How to Maintain a Low Pressure Centrifugal Chiller

In processing plants across the country, low pressure chillers are hard at work satisfying process cooling requirements. Proper maintenance, including purging, is required to keep them operating effectively.

By Mark Key, Redi Controls Inc.

Purge units are an important and vital part of a chiller's ability to operate efficiently and effectively. Although purge units can be utilized on high and low pressure chiller systems, they mostly are found on R-11, R-123 and R-113 low pressure centrifugal chiller applications.

The most important criteria for any high efficiency purge system is its efficiency level. The only assurance one has that a particular manufacturer's purge unit will perform to its published efficiency rating is to make absolutely sure the unit is Air-Conditioning and Refrigeration Institute (ARI) certified to Standard 580. The ARI-certified, tested refrigerant-to-air-emission ratio should be below 0.6 lb of refrigerant per pound of air purged. Make sure this is the certified efficiency of the purge unit alone, without the aid of secondary absorption media.

Secondary absorption media such as activated carbon or a molecular sieve can reduce purge unit emissions. Activated carbon can cut emissions to 0.0049 lb of CFC per pound of air, but it is important to note that the refrigerant absorbed by the canister is not returned to the machine. The typical carbon-absorption canister lasts for approximately three years on an average chiller, and it has a holding capacity of approximately 9 lb of refrigerant. When the canister is saturated, many refrigerant reclamation centers will dispose of them at a cost of about $75 to $100. One can also contact the OEM for further recommendations. Molecular-sieve canisters have virtually zero emissions, and the refrigerant adsorbed by the canister can be reclaimed and returned to the chiller owner via a refrigerant-credit program.

A purge unit should be easy to install and require minimal modification to the chiller. Being able to install the purger without having to remove the chiller's refrigerant charge eliminates the risk of accidental refrigerant loss during installation.

These secondary emission collection canister systems are important in certain applications. In the food processing industry, certain refrigerants assist in accelerating the ripening of fruits and vegetables. Canisters are important in or near explosion-proof areas where one would want to minimize release of chlorine-based chemicals. Also, some Canadian province regulations require purge unit exhaust levels to be at or below 0.1 lb, thus requiring the installation of an absorption canister along with the purge unit. In any of these applications, one would want to make sure the

Refrigerant Handling Has Changed

In the past, when refrigerants were inexpensive and the concern about the harmful effects that chlorofluorocarbons (CFCs) have on the ozone layer did not exist, the technician was simply concerned with getting the chiller purged down as rapidly as possible. During startup after chiller downtime, technicians often purged "off-the-top." This was the practice of simply releasing air from a port at the top of the condenser on some machines. This, of course, allowed refrigerant to escape directly to the atmosphere. This also meant that there was no reason to be particularly concerned about a purge unit's refrigerant-to-air-separation efficiency level. Thus, it was not uncommon for older chiller system purges to release approximately 3 to 8 lb of refrigerant for every pound of air purged. Every startup season saw regular purchases of a drum or two of refrigerant to replace what was lost. Remember, it used to cost cents per pound; today, R-11 can easily run around $8 per pound.

One of the early purge-assist devices captured the purge exhaust, condensed the refrigerant, and returned it to the purge drum while expelling noncondensables.

However, with the growing concern about how refrigerant negatively affects our world's environment, and with the increasing price of refrigerants caused by Environmental Protection Agency (EPA) and Clean Air Act regulations (tariffs and taxes), routine refrigerant losses on any air-conditioning or refrigeration system can no longer be allowed. Older purge units now are viewed basically as blowing dollars out the door.

A purge-assist unit was the first step toward the evolution of high efficiency purge units. By retrofitting existing OEMs' purge units with the purge-assist device, purging efficiency could be improved from 3 to 8 lb CFC per pound of air emission to 0.1 pound of CFC per pound of air emission. This was a dramatic improvement.

