

How to Maximize Supermarket Compressor Life

Proper lubrication is necessary for long service life for what is considered the most expensive single component in supermarket refrigeration

BY STEVE ESSLINGER

The compressor is probably the most expensive single component in a supermarket refrigeration system. It relies heavily on proper lubrication for maximum service life. There are significant differences in compressor lubricants used in supermarkets today with HFC refrigerants when compared to the mineral oil used in the past with CFC refrigerants.

The operating cost of the refrigeration system will increase when HFC refrigerants and polyol ester (POE) lubricants are applied. However, the cost increase can be minimized if proper measures are taken.

It's important to know that POEs used with HFCs are man-made lubricants as POE lubricant is made from carboxylic (organic) acid and alcohol. A key by-product of the chemical reactive process is water, which is then removed, leaving the final product with the desired lubricity.

Therefore, POE lubricants by their very nature are much more capable of absorbing water (hygroscopic) than mineral oil. POE can absorb 10 times more moisture than mineral oil. In addition, HFCs such as R-134a also have a greater ability to absorb water than traditional CFCs. At 32° F, R-134a will hold 25 times more water in solution than R-12.

The saturation point (free water exists) with POE lubricants is around 1,500 ppm. POE left exposed to the atmosphere will reach saturation in a matter of hours, depending on the ambient vapor pressure. Careless handling of POE for only a brief period of time during or prior to installation can result in moisture being charged into the refrigeration system.

Poor service practices such as failure to evacuate after opening the system will yield the same result. At 100 ppm or greater (according to a major compressor manufacturer) the lubricant reverses its composition because of the water absorption, reverting to the organic acid and alcohol base.

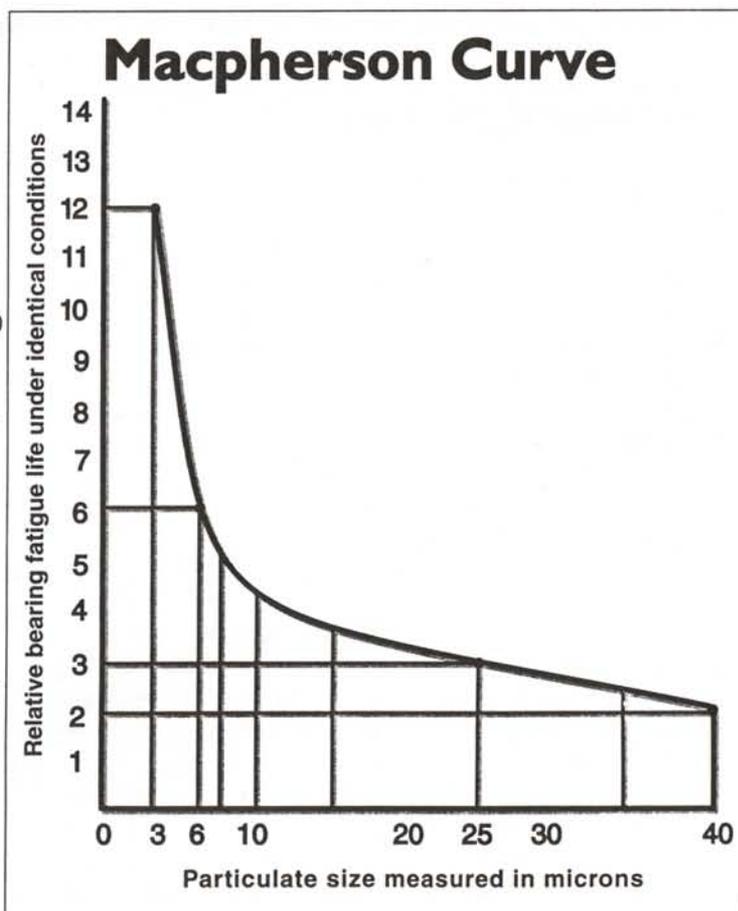
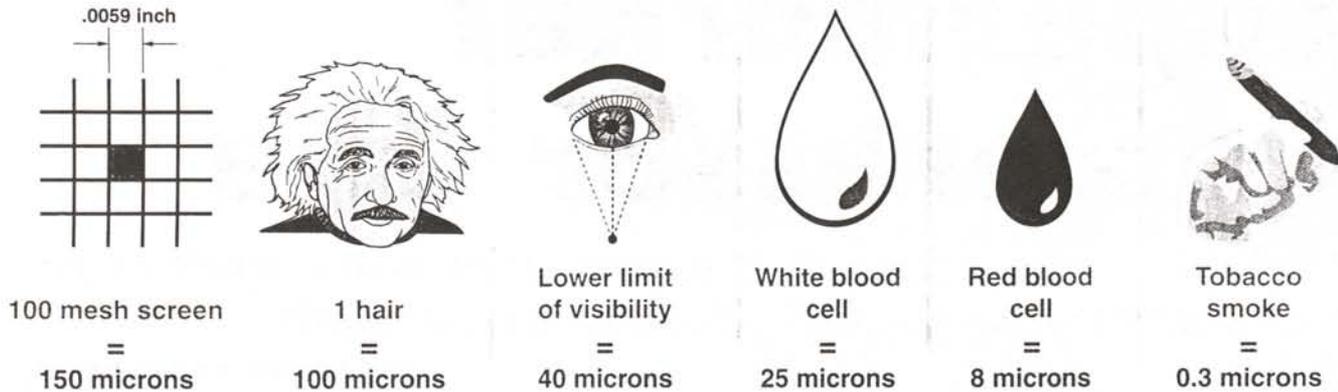


Figure 1. Compressor bearing life increases as the particulate size in oil is smaller, especially 3 microns or less.

