Refrigerant Acids

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The hydrofluorocarbon (HFC) refrigerants and polyolester (POE) oils of today's refrigeration systems have different chemical structures than their predecessors—hyrdrochlorofluorocarbon (HCFC) or chlorofluorocarbon (CFC) refrigerants and mineral oil. Essentially, the refrigerants are more stable, but the oils are less stable. In the presence of air, water, or high operating temperatures, POE oil can break down into organic acids. These acids ***will not*** burn a compressor out (because the acids are not strong) but instead can result in the formation of an oil sludge, which can clog small valves and orifices, or cause the oil to lose its ability to properly lubricate the compressor. Without lubrication, the compressor will seize.

Organic (weak) acids were once considered to be the only acids that could form in HFC/POE systems; however, new research has changed that opinion. Inorganic (strong) acids can still be formed in HFC/POE systems. The problem is that real world systems contain more than just pure HFC refrigerant and pure synthetic oil. The oils have additives that generate mineral acids when exposed to air or water. For example, the 2000 ASHRAE paper by K.C. Lilje, "The Impact of Chemistry on the Use of Polyol Ester Lubricants in Refrigeration," examined the effect of phosphorus antiwear additives in HFC/POE systems and found inorganic acid formation. Therefore, although the failure mechanism in HFC/POE systems is most commonly a compressor seizure due to sludge build-up from precipitation of weak acids (and degraded lubrication), these systems can also burn out due to the presence of strong acids (etching the insulation off the motor windings).

In the old days, CFC or HCFC refrigerants broke down quickly, which resulted in compressor burnout. With today's HFC/POE systems, however, system failure can be caused by rapid compressor burnout or POE oil breaking down into precipitous sludge. The refrigerant is the component that used to break down, but now the oil is breaking down. Today, both forms of acid should warrant consideration.

QwikCheck® Acid Test Kit™ is specifically designed to detect inorganic acids that lead to burnouts. If a system contains no inorganic acid, but instead only contains organic acid, QwikCheck® will not provide a false positive inorganic acid determination. **QwikCheck is not designed to identify organic acid because low levels of organic acid are typically present in ALL POE systems and are not a problem**. These low acid levels are expected as a result of the esterification reaction used to actually make the POE lubricant (esterification is a reaction between alcohols and carboxylic acids to make esters).

With organic acids, moisture in the system is a concern. For a system that uses POE oil, moisture contamination means that conditions are favorable for the formation of additional organic acid, and the filter drier should be replaced to lower the moisture level. Moisture is a problem because it can catalyze the formation of organic acids through a hydrolysis reaction. In the presence of heat, the POE molecule can be converted into its parent compounds, which are an organic acid and an alcohol.

Diagnosing the presence of moisture in a system is easily accomplished if the system is fitted with a sight glass that contains a moisture indicating element. Because moisture is such a problem with synthetic oil systems (due to the oil's greater affinity for moisture), **these systems should always be fitted with BOTH a sight glass (with a moisture indicating element) and a properly sized filter**

drier. This allows a quick and easy check for moisture on a regular basis. A properly sized filter drier will keep a sealed system clear of moisture. If moisture seems to consistently be a problem despite the presence of a properly sized filter drier, a small low-side leak or improper evacuations are likely causing moisture levels within the system to replenish faster than the drier can remove the moisture (or the drier's capacity has been exhausted).

Unlike an inorganic acid problem, which can burn a compressor out in a matter of hours, it normally takes hundreds of hours of operation before organic acids can form sufficient quantities of sludge to cause a component failure. This should allow plenty of time to schedule a service call to correct the conditions that allow the formation of organic acid and add a fresh filter drier to the system.

Today's HFC/POE systems are different from their predecessors a generation ago and in some ways more volatile. Mainstream encourages a holistic approach toward diagnosing the presence of acids within today's refrigeration systems, which includes using QwikCheck® Acid Test™ to prevent burnout by inorganic (mineral) acid *and* diagnosing/treating any moisture conditions to avoid organic acid formation.