Service

This oil type is also double molecularly distilled and is recommended by manufacturers for processes, which involve prolonged exposure to corrosive or

reactive gases. It is rarely used in pumps on freeze-drying systems. Sometimes referred to as "white oil" or "T-Type oil," it is the longest lasting hydrocarbon oil available. One manufacturer claims this oil grade will last 1.5 to 4 times longer than the chemical grade oil. Since the cost is comparable to chemical series oils, corrosive service type oils are much more cost effective. Typical viscosity is similar to chemical grade oil at 260 to 320 SUS at 100°F. This oil is also reclaimable.

Small Rotary Piston Pumps:
General Service

These oils are typical standards for rotary piston type vacuum pumps under 125 CFM in non-corrosive applications. The higher viscosities of 300 to 360 SUS aid in preventing wear of the reciprocating piston(s). They are generally the oils used in freeze dryers with this size vacuum pump.

Medium Rotary Piston Pumps:
General Service

These oils are typical standards for rotary piston type vacuum pumps over 125 CFM in non-corrosive service. Again, this oil grade is the grade, which is generally used in freeze-drying vacuum systems of this size. Kinney Vacuum began recommending this oil grade in their "KT" series pumps some time ago, having formerly recommended their Type A oil which is closer to the small rotary piston pump oil. The 400 to 525 SUS viscosity at 100°F ensures lubrication of the larger moving parts.

Rotary Piston Pumps:
Corrosive Service

Some of these corrosive service oils for rotary piston type pumps are actually high viscosity versions of the "white" or "T-Type" oils used for corrosive services in direct drive rotary vane pumps. This oil type is also double molecularly distilled and is recommended by manufacturers for processes, which involve exposure to corrosive or reactive gases. They are not generally used in freeze-drying systems. Typical viscosity is similar to heavy service oil being between 400 to 570 SUS at 100°F. The "white" oils are also reclaimable.

Medium Rotary Piston Pumps:
Heavy Service

These oils will maintain their integrity at higher operating temperatures than the general services oils. Their 550 to 600 SUS viscosity at 100°F gives them properties similar to that of 30-weight motor oil. However, higher starting torque is required in a cold pump due to the increased viscosity.

Large Rotary Piston Pumps:
General & Heavy Service

This oil grade is recommended by one manufacture in only their largest (700+ CFM) pump. The very high 650 to 700 SUS viscosity at 100°F is required to withstand the operating conditions of very large pumps. Another manufacturer also specifies this oil grade for use in some of their roots type blowers.

Once Through Oiling Systems (OTO)

Once-Through-Oil systems are used where the oil can incur extreme corrosives and particulates. As the name implies, the oil is circulated through the pump but once and then collected in an external container to be later disposed of or recycled. This oil's 750 to 850 SUS viscosity at 100°F makes it similar to 40-weight motor oil. OTO systems are generally not used in freeze-drying.

Blower/Booster Lubricants

These fluids are more similar to gear lubricants than oils. Roots type blowers do not use oil as their sealing agent but only require lubrication of their bearings. Blowers tend to use a high viscosity oil to withstand the heat of friction developed during operation. Blower/booster lubricants typically have viscosities ranging from 1000 to 1200 SUS at 100°F to ensure long bearing life under extreme conditions.

Additives

Many of the above oils are also available with additives, which are claimed to enhance the oil's performance in some area. Typical additives consist of rust and/or oxidation inhibitors, detergents and other anti-wear ingredients. These additives will only affect the freeze drying system in as much as they may or may not extend the life of the vacuum pump. Note again that you should always check your pump's owner's manual and/or manufacturer before changing oil types.

Oil Requirements for Freeze Drying

As has been mentioned above, most freeze-drying applications require only a quality grade of standard oil for the vacuum pumps. In most cases, specifying a chemical grade or synthetic oil results in needless expense. The biggest problem in freeze drying is, of course, water vapor finding its way into the oil and reducing a pump's efficiency as well as the lubricity of the oil. This can be prevented by always ensuring that the condensing plates are at -40°C or colder before running the pumps and/or boosters. Vacuum pump oil should be checked frequently for a "milky" appearance indicating that water vapor has found its way into the oil. If this condition occurs, running the vacuum pump for several hours with the "gas ballast" (crankcase vent) opened slightly can drive out some of the vapors. Many pumps have this feature, which vents the oil reservoir and allows water to vaporize out of the oil.

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