Needless to say, acid in a refrigeration system is not desirable. Free water not checked in the refrigeration system may freeze at the thermostatic expansion valve as the liquid refrigerant/water mixture flashes to the lower pressure/temperature value. A 50 ppm moisture level and a total acid value of .03 to .15 are typical of a POE (dependent on the manufacturer) in the unopened

Reference for particle size dimensions

1 Inch = 25.4 millimeters = 25,400 microns
 1 Micron = .001 millimeters = .000039 inches



The illustration helps depict the relatively minute size of particulates measured in microns.

container as well as in a properly installed, maintained and operating refrigeration system.

If POE becomes wet

Some manufacturers are promoting the use of 100 percent molecular sieve desiccant with POE lubricant applications. Although it's logical to want the increased moisture removal capabilities of this type of desiccant for the water-saturated lubricant, other considerations are involved, including:

- The result of the excessive system moisture, in addition to the heat generated by the compressor, will cause the formation of organic acids. The molecular sieve desiccant is not effective at removing acid.

A filter-drier containing alumina (bauxite) is excellent for the removal of organic acids and the products of oil decomposition. Extensive tests by Sporlan Valve Co. and an independent laboratory indicate HFC/POE systems to be compatible with alumina. Activated carbon also should be applied if the presence of wax or varnish is suspected.

- Time is of the essence: Moisture, acids and varnishes in the system should be removed as quickly as possible. One filter manufacturer recommends desiccant in the oil line management to dry out the "wet" lubricant. This method would seem to be the quickest but an attempt to dry the oil in this location will take almost 100 times longer than a drier placed in the refrigeration system liquid line.

It's important to note that dry refrigerant acts as a plotter and will remove moisture from the oil. Therefore, dry refrigerant equals dry lubricant. The oil circulation rate of a typical supermarket refrigeration rack with semi-hermetic compressors is 1 to 3 percent of the number of pounds of refrigerant in circulation.

Consider that a typical 100-horsepower rack operating at -20 saturated suction temperature and 110 saturated condensing temperature is circulating 9,300 pounds of

refrigerant an hour through the liquid line filter drier. An oil filter/drier on the same system might see 90 pounds of oil in the same time period.

Polyol ester as cleaning solvent

POE lubricant has solvent tendencies because of its acid and alcohol base. A refrigeration system operating for years with mineral oil and no sign of contamination can become badly contaminated only hours after a POE lubricant retrofit. The oil color typically will turn black as the piping and system components are cleaned by the POE.

Analysis of POE samples taken from operating systems indicates a high concentration of two to 20 micron-sized particles, with the largest percentage particulate between two to 10 microns. Several years ago a study was done to determine the effects of differing size particulate and the impact on bearing life.

The result was the Macpherson curve (see Figure 1), which would indicate bearing life is doubled when the particulate size in oil is reduced to three microns or less. The hardness, size and concentration of the particulate in the lubricant will have an impact on the service life of the compressor.

The cost of the POE is about four to five times the cost of mineral oil. A typical rack oil charge for the compressors, separator, reservoir and piping is in the 12 to 15 gallon range. An oil change that once cost \$300 (including labor) with mineral oil will now cost in excess of \$1,000 with POE (not considering the increased disposal cost).

Because of the increased cost, most service technicians are reluctant to change the POE even when the lubricant is black from contamination. Although top quality oil filters cost more (microglass construction), they are extremely cost effective when considering the alternative (cost of an oil change).

