

Acid & Moisture

Don't Treat Today's Refrigeration/AC Systems with Yesterday's Techniques

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The New World - HFCs are stable and the synthetic oils are unstable!

- ▶ In the Old Days - HCFCs were unstable and mineral oil was stable.
- ▶ POE oil is made from an organic acid (esterification)
 - When exposed to water, some of the POE lubricant reverts back to an organic acid
 - More water causes more organic acid
 - Organic Acids form sludge and precipitates(solids)
 - Oxygen reacts with synthetic oil (POE, PVE, PAG) to increase the formation of sludge and solids
 - Organic Acids do not attack compressor motor insulation
 - Normally no burn-out
 - Lubricant thickens
 - Small passages clog (expansion devices, lubrication passages)
 - Compressor seizes

How Much Acid is Too Much Acid?

It depends on the acid and the water!

- ▶ For mineral oil/HCFC Systems the Critical Total Acid Number (TAN) is 50 PPM.⁽¹⁾
 - HCFC system with TAN of 133 – system failure in 33 hours of run time
- ▶ For synthetic oil/HFC systems, where only organic acids are present, the critical TAN is 6-times higher at 300 PPM.
- ▶ For synthetic oil/HFC systems certain wear additives combined with 2,000 PPM water to increase the TAN to 6000 PPM in about a week of operation.⁽²⁾
 - HFC system with TAN of 6000 – system failure in 40 hours of run time
- ▶ Some compounds used in manufacturing have been shown to increase the TAN 4 to 5 times and in some cases resulted in TAN above 1000!⁽³⁾

¹According to an Air Conditioning and Refrigeration Technology Institute Final Report (ARTI-21-CR/611-50060-01), published in July 2003 and based on the analysis of 700 used lubricants from operating and failed units.

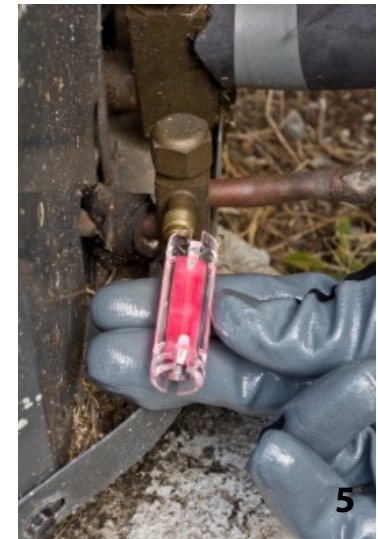
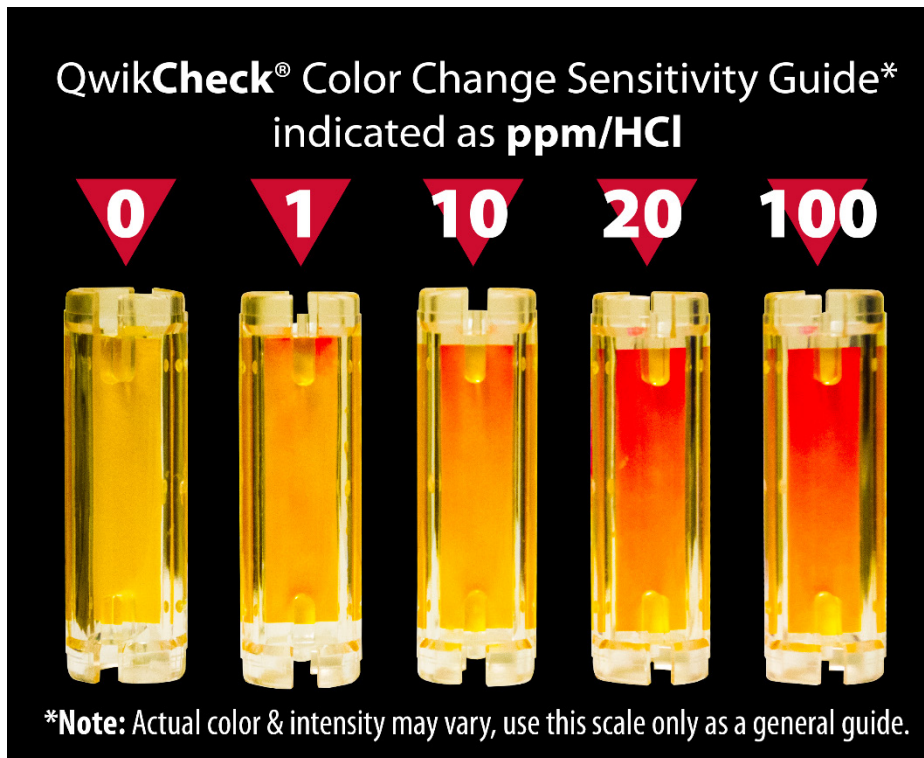
²Lilje (2000) examined the effect of various anti-wear additives on POE oils and found that POE lubricants with 2,000 PPM water increased the TAN to 6000 PPM in about a week of operation. Projected Burn Out in about 40 hours of run time.

