Lubricants

When a lubricant is evaluated for use in a compressor, the following characteristics must be considered, in addition to basic considerations such as product safety and environmental impacts:

Lubricity – The ability of the lubricant to minimize friction and wear between the rotating or sliding surfaces under all operating conditions, including adverse conditions such as high load, flooded start and floodback. With regard to lubricity, the chlorine in CFCs and HCFCs significantly enhances boundary-layer lubrication in bearings used with mineral oil. Since HFCs do not contain chlorine, POE oil must be formulated to provide the necessary anti-wear capabilities without the presence of chlorine in refrigerants.

Miscibility – The ability of oil to mix with the refrigerant in all areas of the system, so that it can return to the compressor without stagnating in the connecting lines, heat exchangers or receiver. Mineral oils are not miscible with pure HFCs; thus, any mineral oil that leaves the compressor in a pure HFC system may get trapped in the connecting lines or evaporator. Since oil acts as an insulator in heat exchangers, oil trapped in the evaporator can significantly reduce system capacity and efficiency, as well as jeopardize compressor reliability.

Viscosity – A measure of the resistance of a fluid to deformation under shear stress. It is commonly perceived as "thickness," or resistance to pouring. Viscosity describes a fluid's internal resistance to flow and may be thought of as a measure of fluid friction.

Oil return and heat transfer – These characteristics of conventional hydrocarbon lubricants (mineral oil/alkyl benzene) with the HFC refrigerants continue to be investigated, due to ease of handling and lower cost.

Stability and compatibility – Stability and compatibility with commonly used refrigeration components and the refrigerant itself are important. Emerson has performed extensive sealed-tube material compatibility tests and has found that selected POE oils have acceptable compatibility with materials commonly used in refrigeration systems.

Most manufacturers of hermetic and semi-hermetic compressors have determined that POEs are the best choice of lubricants for use with the new generation of chlorine-free HFC refrigerants. In addition to providing superior lubrication with the new refrigerants, POE oil has other advantages that increase its attractiveness for use in refrigeration.

What is polyol ester?

Polyol ester (POE) oils are a family of synthetic lubricants used primarily for jet engine lubrication. There are many types and grades of POE oils, and it is important to understand that all POE oils are not the same. Areas of difference include lubricity, miscibility with refrigerant, viscosity, additive packages, pour point and moisture content. Unlike natural mineral oils, POE oil is completely wax free. In addition, POE oil has better thermal stability than refrigeration mineral oils.

POE oil is made from more expensive base stock materials than traditional refrigeration mineral oils and therefore costs more; however, some of the characteristics of POE oil help offset the higher cost. For instance, POE oil is backwards compatible with mineral oil, which means that a compressor containing POE oil can be installed in a refrigeration system that contains mineral oil. Furthermore, the POE oils we recommend are compatible with all refrigerants, so that a compressor containing POE oil can be installed in a system that contains CFCs, HCFCs or the new HFCs; thus, for the higher initial cost of POE oil, we obtain significant flexibility in the face of the changes brought on by the CFC issue.

A second positive aspect of POE oil is that it can be designed to meet lubricity requirements equivalent to those of mineral oils used with CFCs and HCFCs. Standard laboratory lubricant bench tests (Falex, pin on v-block and four-ball wear tests) and accelerated compressor-life tests are used to verify these results. Contributing to the superiority of POE oil is the fact that the viscosity of POE oil has less variation with temperature than mineral oil.

A third positive aspect of POE oil is that its miscibility with refrigerant can be matched so easily to that of mineral oil in R-12, R-502 or R-22; thus, POE oil should have similar oil-return characteristics to mineral oil with conventional chlorine-containing refrigerants.

Finally, from an environmental perspective, POE oil is highly biodegradable and should provide low eco-toxicity.

POE oil can be used with all refrigerants. Because POE oil can be used with all refrigerants and is backwards compatible with mineral oils commonly used with CFCs and HCFCs, it offers the greatest level of flexibility in dealing with the uncertainties imposed by the CFC issue. For example:

- Initially using POE oil in a new HCFC system will allow the easy transition to HFCs, without the expensive, repetitive flushing procedure needed to remove the mineral oil from the system.
- During system service, if POE oil is used to replace any mineral oil removed from a system, it begins the process to flush the system of mineral oil, so that conversion to an HFC can be performed with fewer steps later.
- POE oil can also be used with the intermediate HCFC mixtures if they are used to replace CFCs. A mixture of at least 50 percent POE oil in mineral oil provides excellent lubrication and will begin the flushing procedure if a switch to HFCs occurs in the future.

It is imperative that any system that contains POE oil be clearly marked to identify the composition of the oil and refrigerant contained in the system, to avoid cross-charging with the wrong lubricant or refrigerant.

Handling POE lubricants

POE has one negative aspect, in that it is substantially more hygroscopic than mineral oil. Consequently, exposing POE to air will result in the oil absorbing moisture more quickly than would mineral oil. The hygroscopic nature of POE oils means that moisture in the system can rise to levels that are unacceptable in refrigeration systems.

POE also holds moisture more tightly than mineral oil, so removing it with a vacuum is more difficult. Emerson's specification for maximum moisture content

Figure 11 **Hygroscopicity Comparison**