NATIONAL™ news

A Newsletter from National Refrigerants, Inc.

National News
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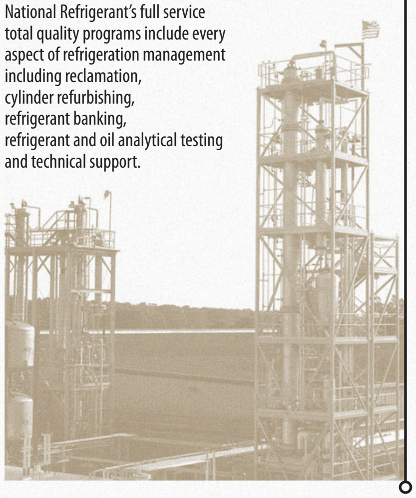
National Refrigerant's full service total quality programs include every aspect of refrigeration management including reclamation, cylinder refurbishing, refrigerant banking, refrigerant and oil analytical testing and technical support.



Feature:

Non-Condensable Gas in Refrigerant

Why it's important to prevent NCG's from entering, or removing NCG's from, your system

Non-condensable gases (NCGs), as the name implies, are not able to condense inside a refrigeration or air conditioning condenser unlike refrigerant gases. This can have a serious impact on system operating conditions, energy efficiency, and lifetime of a system. This article will explore possible sources of NCGs, the undesirable effects of NCGs on systems, and ways to prevent, test for, and remove NCGs if found.

What is a Non-Condensable Gas? How does it get into a system?

The most common NCGs you will find in our trade are air, nitrogen, argon, and maybe carbon dioxide. These gases have boiling points so low that for any practical condition you can experience in a system they will remain in the gas phase. Air enters a system from the surrounding atmosphere when a system is open. Air may also be drawn into a system through a low side leak if the suction pressure drops below 0 psig. {Air should never be pressurized into a system on purpose since the oxygen in air might create a combustible mixture at higher pressures with refrigerants that contain hydrogen (HCFCs, HFCs).} When a system needs to be pressurized, for example to perform leak checking, nitrogen or argon are commonly used. These inert gases are also purged through lines when brazing in order to reduce oxidation buildup inside tubing.

What are the effects of NCGs on the system?

Refrigerant vapor is supposed to condense in the condenser. The process of condensation requires the refrigerant to get close to the walls of the tubing, transfer its heat to the copper, which then flows out to the fins and gets lost into the air stream outside. Considering the basic heat transfer equation, $Q=U \times A \times \Delta T$, the condenser area (A) has been selected to reject the proper amount of heat (Q) based on the heat transfer coefficient of the refrigerant (U) and the difference in temperature between the air and the refrigerant (ΔT).

A non-condensable gas will remain a vapor in the condenser. It will not flow to the outlet like liquid refrigerant does, but instead it will remain trapped inside the condenser tubing. This will do two things; 1) the surface area taken up by the NCG will not be available for the refrigerant to use for heat transfer (A goes down), and 2) the air will reduce the overall heat transfer coefficient of the vapor inside the tube (U goes down). In order to get the same total heat rejected, the heat transfer equation shows that if A and U go down, then ΔT has to go up. In other words, the refrigerant temperature has to go higher compared to the air temperature, which means higher discharge pressures.

With the system operating at a higher pressure, the extra work done by the compressor will

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Ask the Expert

Please forward all questions for publication

Questions & Answers regarding refrigerants, lubricants, chemicals, or regulations.

I have been asked to retrofit a refrigeration system from R-22 to R-407A. Since R-407A is different from R-404A, could you explain how my retrofit project will be different? Will I have to change oil to POE? What about system component changes? How will the temperature glide of R-407A affect system operation?

An R-22 retrofit to R-407A will be a little easier than the project you may have done with R-404A. R-407A has properties much closer to R-22, whereas R-404A looks more like R-502. As a result, the system operation after retrofit will look very close to R-22. The cooling capacity of R-407A will be similar to R-22, which translates into similar run times for the compressor(s). (R-404A will provide a higher capacity, which will require higher amperage draw compared to R-22 but shorter run times.) Efficiency will likely improve just from doing the project. When systems are retrofitted, you will typically repair leaks, replace filter/driers, optimize refrigerant charge, reset the superheat on TXVs, and reset pressure controls. All of these operations will improve system operation and the retrofit will look like it was an energy-saving job regardless of the refrigerant used.

The expansion valves will be sized correctly for R-407A, so they will not need to be changed as is required for R-404A. Minor adjustments might be required to optimize superheat settings. If the system is equipped with electronic expansion valves, they will need additional programming data but the hardware will perform correctly without need for replacement or adjustment.

Much of the existing lubricant will need to be changed over to POE. After the R-22 has been recovered, one oil change in the compressor(s) will likely remove over 70% of the mineral oil. Any other obvious oil hold-up spots should also be drained and the same amount charged back in as POE. Make sure the system has been charged with the correct amount of POE according to manufacturer's specifications.