For those technicians who may run into these units in the field, the device's basic operating procedure is to capture the purge exhaust, condense the refrigerant and return it to the purge drum while expelling noncondensables. Regular maintenance for this device includes checking the diaphragm located in the unit's pneumatic operator bowl; checking that the float ball assembly is working correctly (this allows for liquid refrigerant return to the purge unit's purge drum); and inspecting and, if needed, replacing the strainer in the cooled water inlet line.

By the mid-1990s, many of the original OEM purge units were aging and wearing out, and it became economically feasible to replace the entire older purge system with a high efficiency purge system. Many chiller owners have replaced their inefficient old-style purge units, but some owners have not yet made this change. An owner that has not yet retrofitted to a high efficiency purge should consider the fact that expelling these gases in excessive amounts harms the environment and costs the facility unnecessary financial losses. In addition, these losses could count toward the facility's annual refrigerant emission allowance, which can be determined from refrigerant logbook records.

Requirements for refrigerant handling will continue to change. Eighteen government agencies along with a few corporations and other environmental and professional organizations worldwide have organized with the EPA to form the Building Air-Conditioning Climate Partnership to develop additional environmental performance criteria. Refrigerant release minimization is sure to be a prime topic of concern.

secondary absorption canister being considered is ARI certified to confirm stated emission level obtainment.

Other important considerations include ascertaining that the purge unit is listed by Underwriters Laboratories (UL) listed and that the unit has a duty-cycling mode built into the board functions. Duty cycling allows the purge unit to operate based on actual purging requirements, thereby reducing wear. Duty cycling also significantly reduces power consumption when compared to older-style purges.

Finally, the purge unit should be easy to install, requiring minimal modification to the chiller. When possible, select a purge unit that can be installed without having to remove the chiller's refrigerant charge, which unnecessarily increases the risk of accidental refrigerant loss and increases installation costs.

Most of the above-mentioned criteria for purge unit selection are standard, with slight variations between manufacturers and models. However, one important feature to consider when selecting a purge unit that will vary is technical support capabilities. Feel free to contact the manufacturer's technical support department to check on the ability to respond to technical concerns.

Operation and Service Concerns

The function of the purge system is to maintain the refrigeration system free of noncondensable gases such as air, moisture, acids and oil residue. Accumulation of these noncondensable gases within the refrigeration system causes an increase in condensing pressure and results in the loss of operating efficiency.

Moisture elimination in a refrigeration system is important. Moisture causes the formation of acids that can attack the machine's internal components and ultimately lead to premature failure. This hydrochloric and hydrofluoric acid formation is caused by the chemical reaction between water and refrigerant (i.e., water plus CFCs equals HCL, HFL and byproducts). Additional adverse effects that can be caused by moisture include:

- High head pressures and discharge temperatures.
- Hermetic motor burnout.
- Tube damage.
- Bearing failure.
- Reduced heat transfer efficiency.

Therefore, it is critical to maintain the machine free of noncondensable gases and moisture at all times, and the purge unit provides this function. The purge unit commonly is referred to as the septic tank of the chiller because it is in regular contact with these noncondensables.

Considering this fact, it is important for chiller service technicians to regularly replace the filter dryers that are usually located on the vapor inlet line or the liquid refrigerant return line of the purge unit. A moisture-indicating sight glass is mounted with the filter dryer, and this will assist in determining if the dryer is saturated.

