WHITE PAPERS

INNOVATIONS IN INDUSTRIAL REFRIGERATION

stellar

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Food processors are facing new challenges with their industrial refrigeration systems as regulatory requirements are calling for the reduction or elimination of dangerous components. Ozone-depleting R-22 refrigerants are being phased out requiring facilities to find a more environmentally friendly alternative. Plants are also looking for ways to maintain regulatory compliance and increase safety by reducing their system's ammonia charge. In this white paper, we discuss these topics and answer the many questions surrounding relief valves and compliance requirements.

THE R-22 USED TO COOL YOUR PLANT IS BEING PHASED OUT. NOW WHAT?

Numerous substances used in industrial refrigeration are believed to be responsible for ozone depletion, especially a common low-temperature refrigerant – R-22. While R-22 is widely used in numerous food plants and cold storage facilities, an international treaty, the Montreal Protocol on Substances that Deplete the Ozone Layer calls for a halt in the production of R-22 and other chemicals damaging to the atmosphere.

This significant change in how food manufacturers and distributors conduct their day-to-day operations is leaving many questions unanswered. For those bracing themselves and wondering what's next, here's what you need to know:

WHAT'S THE TIMELINE AND HOW LONG WILL I BE ABLE TO PURCHASE R-22?

The Montreal Protocol calls for a gradual phase-out of R-22, with complete elimination by 2030.
Production of new R-22 equipment ceased in 2010, and with a lifespan of approximately 15 years, most of these units are one third of their way through their useful live. The phase out of the manufacturer of R-22 refrigerant has already begun. The EPA plans to end all production and import of R-22 by 2020. Recycled R-22 will be available for use in R-22 units, but as the available supply of R-22 decreases, costs will inevitably rise.

CAN I UPGRADE OR RETROFIT MY EXISTING R-22 SYSTEM?

Food processing plants should be planning for new refrigeration systems rather than investing in existing R-22 units. As these pre-2010 units continue to age and R-22 refrigerant becomes scarcer, costs to maintain these systems will increase, both for maintenance and for the refrigerant. While switching out the refrigerant of an R-22 unit to an alternative blend is an option, it's not necessarily feasible for all plants. Changing out the refrigerant requires shutting down the system, changing out seals and other components and flushing it numerous times, which can require significant downtime. This may be a short-term option for smaller systems, but for bigger systems it becomes too costly and time consuming.

WHAT DO I NEED TO KNOW ABOUT INVESTING IN A NEW REFRIGERATION SYSTEM?

The decision for an industrial processing plant to invest in a refrigeration system requires a detailed, thoughtful plan. The costs for the actual system will vary depending on your facility's process requirements, yet it is equally important to develop a phased approach that incorporates a plan for downtime during the transition.

WHAT ARE THE ALTERNATIVES TO R22?

There are a number of environmentally friendly refrigerants available. Ammonia and CO2 are natural refrigerants, which have zero ozone depletion and zero global warming potential (GWP). Ammonia continues to be a popular alternative, followed by CO2 and blends, which include R404A, R407C, R410a, and R507, among others. The alternative blends have a relatively high GWP, which potentially puts them at risk for phase out at some future date.

IS THERE A DIFFERENCE IN EFFICIENCY OF NEW REFRIGERANTS?

These new units are often more compact, with fewer and smaller pipes, thus requiring a reduced volume of gas. Their increased efficiency can result in less energy consumption and lower energy costs.

TWO APPROACHES, ONE GOAL: REDUCING YOUR AMMONIA CHARGE

Efficiency and low cost are the major reasons ammonia is the preferred industrial refrigerant in the food processing industry. Ammonia is often a natural refrigerant and has no ODP/GWP. However, ammonia is a dangerous substance and there are several advantages to lowering the overall amount of ammonia used at a facility.

To avoid these risks and increase safety, many plant owners are looking at ways to reduce their ammonia charge. Two of the most common approaches include:

1. LIMITING AMMONIA CHARGE THROUGH A CASCADE SYSTEM

Most refrigeration systems use only one refrigerant in the system. In a cascade system, two refrigerants are used with a heat exchanger in the middle. This allows the engineer to take advantage of the best characteristics of each. At lower temperatures, generally between –31°F and –60°F, a NH3/CO2 cascade system becomes more efficient than a two-stage ammonia system. As with any cascade system, the charge of each refrigerant will be reduced. There is also the option to design this process so that ammonia is confined to the machine room to increase safety throughout the rest of the plant.

2. LIMITING AMMONIA CHARGE THROUGH USE OF A SECONDARY REFRIGERANT

Typically, ammonia is piped from the machine room out to the facility to all points of use. By incorporating a secondary refrigerant, ammonia is limited to the machine room and the secondary refrigerant is piped to the points of use. This reduces the total quantity of ammonia required for a system. It also limits ammonia to the confines of the machine room where there are measures to deal with an accident. Compared to a conventional system, it greatly reduces the probability that a facility worker would be exposed to an ammonia leak inside the facility or on the roof.

