MIDWEST TUNGSTEN SERVICE

Tips

DIFFERENCES IN DIFFUSION PUMP FLUID

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The diffusion pump is an essential piece of machinery in many vacuum metallizing operations. However, the type of fluid that goes inside the diffusion pump is as crucial as the pump itself. Since the diffusion pump has no moving parts, much of the performance is dependent upon the diffusion pump fluid. Therefore, it is important to select a fluid that will withstand a variety of severe conditions, as well as meet the needs of a particular vacuum process.

A diffusion pump fluid must do four things; (1) vaporize, (2) trap and compress gases without being destroyed or altered itself, (3) condense, (4) have a volatility lower than the required operating pressure. Unfortunately, there is no universal fluid to date that will satisfy all the needs of every type of pump and the variety of vacuum applications.

There are basically two groups of diffusion pump fluids. They are distilled hydrocarbons and synthetics. Each of these different fluids has certain advantages and disadvantages.

HYDROCARBONS

Hydrocarbons are distilled from crude oil and treated with sulfuric acid. The fluid is further refined by single and double vacuum distillation. This distillation removes the light ends (commonly referred to as low boiling point volatiles), and heavy compounds. By distilling off these light ends, one attempts to eliminate the components of the oil that would backstream from the diffusion pump. Moreover, the high rate of migration of these light ends would also severely diminish the fact that these fluids will possess less of these light ends and heavy compounds. The major advantage of hydrocarbon-based fluids is that they are relatively low in cost. This reduces the total operational cost of the vacuum system, and encourages frequent pump maintenance. The price of a particular hydrocarbon based fluid will vary according to how much it has been distilled. The further the fluid is distilled, the higher the cost.

An added benefit of a hydrocarbon-based fluid comes in the area of reclamation. Hydrocarbons can be reclaimed at a relatively low cost when compared to synthetic fluid reclamation.

A hydrocarbon-based fluid does, however, have certain disadvantages. The major detractor of hydrocarbons is their toxicity and the constant danger of fire or explosion in oxygen service. Backstreaming into the chamber is also more likely to occur when using a hydrocarbon-based fluid. What this means is that the vapor of a pump's fluid moves in the direction of the region being evacuated (the chamber). This problem can be minimized by implementing a good trap in the foreline. The ultimate vacuum achieved with a hydrocarbon-based fluid is also somewhat limited. In most cases the ultimate vacuum pressure using a hydrocarbon will not exceed 1x10-7 torr.

The final disadvantage in using hydrocarbons comes in the area of disposal, if the fluid is not recycled. Complicating the matter of disposal, is the fact that in many cases the fluid may become contaminated with hazardous materials. Historically there have been two options for disposal;

burn it with fuel oil (if free of hazardous material), or pay to have it hauled away. In either case we suggest that disposal procedures be in strict accordance with EPA and OSHA regulations.

SYNTHETICS

Synthetic fluids are man-made fluids that are not produced by the distillation and hydrogenation of crude oil. Here we are discussing the silicone-based fluids; specifically the phenylmethy-siloxanes (702), tetramethyl trtraphenyl trisiloxane (704), and pentaphenyl trimethyl trisiloxane (705) fluids.

Durability is the biggest advantage in using silicone-based fluids. These fluids have excellent chemical resistance, oxidation resistance, and radiation resistance. These characteristics allow for longer fluid life, cleaner vacuums, and better pump down times. Another advantage in using silicone-based fluids comes in the area of ultimate vacuum pressure. One can achieve a higher ultimate vacuum pressure by using silicone fluids. This can range from 10-8 torr with 702 to 10-10 torr with 705. Safety is yet another advantage in using silicone-based fluids. The threat of fire or explosion is minimized when using silicone fluids. Moreover, since silicone fluids are inert, they do not react with metal parts, elastomeric seals, and gases like hydrogen and carbon monoxide, which are commonly found in high vacuum systems.

The largest detractor of silicone-based fluids is the price. They are expensive when compared with hydrocarbon fluids. This cost, however, can be subsidized by recycling, thus resulting in a reduction in consumption over time. The price of a silicone-based fluid is dependent upon its chemical composition. For example, the amount of phenyl in each type of fluid varies. Phenyl allows the fluid to exhibit resistance to gamma radiation. The larger the amount of phenyl, the greater the resistance, the greater the cost.

There are other synthetic fluids available as well. These are polyphenyl esthers and perfluoro polyethers. These fluids can attain ultimate vacuum pressure of 10-11 torr and higher. They are extremely resistant to oxidation, radiation, and chemicals. They are, however, very expensive.

Routine maintenance of pump fluids is an issue that cannot be stressed enough. Fluid lifetime is usually determined by the oxidizing components in the gases being pumped. These components will cause organic acids to form in the fluids, thus affecting fluid performance. We suggest that a working record of each pump should be kept and that the fluids should be changed according to the manufacturer's recommendation, or as determined by each individual schedule. If the proper fluid level is not maintained the fluid will completely vaporize, no liquid will be left in the pump, the temperature will increase rapidly, and the remaining oil vapors will be ejected. The temperature can increase to the point that the boiler plate will distort, aluminum jet parts in contact with the boiler plate can soften and melt, heaters will fail, and serious damage to the pump will occur.

The fact is, disregarding regular fluid changes in an effort to get more use out of the pump oil is not worth the potential risks. Increases in cycle times, pump repair bills, and loss of production because of a damaged pump are far more expensive than an oil change.

We invite our customers to call us if they have any questions about diffusion pump oils in general or for information about choosing the correct diffusion pump fluid.

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