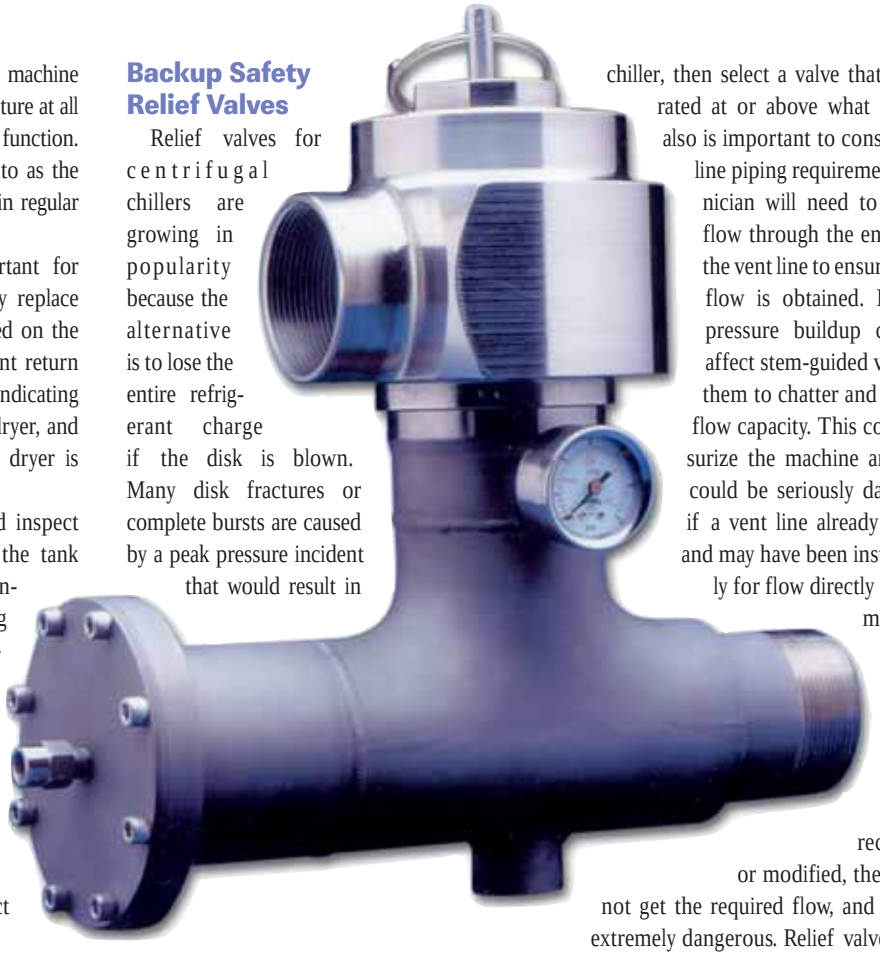
Additionally, the technician should inspect the purge tank sight glass to view the tank refrigerant liquid level and assess potential scale buildup. Purge tank cleaning kits are available from some manufacturers, and using this type of product will assist in regaining the purge tank's condensing efficiency and potentially increasing its longevity.

Before leaving the job site, a technician may want to run through a regular purge cycle to ensure that all parts are operating within correct parameters.

Technicians may be interested in knowing that portable service purges are now on the market. The newer, high efficiency purges typically are slower than the inefficient older purges, sacrificing speed for efficiency. Quick-purging service purges have been developed to allow a technician to rapidly purge a chiller after servicing, to get the chiller up and running immediately.

Backup Safety Relief Valves

Relief valves for centrifugal chillers are growing in popularity because the alternative is to lose the entire refrigerant charge if the disk is blown. Many disk fractures or complete bursts are caused by a peak pressure incident that would result in minimal refrigerant loss if a relief valve were installed.



Relief valves minimize the risks associated with an overpressuriztion incident, including potential loss of the entire refrigerant charge.

When selecting a relief valve, it is important to check the required scfm flow rating for the chiller, then select a valve that is scfm-flow rated at or above what one needs. It also is important to consider the vent-line piping requirements. The technician will need to calculate the flow through the entire length of the vent line to ensure the required flow is obtained. If not, back-pressure buildup can adversely affect stem-guided valves, causing them to chatter and not reach full flow capacity. This could overpressurize the machine and the chiller could be seriously damaged. Even if a vent line already was installed and may have been installed correctly for flow directly from a disk, it may not reach the required flow when a valve is inserted. If the vent line is not correctly installed or modified, the chiller would not get the required flow, and this could be extremely dangerous. Relief valve manufacturers are capable of addressing concerns about vent-line length and valve applications, and technicians should feel free to contact them with any questions.

