

Mechanical Vacuum Pump Fluids

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Mechanical vacuum pump fluid is an integral part of a mechanical vacuum pumping system. It is as important as the pump itself in achieving rapid, clean vacuum. A good fluid will perform the following functions:

- lubricate moving parts, bearings, and bushings to reduce friction, heat, wear, and power consumption
- transfer heat from the pump, preventing warpage and seizure of pump parts
- form a protective layer on metal pumping surfaces, preventing corrosion
- seal the small clearances between moving pumping surfaces
- flush away deposits, moisture, dirt, and wear debris

Here are the important properties to consider when selecting a mechanical pump fluid:

Vapor Pressure - the pressure resulting from the evaporation of a fluid in a sealed container. Vapor pressure will rise with increased temperature. A low vapor pressure fluid achieves low working pressures, minimizes backstreaming, and reduces pump-down time. The vapor pressure of a fluid increases as it becomes contaminated.

Viscosity - the resistance of a fluid to flow (technically resistance to shear) at a given temperature. Viscosity increases as temperature drops or as fluid becomes contaminated. Fluid viscosity required for a particular pump depends on clearance between moving parts, speed of rotation, and the operating temperature of the pump. If a fluid is too viscous at room temperature, parts of the pump will not turn freely and the pump will be difficult to start, or may need heating prior to operation. If a fluid is too viscous at operating temperature, the fluid will not circulate properly. Pump wear, temperature, and backstreaming will increase. If the fluid has too low a viscosity (too thin), it will not seal the gap between pumping surfaces. The result is poor pumping speed and poor working pressures. A thin fluid may not lubricate properly, causing high temperatures and increased wear. Pumps with smaller clearances usually require a less viscous oil than pumps with larger clearances.

Pour Point - the lowest temperature at which a fluid will flow. Important when selecting a fluid which will operate in a low temperature environment.

Chemical Inertness - a pump fluid should resist oxidation, which is the increase in the length of an oil's polymer chain length when hot fluid is exposed to air. Oxidation can cause an increase in a fluid's viscosity and formulation of sludge. A pump fluid should also have low levels of aromatic compounds and unsaturated double carbon bonds. Both of these will increase the formation of sludge. Finally, a vacuum fluid should not react with any process gas to increase the potential for explosion.

Water Separation - some pump fluids contain impurities which will allow the pump fluid and water to emulsify. A hydrocarbon fluid without additives can oxidize and increase in acidity as sulfur in the forms sulfuric acid. The acid will react with metal causing the oil and water to emulsify. It then becomes difficult to remove the water from the fluid. Lubricating properties degrade, vapor pressures rise, viscosity changes, and corrosion may develop. A fluid which emulsifies easily should not be used to pump large amounts of water vapor.

Specific Gravity - the density of a pump fluid divided by the density of water. If a fluid has a specific gravity of less than 1, water will sink in it. If a fluid has a specific gravity higher than 1, water will float on top of it. Hydrocarbon fluids have a specific gravity less than 1.

Molecular Weight - the sum of the atomic weights of the elements that comprise a molecule of pump fluid. The higher this molecular weight, the less backstreaming. Some fluids contain more than one component, so the molecular weights are averaged.

Color - oil color can vary from clear to dark amber. Generally, as fluid darkens it is considered less fit for use, since oxidation, breakdown, and contamination contribute to the color change. See the scale below. When an oil reaches the center color or darker, it should be replaced or recycled.



Flash Point - the temperature at which a fluid will burn momentarily when exposed to an open flame. The flash point of a pump fluid should be twice the normal operating temperature of the pump. The temperature at which burning is continuous is called the Fire Point.

Cloud Point - the temperature at which dissolved solids begin to precipitate from the fluid.

Neutralization Number - the quantity of potassium hydroxide required to neutralize a one gram sample of oil. As oil oxidizes, it becomes increasingly acidic. Because pH measurement is for water-based solutions, this alternate method is used.

The least expensive fluids are hydrocarbon based. These fluids are susceptible to all of the problems discussed above. There is a choice of brands and grades. You generally get what you pay for. Some hydrocarbon oils have been formulated to have improved resistance to oxidation and mildly corrosive gases. Certain highly oxidative or corrosive environments require the use of an more inert pumping fluid. The most common of these is polyfluoropolyether fluid. It does not oxidize, so it is safe to use in high oxygen service. PFPE fluid should not be used, however, with ammonia, amines, liquid fluorine, sodium, or potassium. In addition to its other characteristics, it is non-flammable, has a high density, and a low vapor pressure.

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