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WHAT'S NEW:

Feature Story:
Carbon Dioxide: *The Next Step For Industrial Refrigeration*

Gartner Refrigeration has been in the industrial refrigeration business since 1945. Over the years, we have seen many refrigerant trends come and go. Freon refrigerants had their heyday, and are now virtually phased out. Rotary vane and reciprocating compressors have been replaced by screw compressors. Electromechanical controls have been replaced by PLCs and computers. Through all this change, ammonia has been one thing which has lasted. It has the virtues of being environmentally friendly, highly efficient over a wide range of temperatures, and inexpensive to manufacture. However, anyone who has gotten a whiff of ammonia knows that in high concentrations it can pose a serious health risk. It has a distinct, noxious odor that can permanently damage food products, and can ignite if in sufficiently high concentrations. Those are the reasons that for the past 60 years, we have worked hard to minimize the risks of ammonia, to assure our customers and the public that a Gartner designed and installed system adheres to the highest standards of the industry.

Although we still feel strongly about the benefits of ammonia, we also recognize that the risks of large ammonia systems are becoming a real concern for both our customers and the public. OSHA and EPA regulations for large ammonia systems are becoming more stringent, and costlier to stay in conformance with. Insurance carriers, stung by recent losses, are looking hard at alternatives for large ammonia charge systems. In Europe, plants are being designed to minimize the charge of ammonia, and alternative refrigerants are being used simply because of the safety and health implications of a large ammonia release. As we look into the future, refrigeration plants with large charges of ammonia in the United States may come under increased regulatory and insurance scrutiny, and hence become less attractive from a bottom line cost to operate standpoint.

Finding an Ammonia Alternative?

Ammonia has been a friend to the food and beverage industry, and we feel strongly that it will continue to serve the industry well into the next century. The problem is not so much the ammonia itself, as it is the vast quantities of ammonia that are required to feed multiple evaporators in large plants. Small charges of ammonia are reasonably safe and easy to stay in regulatory conformance with, large charges are a whole different matter. So, if safety and large quantities of ammonia are a concern, as we believe them to be, what would be the alternative?

As we look for alternatives, it is reasonable to ask what would be the ideal refrigerant. First, it would be a natural refrigerant: a chemical which is commonly found in nature. Secondly – it would be regulation proof; a chemical which is so benign as to not attract the attention of lawmakers and environmentalists. Third – it must be energy efficient. In order to be a viable alternative to ammonia, the refrigerant should be at least on a par with other refrigerants from an energy consumption standpoint.

This may seem to be an impossible set of criteria. The only natural refrigerants are water, air, oxygen, nitrogen, short chain hydrocarbons (ethane, butane, propane, etc) ammonia, and carbon dioxide. Water can't be used at low temperatures, and the hydrocarbons have a well known flammability issue. Oxygen, air, and nitrogen are not very efficient for temperatures in the range of modern refrigeration systems. That leaves us with carbon dioxide (CO_2). It is in fact the only non-toxic, non-flammable, non-ozone depleting, non-global warming refrigerant suitable for use in a traditional refrigeration system. CO_2 is safe, proven, and efficient for temperatures down to -50°F. We believe that CO_2 is the future of industrial refrigeration in the United States.

Finding an Ammonia Partnership

Actually, ammonia and carbon dioxide work well together. Carbon dioxide has some limitations – the greatest of which is that it has a very high saturation pressure at ambient temperatures. The table below shows some of the differences between ammonia (R 717) and CO_2 (R-744). All pressure in pounds absolute (psia).

Temperature	CO_2 (R 744) Pressure	Ammonia (R 717) Pressure
-50°F	118	7.66
-20°F	215	18.2
0°F	306	30
20°F	422	48
40°F	567	73
60°F	747	107
80°F	969	152
100°F	(Beyond critical point)	211

Source: ASHRAE Thermodynamic Properties of Refrigerants, 1986.

