## Good, Bad or Ugly

# Lubricating Oil

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*This article is the ninth in a series exploring refrigeration and heat pump concepts without using jargon. Last month we started looking at the unsavoury side of refrigeration. This continues with a sideways look at lubricating oil.*

About seven years ago we started building chillers with centrifugal compressors that have magnetic bearings and, therefore, don't need any lubricating oil. Until then I knew, in theory, that oil is a good thing in a compressor and a bad thing in the rest of the plant, but I had never truly appreciated quite how ugly it can be.

Oil in a refrigeration system is a necessary evil; it is critical to the continued operation of the compressor, but when it gets to the low temperature part of the circuit it becomes a troublesome nuisance. It coats the inside surface of the heat exchangers, acting as a layer of insulation. It collects in pools in low spots and can cause sudden changes in operation that destabilize plant operation and can damage components.

Last year I saw a horrific video made by Garden City Community College that filmed the behavior of refrigeration oil in ammonia at low temperature. This stuff was disgusting! It had the consistency of two-part epoxy resin adhesive shortly before it hardens, and it flowed with the speed and agility of a dead possum. The mental picture I had cherished for years—of the oil in low temperature receiver vessels willingly flowing down small pipes into oil recovery pots—was shattered.

The problem with oil is that we need it to be reasonably stiff (but not too thick) in the compressor bearings, which are hot, and yet to be free-flowing and easy to recover in the low temperature part of the plant. However, the oil is an uncooperative player in the game; it gets thicker and stickier as it gets colder. It is even possible to have an oil that is too thin and runny when hot to be any good in the bearings and at the same time is too thick and sticky when cold to be any use in the evaporator. If the oil is capable of absorbing high pressure refrigerant, it might be of even less use in the bearings.


There must be better ways of choosing refrigeration oils than this.

This problem becomes even trickier if the oil is susceptible to changes in its properties over time. If it is made from long strings of carbon atoms it might become thinner as time goes by; if it gets contaminated with dirt, water or other chemicals, it can turn to sludge and become impossibly thick.

The "grade" of oil is important. This single number gives a measure of how runny the oil is at about 100°F (38°C). Typical grades are 32, 68, 100 and 220. However, since neither of the two parts of the system that are of interest, from an oily point of view, operate at this temperature, it is a kind of an unhelpful measure. The key temperature in the compressor bearings, where the oil must be thick enough to work, is likely to be about 200°F (93°C). In the evaporator, where the oil has to be thin enough to flow, the temperature might be 0°F (–17°C) or lower.

Traditional refrigeration oil was refined from crude, as a by-product of gasoline production. Refrigeration systems required highly refined, stable product usually based on cyclic carbon-based molecules. These oils get runny fast as they are heated, but get thick quick when they are cooled. They were very common in CFC and HCFC systems, but they do not dissolve in modern refrigerants.

New types of oil were developed to go with the new HFC refrigerants. They all seem to have names that are three-letter acronyms starting with P and combining any two from A, E, G and O. However, don't be fooled. They are significantly different and putting the wrong one into your system could have disastrous results.

For example, oil suitable for HFC refrigerant put into an ammonia system might turn to expanded foam: not the best way to look after the compressor. Some of the synthetic oils show much less variation in their thickness as the temperature changes, and remain relatively free-flowing even down to –50°F (–46°C). This also means they are thicker where they need to be—in the compressor.

Until magnetic bearings or other oil-free technologies are developed for more traditional compressors—screws, pistons and scrolls—the best advice you can follow with regard to lubricants is "pay close attention to the compressor manufacturer's recommendation for the refrigerant you are using and follow it *to the letter*."

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