The primary concern with servicing the relief valve and disk assembly is to ensure that no leaks have developed that would allow air to seep into the chiller. All of the valves designed for centrifugal chiller applications come with a pressure gauge that monitors the internal pressure between the disk and the lifting seat of the valve. If the gauge indicates a vacuum, then the disk is fractured or completely blown and the gauge is reading the internal pressure of the chiller. At this point, the disk most likely will need to be replaced.

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Equipment and Comfort Cooling

Although designed for industrial processing applications, low pressure centrifugal chillers also have been installed in factories and institutions to provide comfort and equipment cooling. Like their industrial processing cousins, these chillers need protection from refrigerant loss. As an added benefit, adding a safety valve can reduce refrigerant consumption and cut operating costs.

For instance, Mark Provencher of Black & McDonald in Hamilton, Ont., installed a backup safety relief valve on a Mohawk Community College chiller and it ended up saving $72,000 of refrigerant.

"The decision to retrofit the college's Carrier 19C centrifugal chiller with a safety valve was made because of the potential risk of an overpressurization incident," Provencher said. "Had the carbon disk burst, it would leave the chiller open to the outside atmosphere."

With the relief valve, savings have been substantial. According to Provencher, the value saved 3,600 lb of a 4,400 lb charge, equating to saving $72,000 of refrigerant.

The technician can confirm this when leak testing the chiller. When the chiller internal pressure is increased, the gauge will indicate an increase in pressure. If the disk is removed, one may consider replacing the O-rings and gaskets and noting the change on the valve manual's logging section. One should adhere to the manufacturers' stated recommended O-ring and gasket replacement timetable.

Some valves come with pull-ring levers that allow valve-function testing without having to build up to 15 psi pressure to determine if the valve works. This is a convenient feature because some insurance and OSHA inspectors may want to confirm valve operation. If the valve has this option, the technician should confirm operation when performing regular maintenance. Remember, when leak testing, to avoid accidentally blowing the disk, do not exceed the pressure recommended by the disk manufacturer. Additionally, keep in mind that reverse-buckling, metal nonfragmenting rupture disks are extremely fragile, and one should refrain from touching the dome section because it could ruin the disk. Periodically, curiosity has caused a technician to purchase another disk. Also, a burst-metal disk should be handled carefully because the metal edges can be sharp and could easily cut a technician's hands.

Technicans can take a portable service device from one chiller to another throughout the plant while performing repairs and checking for leaks.

Pressurization Equipment

There are a few devices that allow one to pressurize low pressure chillers. One would want to pressurize a chiller to perform some repairs on the system — which usually is held at 0.00 psig to minimize refrigerant loss to the atmosphere — and go above atmospheric to search for leaks. Centrifugal chillers operate in a vacuum so one has to pressurize them to search for leaks.

Pressurization equipment can be portable or permanently installed. Portable service devices include designs that allow the technician to circulate warm water through the chiller and thus increase the system's internal pressure. It is important to gradually increase the temperature because a lag exists between the temperature increase and the resulting pressure increase. It is advisable to stop incrementally to determine the pressure gain and minimize the chance of overpressurizing and blowing the disk. Before starting the procedure, one should confirm the disk variance pressure allowance and the chiller manufacturer's pressure testing recommendations.

A technician may find that some chillers have been retrofitted with a permanently installed pressure-testing device. These devices can utilize a heat blanket installed on the bottom of the evaporator or a water-heating element that is monitored by permanently installed controller. These systems will circulate warm water through the chiller while monitoring pressure

Some chillers have been retrofitted with permanently installed devices that monitor the system and automatically protect against inadvertent overpressurization during repairs and servicing.