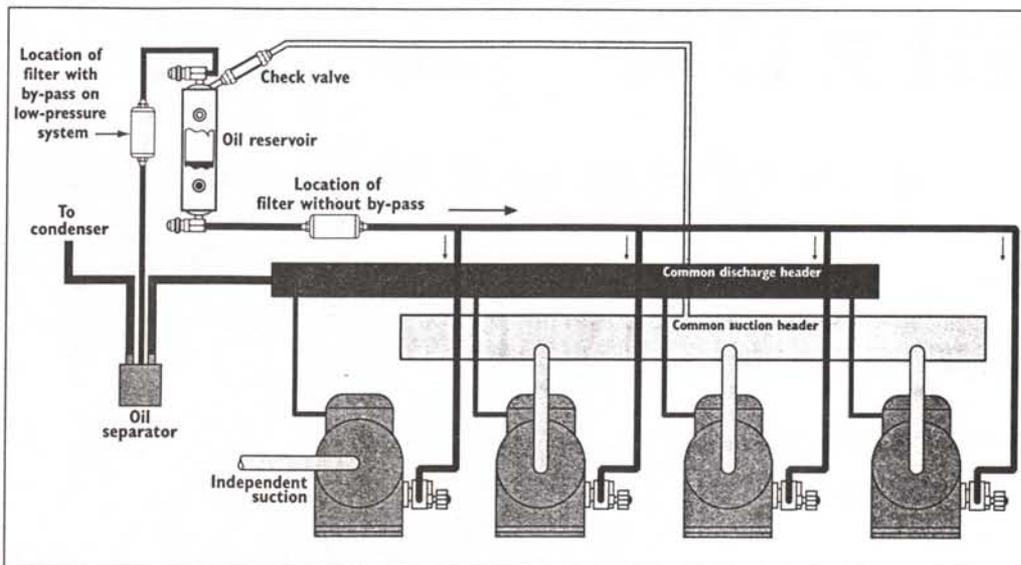


Figure 2. The oil filter should be in the oil line or oil feed line, depending on the application.

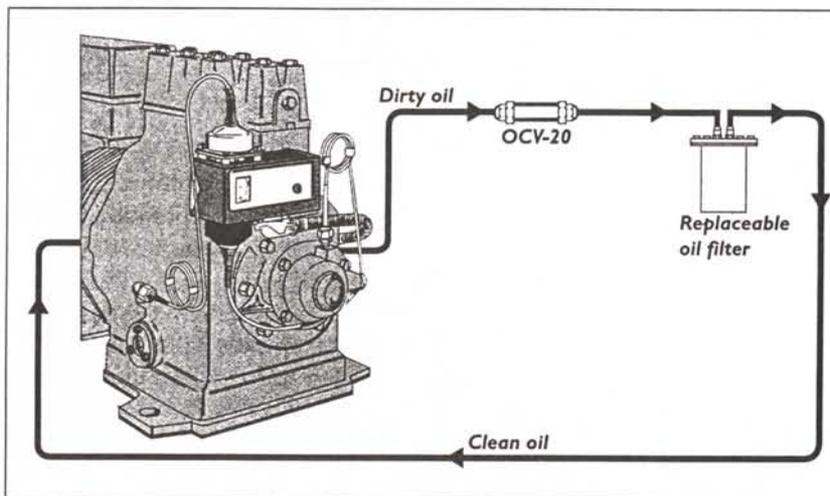


Figure 3. Oil pressure above the oil check valve (OCV) setting will pass oil to the filter for filtration.

Ensuring clean compressor oil

In order to ensure clean compressor oil, a filter specifically designed for lubricant cleaning should be used. A standard filter-drier will remove particulate in the 40-micron range, leaving the oil visually clean while remaining heavily laden with concentrations of the smaller harmful contaminants (refer to Macpherson curve). Several things should be considered when choosing a lubricant filter:

- **Filter location:** The oil filter should ideally be located in the oil line from the oil separator to the reservoir or in the oil feed line to oil level controls, depending on the application (Figure 2). The filter may be changed in a matter of minutes in these locations without shutting down the refrigeration system.

Coalescent-type oil filters (also separate the oil from refrigerant vapor) are sometimes installed in the discharge line of the supermarket system. Contaminants

that collect on the element in this location will cause a decrease in system efficiency due to a higher than normal head pressure.

Should the filter element completely plug in this location, the refrigeration system could shut down on the safety control circuit (high pressure). An oil filter change in this location requires that the entire rack and system be shut down. The service may take several hours. (Possibly less when dedicated isolation valves are applied.)

- **Filter efficiency:** The micron rating in terms of size

of particulate as well as the percent of efficiency at the stated micron size should be evaluated. Oil filters that give a low micron rating but do not state the percent of efficiency may be no more effective than a standard filter drier.

- **Determine if the application requires a bypass:** Some applications require the oil to bypass around the filter when plugged with contaminants. The alternative is to stop oil flow to the level control. Checking an oil filter for pressure drop is difficult because to achieve the maximum drop all oil level controls must feed simultaneously.

- **Check if a filter with a replaceable element is needed:** Extremely contaminated systems may require repeat oil filter changes.

A shell type filter with a replaceable element is most economical for severe duty filtration requirements. This type of filter is also used as a service tool for single compressor systems that do not have an oil management system.

An OCV-20 (oil check valve) is placed in series with the compressor oil pump, through the oil filter returning to the compressor crankcase. Oil pressure above the OCV setting will pass oil through to the filter (see illustration) for filtration (Figure 3).

Typical lubricant cleaning times for single compressors with normal oil pressure and a high quality oil filter are less than five minutes. The filter is then sealed and stored in the service truck for the next compressor oil problem. The filter element is changed when flow is restricted. ♦

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