³Cavestri and Schooley (1996) investigated the effects of 64 fluids used in the manufacture of systems.

- ▶ Tecumseh's guide for the use of R-410A states that 80 ppm water in the oil is the maximum threshold of moisture allowable in a system.
- ▶ The AHRI 700 purity standard for maximum water in new pure refrigerant R-22, R-404, R-407, or R-410A is 10 PPM.
- ▶ For synthetic oil/HFC systems certain wear additives combined with 2,000 PPM water provide a system failure in 40 hours of run time*
- ▶ 1 bottle of QwikShot removes 26 drops of water.
 - For an oil charge of 45 ounces of oil, 1 bottle of QwikShot will drop the moisture level in the oil by about 1000 PPM.
- ▶ 80 PPM is the recommended maximum after-treatment moisture level.

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- ▶ Hold QwikCheck® on the low-side service port Schrader valve of operating system for 2 seconds.
- ▶ If the Yellow indicator paper turns Red or Pink, acid is present.



Inorganic (Mineral) Acid Dissolves the Lacquer Insulation on the compressor wires and they short out.

Moisture Makes it Happen Faster



Motor burnout

HFC/POE systems “Normally” Fail From Sludge & Precipitates

- ▶ Clogged Expansion Devices and Oil Passages
- ▶ Decreased Oil Lubricity – seized compressor
- ▶ Decreased Oil Circulation (thickening of oil)

Moisture and Oxygen Accelerate Sludge & Precipitate Formation

- ▶ Synthetic oils adsorb more water
 - Mineral Oil 25 ppm water
 - POE 2,500 PPM water (100-times mineral oil)
 - PVE 6,500 PPM water (260-times mineral oil)
 - PAG 10,000 PPM water (400-times mineral oil)

- ▶ Oxygen further accelerates sludge and precipitate formation

▶ In a perfect world

HFC/POE systems can only form Organic Acids – Mild Acids – **That Means - No More Compressor Burn Outs**

- Organic Acids are milder than Inorganic (Mineral Acids)
- Typically only Inorganic (Mineral) Acids will lead to compressor burn-outs – **unless organic acid level is very high (300+ PPM)**
- Organic acids normally kill the system via precipitate formation and thickening of the lubricant
 - plugging the expansion valve
 - reducing oil mobility and lubricity

▶ **The world is not perfect – Compressors Still Burn out!!**

Additives/Impurities/Contamination can cause inorganic acid formation in HFC/POE systems

- x Poor Flushing of reused Components (Line-Sets)
- x Oil additives used to reduce wear or oxidation (Lilje, 2000)
- x Chemicals used during manufacture (compressor mold release agent)
- x Chemicals released from the materials of construction (elastomers, seals, cleaning agents)
- x Junk added by the technician to “*FIX*” the system

- ✓ Proper Flushing of Reused Components
- ✓ Proper Evacuation to at least 500 Microns (300 preferred)
- ✓ New Filter-Drier every time the refrigerant circuit is opened.
- ✓ Use a pretreatment such as QwikShot to condition the oil and refrigerant and remove residual acid and moisture.
- ✓ Only use leak sealants (including QwikSeal) and other additives as a last resort, never in new systems.
- ✓ Never use acid neutralizers.

