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The Big Easy

BY ANDY PEARSON, PH.D., C.ENG., FELLOW ASHRAE

If it were invented today it would surely be prohibited! It is flammable. It is highly toxic. It is ethyl alcohol. The United States tried prohibition 100 years ago when the 18th amendment was ratified on Jan. 16, 1919. While it had undoubted short-term medical benefits (reduced liver disease, reduced poverty, reduced violent crime), these were soon reversed by the illicit trade in alcohol and within 15 years the 18th amendment had been repealed by the 21st, ratified on Dec. 5, 1933.

There are some parallels between alcohol and ammonia. They are flammable, they are toxic and yet people seem to really like them—sometimes to the point of apparent addiction. Despite an old-fashioned image that harks back to a bygone era, ammonia is still an extremely popular and effective refrigerant. For anyone slightly familiar with ammonia this is really puzzling—why would you choose to work with something that seems to be so unpleasant? Modern legislative requirements have made this puzzle even more obscure; why would anyone put themselves through the pain of an OSHA audit or expose their business to the risk of adverse public press in the event of an incident? The answer is "because it's worth it."

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The fact is that, as a refrigerant, ammonia is very easy to work with. Several independent properties combine to make this so. It takes a lot of heat to boil it—in this respect it is almost as unusual as water, which clouds our thinking about heat content because it is so extreme. To boil a pound of ammonia under typical refrigeration conditions takes almost eight times more heat than to boil a typical HFC. This makes it a big carrier of heat; it's like filling a swimming pool from a well. Would you rather use a child's play pail or a proper 10-gallon bucket? Water and ammonia are similar in this respect because they are both polar molecules, so the forces holding them together are stronger that in non-polar molecules like R-134a or carbon dioxide, and so more energy is required to turn liquid into gas.

The high heat content required to boil liquid ammonia also means that it takes a long time to evaporate if there is a large liquid spill. This may seem like a disadvantage but it makes the management of an accidental release much easier than if it were more volatile. My old friend Anders Lindborg once observed that there is a reason why fire chiefs choose to practice their emergency response drills with ammonia but, despite its widespread availability, terrorists don't favor it. It's because it is easy to get it back under control (provided, of course, that you know what you are doing).

Another way in which ammonia is easy stems from its solubility in water. Aqua-ammonia is sometimes used as a secondary refrigerant as it has a higher specific heat capacity and lower viscosity at low temperature than any other common brine or glycol. Inside the refrigeration system this affinity for water makes ammonia easy. If there is a small amount of water in the ammonia, the effect will be almost imperceptible but the same amount in an HFC plant will spell disaster as it will freeze at the expansion valve and cause erratic and unreliable behavior. This is why HFC plants need well-maintained filter driers in the liquid line and ammonia plants don't. It's also why it is highly undesirable for the suction pressure of an HFC plant to drop below atmospheric pressure but this really doesn't matter in an ammonia plant.

Ammonia: it really is the big easy. ■

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