For R-407A, all system components will be sized correctly if they were originally sized for R-22. TXVs, distributor nozzles, capillary tubes, filter driers, pressure controls, line sizing, and compressors will all have similar operation with R-407A compared to R-22; no component replacements will be necessary.

Fractionation and temperature glide will be higher for R-407A compared to R-404A. In general, vapor refrigerant should not be removed from the cylinder. Liquid charging should be done slowly to allow the refrigerant to flash to vapor as it enters the system (particularly during final stages of charging where the compressor is running). As far as leakage is concerned, the loss of vapor refrigerant while the system is idle will promote fractionation, but losing either liquid refrigerant or any refrigerant while the system is running will not provide any significant fractionation effects.

Temperature glide will have some effect on evaporator operation, particularly when it comes to adjusting superheat settings. Since the blend will

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decrease overall energy efficiency for the system. Discharge temperatures will also go up accordingly, which can lead to increased lubricant breakdown and shorter compressor lifetime. In addition, air contains oxygen, which promotes bad chemistry in the system.

*You should **not** automatically assume that high head*

How do you know you have NCGs?

You should NOT automatically assume that high head pressure means NCGs. Other potential causes for high head pressure should be checked first:

- reduced airflow over the condenser coil
- dirty or blocked condenser coil
- hot air from the discharge side of the coil recirculated back into inlet
- too much refrigerant charge (verify by checking subcool temperature)

If these have been ruled out, it is possible to check for the presence of NCGs in the condenser: isolate refrigerant in the condenser, take the compressor offline, and run the condenser fan. When the refrigerant in the coil has come to air temperature, measure the air temperature and the pressure of the refrigerant inside the condenser. If the measured pressure matches up with the pressure indicated on a pressure/temperature chart, then there are no NCGs in the coil. If the pressure is more than a few psi higher than the chart, then NCGs are probably to blame.

How can you avoid NCGs?

After a system has been opened, or if gas has been introduced during service, the best way to remove NCGs is to pull a good vacuum. Evacuation is also needed to remove any moisture that may have entered the system while it was open. Be sure to purge air from charging hoses before opening system valves.

To remove NCGs from refrigerant in:

Smaller systems—recover the entire charge and recharge with fresh refrigerant. It is hard to get to the vapor space in the condenser without tapping a line.

Larger systems—use the nearest access valve to the vapor inlet to the condenser. Recover vapor from the system for a long enough period to make sure that most of the vapor has been removed from the condenser. This will be a judgment call based on the size of the condenser, the amount of tubing between the condenser and the access point, and the vapor recovery rate of the recovery machine.

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enter the evaporator at a cooler temperature and leave at a warmer temperature, compared to R-22, then the superheat setting will rely on proper reference to the vapor column of the PT chart. The opposite process happens in the condenser, so the liquid side of the PT chart should be consulted when measuring a subcooling temperature. Beyond these considerations, temperature glide will not affect the overall operation of the refrigeration equipment. The average temperature of the evaporator or condenser will adjust so that the proper operating conditions for the system are achieved.

Finally, as with any retrofit job, new seals and o-rings should be installed wherever they are accessible. Even though they may be made of the same material, new seals will ensure that leaks are kept to a minimum because the old seals may be compressed or otherwise unseated from their original placement. In general you will find that a retrofit from R-22 to R-407A will be easier and perform better than an R-404A retrofit.

For more information, refer to NRI's "R-22 Retrofit Guidelines and Procedures" handbook.

pressure means NCGs.

A recovery cylinder—given the density of refrigerant vapor and typical recovery rates of small recovery machines, it should take about 2 minutes to pull the air-filled vapor from a half full 50 lb recovery cylinder. Adjust time for cylinder size and fill level. The process should be repeated 3 or 4 times, shaking the cylinder around after each withdrawal. This will reduce the air by at least one order of magnitude (10% down to 1%). *Note, along with the removed air, there may be 3 or 4 pounds of vapor refrigerant also transferred to the new cylinder.* ■

Why Test Refrigerant and Oil Samples?

Why should you regularly test a sample of refrigerant or oil from a system? What benefits do I get from testing?

If you own a system, or have a fixed price service contract to maintain a system, then you are concerned with the overall cost to operate the system. If the system breaks down, it will cost money to repair it and bring it back into service. Finding out a system is not in good health before it fails can potentially reduce the amount of money needed to keep a system running. If the system is not running as well as it can, then more money is spent on power to operate the system than needed. Finding these problems early can save a lot of money on the bottom line.

Refrigerant testing can help diagnose several critical potential failures. The first is compressor burnouts due to moisture contamination. Testing the refrigerant is the best way to look for moisture because the sample is contained in a sealed metal container at all times. Early detection of excess moisture can allow repairs to the system prior to the moisture attacking the refrigerant and motor insulation materials. Fixing the leak that allowed moisture into the system may also save a lot of refrigerant from leaking out of the system as well.