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Low pressure centrifugal chillers are a narrow niche in the refrigeration and service market, and special training is advisable for technicians who plan on working on this equipment. OEMs regularly offer classes on their chiller servicing needs. Some independent organizations also offer training. Any technician interested in working on these systems should take courses to familiarize themselves with centrifugal chiller operation. **PCE**

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For more information ...

Call (317) 865-4130, ext. 206.
Visit www.redicontrols.com.

Photo of a Redi-Purge Model PRG-11/123-C2 ARI Certified UL Listed High Efficiency Non-Condensable Purge installed at Complex LaLaurentienne Canada.

Photos are of the RuptureSeal Model NRS-2 backup safety relief valves for low pressure centrifugal chillers installed by Johnson Controls Alaska at the BP and Frontier Group facilities.

For engineers who specify cooling equipment, components and materials.
PROCESS COOLING & EQUIPMENT
A Supplement to Process Heating

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NEW!

Oil, Acid & Moisture PURGER Saves $24,000 per Year!

(Approximate Savings for an average Chiller)

Removes Oil, Acid and Moisture from Centrifugal Chiller's refrigerant charge and Returns the Oil to the chiller's oil sump where it belongs.

Redi Controls is pleased to announce the introduction of its new patent pending "OAM Purger." The OAM Purger is designed to remove Oil, Acid and Moisture from a chiller's refrigerant charge (its main purpose is to remove OIL and automatically return it to the chiller's oil sump where it belongs). It is common knowledge that oil build-up occurs in all centrifugal chillers. Oil invariably finds its way into the evaporator where it mixes with refrigerant, degrading system efficiency and capacity. This occurs when the evaporator tubes become coated with oil, heat transfer efficiency is retarded and drastically reduces the cooling effect. In fact, recent studies have identified excess oil on the refrigerant side of a chiller as a leading contributor to chiller inefficiency, and that the problem is widespread.

In one study, ASHRAE Research Project 601-TRP, refrigerant samples were taken from 10 operating chillers and analyzed for oil content. All of the chillers were found to contain excess oil in varying amounts from 3% (enough to significantly degrade performance) to as high as 23%. According to one OEM, as little as 1% (by weight) of oil in refrigerant could result in as much as a 3% loss in chiller efficiency.

Chiller manufacturers recommend oil concentration levels no higher than 0.5% by weight. However, in our conversation with the OEM's we learned that 12% is typical. Thus, for the typical 500 ton chiller, this could mean a 36% loss in efficiency and a penalty to the chiller owner of $24,000 per year in additional energy cost!

As you know, once oil gets into the chiller's refrigerant it's very difficult to get it back out. In the past, the only way an oil-logged chiller could be fixed was to either remove and distill the refrigerant, or replace the charge with virgin refrigerant. In either case it was a very expensive process and it required a considerable amount of down time. As you are aware most centrifugal chiller applications simply cannot afford to have a chiller down, Period! Also utilizing the past methods, the fix was only temporary. The minute the chiller was placed back into operation oil contamination began all over again.

Advantages to the chiller owner

OAM Purger installed at the 3M facility, Buffalo, NY

1. **The OAM Purger** quickly cleans the chiller's refrigerant charge to only a trace level of oil.
2. **Quickly restores** chiller to peak operating efficiency.
3. **Substantially reduces** energy consumption saving the owner thousands of dollars in operating cost.
4. **The OAM Purger pays** for itself in 3 to 4 months. So, in effect, retrofitting an OAM Purger doesn't really cost the owner anything. In fact, retrofitting an OAM Purger is a financial investment that keeps on paying dividends (in some cases thousands of dollars per month).
5. **Reduces maintenance** and helps prevent premature failure.
6. **The OAM Purger is extremely energy efficient;** in fact, power consumption is approximately equivalent to a 200 Watt light bulb.

Conclusion: Every chiller truly needs an OAM Purger. All you need to do is refer to the results of the latest refrigerant analysis, and consider the benefits of retrofitting an OAM Purger.

Redi Controls

Check our Web Site: www.RediControls.com

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