A glycol/brine solution is often used as a secondary refrigerant for temperatures above 0°F. When temperatures fall below that level, special heat transfer fluids are required. While most secondary refrigerants only transfer sensible heat, CO_2 can be used as a volatile brine. This allows much higher heat transfer, dramatically reducing pipe size and pumping horsepower. Because a heat exchanger is required to go from the ammonia to the secondary refrigerant, there is decreased efficiency. In addition, the pumping horsepower associated with a secondary refrigerant will be higher than directly distributing ammonia.

RELIEF VALVE COMPLIANCE ISSUES FOR OLDER SYSTEMS

Whether companies are maintaining outdated systems or upgrading to newer ones, they need to be aware of the safety issues and requirements related to the systems' relief components.

The American National Standards Institute (ANSI) approved ANSI/ASHRAE Addendum C as a formal revision to ANSI/ASHRAE Standard 15 in 2000. This revision was a major change and created questions that still linger about the compliance of older systems, especially where renovations are concerned.

Many food processors will outsource compliance efforts through a Process Safety Management/Process Hazard Analysis consultant. The best approach for manufacturers to see where they stand is to conduct a relief valve calculation study.

RELIEF VALVE CALCULATION STUDIES

Relief valve calculation studies are a very common service and offer an in-depth analysis of the overall relief valve system. These studies typically include the following services:

- Evaluation of the current relief valve sizing for each piece of equipment
- Evaluation of the existing relief valve piping system
- Recommendations to bring a system into compliance
- Drawings outlining recommendations
- Updated relief valve schedule
- Documentation for a compliant system

COMPLIANCE CRITERIA

In order to provide the relief system documentation to show compliance with the relevant codes, standards and OSHA regulatory requirements, the following criteria are suggested:

<u>1. A relief vent header system requires no modifications if all the following conditions are met:</u>

- There is design documentation that the system was installed in compliance with the codes and standards in place at the time of the design and installation. This was not required until 1992, so facilities constructed before 1992 likely will not have this documentation.

- There is a documented design basis for the vent system that shows compliance with the codes and standards in place at the time the last substantive change to the vent system occurred.
- There have been no modifications to the relief vent system other than replacement with the identical type of valves.

2. The entire relief vent header system should be evaluated against current code and updated **IF ANY** of the following conditions exist:

- There is no existing documentation of the design basis for the vent system.
- It can be demonstrated that one or more elements of the relief vent do not meet the codes and standards that were in place at the time the relief vent system was initially installed or substantively modified.
- The relief system has or will undergo substantive modification including 1) addition of new relief valve(s) and/or branch piping to a vent header, 2) addition of header piping, or 3) addition of a diffusion tank or other outlet diffuser.
- It can be demonstrated that any portion of a modified relief system did not comply with the codes and standards in place at the time of the modification.

SIX TIPS TO OPTIMIZE REFRIGERATION EFFICIENCY AND LOWER ENERGY COSTS

With industrial refrigeration accounting for up to 60 percent of a manufacturing facility's total operating expenses, it's no surprise that increasing refrigeration efficiency is a priority. However too often engineers look to optimize individual components rather than taking a holistic approach, leading to wasted energy and operational inefficiencies. To avoid this fragmented approach, below are six steps engineers can take to optimize the entire system and achieve the greatest energy efficiency:

- Optimize set points, as condensing pressure should typically be run as low as possible. Suction pressure should be run as low as possible while still maintaining the desired room/product temperatures. Even adjusting the suction pressure up a degree could mean a 1.5 percent savings for those compressors.
- Size compressors to match loads as closely as possible. Two equally sized compressors, each running at 50 percent capacity, can require 30 percent more horsepower than one compressor running at 100 percent, so proper selection up front and sequencing are important. It's also good practice to include different-sized compressors and sequence them properly to keep the machines as fully loaded as possible. For large systems, large compressors handle the majority of the load, while a smaller unit is included as a trim compressor to handle the swings. This will keep the larger compressor fully loaded at all times.

- Install VFDs on screw compressors to optimize mechanical efficiencies of the machines. The best approach is to set the slide valve position at 100 percent and vary the RPM of the motor according to the refrigeration needs of the machine, which allows it to run more efficiently.

- Install VFDs on condenser motors to stabilize head pressure and prevent the motors from heavy repeats and intense start/stop cycles. This will allow the fans to change speeds so they don't continually stop and start, which requires additional energy and results in mechanical wear. The biggest payback from a VFD will be on systems with variable loads.
- Use floating head pressure to maintain the ideal temperature for compressor and condenser operations. Higher condensing temperatures require compressors to work harder. Find the optimal break-even point where the condensers and compressors are cumulatively using the lowest overall horsepower requirements.
- Use a completely integrated automation system to run your machine room, ensure efficiency and automate temperature controls within zones. Automating defrost cycles to sequence at different times can result in significant energy savings. An automated system can make calculations and adjustments automatically, whereas a manual system requires constant operator attention, is susceptible to human error and will react much slower.

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Published by Stellar 2014
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