If the system has a mechanical wear problem, often the refrigerant is overheated at the hot spot where the wear problem occurred. The heat generated can cause the refrigerant to break down so the lab analysis looks for these refrigerant decomposition products. This may also be a sign the system is very acidic as well. One other sign is lubricant decomposition products such as methane, ethane and other light hydrocarbons formed when mineral oil is overheated. Early detection of wear problems may allow correction of the issue before it causes an expensive compressor repair and associated system cleanup.

Oil testing can also detect potential system problems. Incorrect oil type and viscosity may cause poor system performance or possible compressor failure. Depletion of oil additives may leave the compressor prone to wear problems. The presence of larger visible particles may be a sign the compressor is experiencing abnormal wear, or there is severe corrosion inside the system.

Metals analysis of the oil looks for the presence of bearing metals, corrosion metals, lubricant additives and system contaminants. Early detection of wear metals may allow correcting the operating conditions of the system before the compressor fails and requires a new compressor. Early detection of corrosion allows correction of the problem before extensive damage occurs. Detecting the presence of contaminants allows the system to be cleaned up prior to the contaminants causing excessive damage.

Oil testing is the best method of detecting acidity in the system due to the use of plastic sample containers. Metal walled containers absorb acidity present in the sample on the way back to the testing lab. Unfortunately, oil testing is not the best way to test for moisture since the refrigerant needs to be vented from the sample prior to shipping which exposes the sample to moist air. It is not uncommon for a refrigerant sample and an oil sample from the same system to have different moisture test results.

In summary, regular testing of refrigerant and oil from systems can save the system owner and the service contractor money. Early detection of potential problems allows the correction of the condition that may lead to an eventual expensive repair. The combination of laboratory testing and the eyes, ears and hands on feel of the system is a powerful tool to prevent spending unnecessary time and money. The information resulting from laboratory testing may also allow prioritization of repair work to the systems that are more likely to fail or that may generate the most expensive repair costs. The peace of mind in knowing a critical system is in good operating health may also have benefits for many system owners. ■

EPA Proposes Changes to Leak Repair Requirements

EPA has proposed a rule to lower the leak repair trigger rates for comfort cooling, commercial refrigeration, and industrial process refrigeration and air-conditioning equipment (i.e. appliances) with ozone-depleting refrigerant charges.

Owners or operators of comfort cooling appliances with a full charge greater than 50 lbs. of refrigerant must have all leaks within the appliance repaired within 30 days, if the leak rate exceeds 10%. Owners or operators of commercial refrigeration or industrial process refrigeration appliances with a full charge greater than 50 lbs. of refrigerant must have all leaks within the appliance repaired within 30 days, if the leak rate exceeds 20% of the full charge. The leak rate must be calculated immediately upon each addition of refrigerant.

Many of the provisions of proposed rule are meant to clarify existing requirements and do not impose new requirements. EPA has proposed to amend the existing required practices and recordkeeping requirements as follows:

- Lower leak rates
- Require written verification of all repair attempts for comfort cooling and commercial appliances, and not just industrial process refrigeration equipment (as currently required)
- Exempt addition of refrigerant due to "seasonal variances" from the existing leak repair requirements
- Allow all appliance owners/operators additional time to complete repairs due to unavailability of components
- Require service technicians to maintain records of the fate of refrigerant that is recovered from but not returned to appliances during service
- Decrease the amount of time allowed for the completion of currently required retrofit/retirement plans

For more information, please visit EPA's web site**: www.epa.gov/ozone/strathome.html**

National is pleased to become a member of the **GreenChill Advanced Refrigeration Partnership**. GreenChill is an EPA Partnership with food retailers, manufacturers of advanced refrigeration systems and manufacturers of non-ozone depleting refrigerants and secondary fluids whose goal is to reduce refrigerant emissions and decrease their impact on the ozone layer and climate change.

The GreenChill Partnership works to help food retailers:

- Transition to environmentally friendlier refrigerants;
- Lower refrigerant charge sizes and eliminate leaks; and
- Adopt green refrigeration technologies, strategies, and practices.

As a GreenChill Partner, National has made a commitment to promote the adoption of retrofit chemicals and secondary fluids. National has been supplying non-ozone depleting refrigerants and secondary fluids to the supermarket industry for nearly 2 decades. In addition, National's vast resource of refrigerant specialists, chemists, chemical engineers, and regulatory experts combined with technical guides for retrofitting refrigeration systems provide additional expertise to the GreenChill Partnership. ■

For more information, please go to **www.epa.gov/greenchill**

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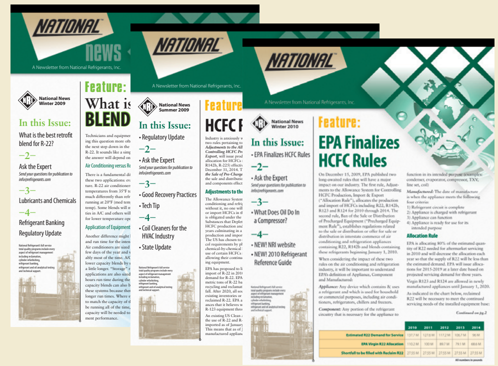

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