- ▶ Need a clean conversion
 - ✗ Dilution and removal of the oil is not sufficient
- ▶ Improper Clean-out can result in an inorganic (mineral) acid burn-out
- ▶ Freon-11 is gone but there are substitutes – choose wisely
 - ✓ Residues more of a problem – its not dirt that is the issue!
 - ✓ NEVER use water flushing agents
 - ✓ Use a flush that also removes acid & water - like Qwik **System Flush®**
Always use a pre and post nitrogen flush
 - ✓ Qwik **System Flush® in the Orange Can** – see independent test results
- ▶ Think about additives before using them
 - ✗ No neutralizers
 - ✗ Avoid Leak Sealants – use ONLY as a last alternative

- ✓ Replaces Refrigerant-11 for flushing
- ✓ Flushes more moisture, oil, acid, and impurities than our competitors
- ✓ Safe for all refrigerants & oils
- ✓ Flush systems after burn-outs
- ✓ Ideal for R-22 to R-410A refrigerant conversions
- ✓ Flush systems before new component installation
- ✓ Independently tested to be the best



- ▶ Keep water out of your “Clean” oil.
- ▶ Check for inorganic mineral acids – use QwikCheck®
 - ✗ Don't test for all acid, even new POE can fail that test!
- ▶ If inorganic acid or water is found:
 - ✓ Change filter/driers – verify it is a compatible drier
 - ✓ Use QwikShot®, **NOT a Neutralizer** to get both the water and acid out of the refrigerant, oil and surfaces.
 - ✓ Determine the Source of the Acid Formation
 - ✓ Check cleanliness of coils
 - ✓ Check compressor, fan and blower operation
 - ✓ Additives/improper conversion (no flushing)?

Interesting Compressor Failure Experiments

- ▶ **133 PPM Inorganic (Mineral) Acid in a New Compressor with a Fresh High-Acid Filter-Drier**
 - ✓ Failed after 32 hours
 - ✓ Acid Level dropped to 73 PPM before failure – but still failed
 - ✓ Same test with QwikShot Acid Flush all acid removed in 20 minutes, no failure
- ▶ **120 PPM Inorganic Acid in a Compressor with a Fresh High-Acid Filter-Drier**
 - ✓ Failed after 12 hours
 - ✓ No measurable drop in Acid Level
 - ✓ Same test with QwikShot all acid removed in 2 hours, no failure

Why did the lower acid level fail sooner?

Why did QwikShot take longer to remove the acid from the system with less acid? – Same Answer for both Questions:

Lower oil circulation rates – lower acid transport into filter-drier – faster burnout.

▶ **Perform Side-By-Side tests**

- ✓ Extremely hot operation (removed thermal protection) to accelerate Failure
- ✓ New Filter Drier in both
- ✓ Same Compressor & Lubricant (rated for both R-22 & R-404A)

▶ **HFC-404A (converted from R-22)**

- ✓ No Flushing
- ✓ Failed <1hr

▶ **HFC-404A (new R-404A system)**

- ✓ Perfect Flushing “New System – no chance of R-22 carryover
- ✓ No Failure after 30 days (720 hours operation).

Why different?

- ✓ Clearly shows flushing affects life! – Just Do it!
- ✓ Always use a flushing product that removes oil, acid, moisture and impurities. – use Qwik **System Flush®**

- ▶ **Synthetic oils are unstable and form sludges and solid precipitates if acid or moisture is present.**
- ▶ **Synthetic oils capture 100 to 400 times more moisture than mineral oils**
- ▶ **Never use Acid Neutralizers**
- ▶ **Every time a refrigerant circuit is opened**
 - ✓ Evacuate to at least 500 microns before recharging
 - ✓ Install a new Filter-Drier
 - ✓ Use QwikShot® refrigerant & oil pretreatment
- ▶ **Anytime you perform a HCFC to HFC conversion**
 - ✓ Flush all components (line set) that are being reused
 - ✓ Only use a flushing agent that also removes acid, moisture and oil like Qwik **System Flush**®