Ammonia has been used in the refrigeration process for more than 100 years. Find out more about how this efficient refrigerant can be utilized—safely—in today's systems.

BY AL SMITH, CMS

When it comes to ammonia (and working in and around ammonia-using systems), experienced technicians are certain to agree on one thing: ammonia stinks. It is self-alarming. And its distinct, pungent smell offers a sort of built-in leak detection. If a technician enters a mechanical room and that scent is present, a big leak is happening somewhere—and they need to get out and get properly equipped to find it.

Ammonia (which has a chemical designation of NH$_3$; and a refrigerant designation of R-717) is generally used in large-capacity refrigeration equipment where safety, compressor durability and economic operation all are important. The majority of ammonia systems are found in the food-refrigeration industries at holding temperatures above 30°F; and frozen storage and blast freezing to -50°F—though other applications include the pharmaceutical industry for freeze-drying and process cooling; ice-arena freezing; gas processing; and refineries and chemical plants. [Editor's Note: Visit www.rsesjournal.com and check out the November 2009 RSES Journal Web Exclusive, which discusses how a Canadian ice rink is maximizing the efficiency of its ammonia-refrigeration system.]

Since most plants utilizing ammonia refrigeration are large operations, they typically require quantities of R-717 ranging from 3,000 lb.–500,000 lb. Ammonia-refrigeration systems also utilize evaporative condensing, which provides a lower system condensing pressure and temperature versus air-cooled or water-cooled condensers.

UNDERSTANDING AMMONIA AND LEAKS

Anhydrous ammonia is by far the oldest commercial refrigerant, and certainly one of the most efficient. The word anhydrous is Greek and literally means “without water.” Since ammonia lacks water, it constantly tries to obtain it, and will migrate to the closest source. This is something that HVACR professionals must keep in mind, as those sources can include the eyes, nose, armpits, etc.
Leak-detection in anhydrous-ammonia refrigeration systems is very simple. The refrigerant supplier should have books of litmus paper. The technician should tear off a strip of litmus paper and wet it with their tongue. Passing the wet litmus paper over a suspected leak will cause the paper to change color.

One safety tip that technicians should perform for their customers is moving the gas mask—which should be in the building—to a point right next to an outside door, so it can be reached without going in the building. Technicians also should take a look at the canister and check to see if the seal is broken. If it is broken or appears tampered with, do not use it and advise the customer immediately.

If a service technician is in a situation where they must enter a room with an ammonia leak, it is critical that they follow all OSHA guidelines for entering a confined space, as well as OSHA and EPA guidelines for facility safety. [Editor’s Note: These guidelines include 29 CFR part 1910.119; and 40 CFR part 68.]

Any individual entering a potentially contaminated space should have an assistant with them at all times. This person’s job is to call 911 if the person entering the space runs into trouble. It is not the assistant’s job to attempt to rescue the person working around a leak.

Once the problem has been isolated and the leaking component(s) has (have) been replaced, the best way to dilute the smell is to get a hose and wet down the floor. Utilizing a fine spray in the air also can help mitigate the odor.

**TIPS FORTECHS**
The corrosive nature of ammonia—which necessitates the need for steel to be used on all fittings, piping, etc.—can pose a problem for technicians that might attempt to use a “just-as-good” part off their service truck. No brass/copper pipe or fittings should be used in an ammonia-refrigeration system.

Another of the most misunderstood service problems is that ammonia is not miscible (will not mix) with oil. Any oil that gets downstream of the system’s compressors will end up in the lowest place with the lowest velocity. A well-designed system will have drain valves at these locations. It is very important to
drain these traps on a set schedule. The service technician also should keep a log book of drain times and drain volume to use for comparison purposes. Once, I once was installing a new 300-hp compressor in a plant that was dealing with a lot of problems. I proceeded to drain the oil traps and collected more than 150 gal of oil. After I was done, the operator said that, to his memory, the system had never worked that well. If this recovered oil is heated to drive out the moisture and is run through a filtering system, it can be used again. As an example, I was in a plant that had more than 1,000-hp of connected compressors and only used a 55-gal drum of oil every two years. All of the oil they used came through the shaft packing on the compressors.