Most condensing is done from 90°F-100°F. CO_2, by virtue of its high pressure and low critical point, cannot be used on the "high" side of the system. However, it is an excellent choice on the "low" side of the system. That is where the partnership between ammonia and carbon dioxide comes in. In a CO_2 ammonia cascade system, each refrigerant is used where it has its best characteristics. CO_2 is used on the low temperature side of the system, serving the freezers, coolers, and refrigerated docks, and ammonia is used on the high side of the system, confined to the engine room and evaporative condensers. This keeps the charge of ammonia in the plant low, typically well below the 10,000 lb OSHA limit. It also keeps the ammonia well away from people and products, which is music to the safety department and insurance company's ears.

The United States has started to follow the lead from Europe and both storage and production facilities have been built with CO_2/ammonia cascade systems. If you are considering a new facility, or a major expansion to an existing facility, you should carefully consider the choice of refrigerants. We believe that when you consider the total cost of a facility, the CO_2/ammonia cascade system will show great benefits.

We know there are many questions you might have about CO_2 and ammonia. Please look over our FAQs section, then, give Gartner a call. We have seen a lot of changes in the past 60 years, and we look forward to the changes we will all see in the next 60 years.

Frequently Asked Questions

Doesn't CO_2 contribute to global warming?

CO_2 in the upper atmosphere does contribute to global warming. CO_2 emissions are the subject of the Kyoto Treaty, and there is a general consensus among scientists that CO_2 emissions contribute to global warming.

However, when CO_2 is used in a closed refrigeration system it does not contribute to global warming.

What if there is a release of CO_2? Will I be subject to EPA fines?

Since CO_2 is not classified as a highly hazardous substance, there is no reporting requirement under the EPCRA. Further, there is no reporting requirement on inventory because of the non hazardous classification.

What if I lose power for an extended period of time?

If there is no source of backup power, the pressure in the CO_2 portion of the system will build, and the automatic relief system would relieve the pressure to keep the system below its design pressure. If there is a backup power system, it can be used to run a small compressor until power comes back on. Brief power interruptions are not a problem.

Can you still hot gas defrost with CO_2?

Hot gas defrost is one of the big advantages of industrial refrigeration systems. However, conventional compressor driven hot gas defrost systems are difficult and expensive with CO_2, because of the high pressures. We use an alternative system developed and patented by our partner, Star Refrigeration, to provide a safe and efficient source of CO_2 hot gas for defrosting – a Gartner exclusive in the US.

Are there patents that would prevent me from using CO_2 in a cascade system?

There are some patents in the US that cover certain CO_2 ammonia cascade system applications. We partner with some of the patent holders. Many of these patents are limited in their scope, thus most applications will not have a problem with the patents. At Gartner we are familiar with the patents and their scope.

CO_2 is odorless. How will I know if I have a leak?

Just as most ammonia systems utilize ammonia detectors, we install the systems with CO_2 detectors in the engine room and refrigerated areas. Since there is CO_2 in the atmosphere normally, the detectors would be set to a level where there is an abnormally high amount of CO_2 present.

Would my plant be subject to OSHA Process Safety Management (PSM)?

OSHA PSM regulation is officially called “Process safety management of highly hazardous chemicals. – 29 CFR 1910.119”. CO_2 is not classified as a highly hazardous chemical. Ammonia is classified as highly hazardous. Thus the ammonia part of the system could be subject to PSM regulations. However, with proper design, most ammonia high side systems can be designed to have less than 10,000 lbs of ammonia as the charge, which is the current threshold limit for PSM. Therefore, under the current standard, most ammonia CO_2 cascade systems would not be subject to PSM.

Can I convert my existing ammonia system over to CO_2 cascade?

Because CO_2 works at much higher pressures than ammonia, most evaporators would not be suitable for use with CO_2. However, ammonia high side compressors and condensers would be able to be re used in a retrofit.