With ammonia-refrigeration systems, a very common service problem is expansion valves overfeeding and flooding the evaporators. If confronted with this problem, pump down the system and isolate the problem valve. When the valve is opened, use a very powerful magnifying glass and look at the valve seat and the needle. The technician most likely will find the seat has very fine grooves in it. The valve is passing liquid into the system even though the valve is closed down, a condition called “wire drawn.” Adjusting the superheat on the valve will do absolutely nothing—except perhaps get the aforementioned technician replaced because they did not arrive at the correct diagnosis and made an unneeded adjustment.

Always remember that, anytime troubleshooting or maintenance is being performed on a system, the system did work. Along this line is the use of extra liquid-line screens in an ammonia refrigeration system. A well-designed plant will have screens upstream of all automatic valves to protect the system. The problem, however, is that steel pipe rusts and gets dirty on the inside before installation and very few installation contractors “gun barrel” the pipe. This dirt gets into the valves and wrecks havoc. Any time the service technician isolates a strainer, they should open it up and clean it. Once on a job in the Middle East, I removed nearly half a barrel of sand from the suction lines.

Another problem that comes up more often than one would think is a liquid line that is designed on the edge of the chart, and then that liquid line is run through a high-temperature room. A ½-in. iron pipe is rated to carry about 28 tons of refrigeration under stated conditions of temperature and the equivalent length of run. But remember that whenever working with a system, stated conditions versus actual conditions may not be one and the same. As an example, a project in Greece had a very large ice-cream freezer rated at 25 tons of refrigeration that was giving the owner a lot of trouble. The ice-cream freezer manufacturer hired me to go look at the situation. The only problem was that the liquid line was too long and too hot. After some discussion with the owner and the contractor, it was decided to increase the line size to 1 in. to allow for future expansion. Everyone was amazed how much better the freezer worked.
In short, as with all refrigerants, technicians should put safety first when working with ammonia-refrigeration systems. Remember to remain vigilant and well-versed on all OSHA rules regarding confined-space entry, as well as lockout/tagout procedures and other regulations that may be required for work to be performed.

The usual problems associated with an ammonia refrigeration system are no different than a large R-22 system. A burnt-out solenoid coil is the same in either kind of a system. However, a solenoid coil should last 40 or 50 years. If the system is not that old, the service tech needs to find out what caused the failure. This is where valuable training from organizations such as RSES comes into play. Only two things can burn out a coil: the first is wrong voltage (which could occur via a lightning strike); the second is powering the coil without an armature to move it. Do not ever think you can test a coil by powering it and putting a screwdriver down the center of the coil. It may not burn out right away, but it will surely shorten its life.

Keep in mind too, that according to the pocket guide to chemical hazards published by the U.S. Dept. of Health and Human Services' National Institute of Occupational Health, “Although NH₃ does not meet the DOT definition of a flammable gas [for labeling purposes], it should be treated as one.” This is because while the combustion of ammonia in air is very difficult without a catalyst—the temperature of the flame is generally lower than the ignition temperature of the ammonia-air mixture, and the flammable range of ammonia in air is 16%–25%—ammonia is flammable under certain conditions.

In short, as with all refrigerants, technicians should put safety first when working with ammonia-refrigeration systems. Remember to remain vigilant and well-versed on all OSHA rules regarding confined-space entry, as well as lockout/tagout procedures and other regulations that may be required for work to be performed. Follow procedures, keeping in mind that oil and ammonia do not mix; be sure to drain oil from any traps in the system; and keep in mind that screens are put in a system to remove junk—the technician’s job is to remove the junk from the screen. Following these rules, and staying current on training and new technologies, will ensure that today’s technician will continue to be able to tell others why ammonia stinks. 

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