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

# Purging Your System

Learn how an oil purger can help you regain lost chiller capacity in your refrigeration system and save thousands of dollars each year.

Retrofit an oil, acid and moisture purger like this one from Redi Controls to your chiller to increase chiller efficiency as well as the bottom line.The system operates 24 hours a day, regardless of chiller operating status, so the refrigerant is maintained in a virtually oil-free state. This allows the chiller owner to regain lost capacity.

Oil entrained in a chiller's refrigerant charge costs companies thousands of dollars each year in wasted energy — along with causing significant decreases in chiller system capacity. Now is the time to address this issue to improve a chiller's efficiency and obtain substantial energy savings.

Oil enters the chiller's refrigerant charge as the refrigerant is circulated through the chiller's compressor. On low pressure chillers — typically those that use R-11, -113, -114 and -123 refrigerants — the oil is used as a lubricant for the centrifugal pump, and it seeps through the compressor's seals and becomes entrained in the refrigerant charge. This same process occurs with high pressure centrifugal chillers, which most commonly use R-12, -22 and -134a refrigerants. High pressure screw chillers, which also use R12, -22 and -134a refrigerants, utilize oil for lubrication, as a coolant and as a sealing mechanism on screw rotary tips. This oil inevitably finds its way into the refrigerant charge.

Many technicians agree that older screw chillers slug the system with oil upon startup. The oil problem also extends into other systems, including high pressure reciprocating chillers, certain ton-rack systems and ammonia refrigeration systems.

Concerning low and high pressure centrifugal and some high pressure screw chillers, oil basically finds its way into the evaporator, where it mixes with refrigerant, eventually degrading system efficiency and capacity. This occurs when the evaporator tubes become coated with oil, creating a thermal barrier. The heat transfer efficiency is retarded and reduces the cooling effect.

"Oil migration to a flooded evaporator may be clearly understood by chiller professionals, but the actual impact on performance is almost certainly not. Factors such as aspect ratio, refrigerant and oil type, [and] level and load affect this determination. The most important factor, however, is tube design. For integral tubes, the foaming effect [that results] from a small percentage of oil can actually increase performance, whereas, any oil on nucleate boiling tubes can cause a significant degradation of performance. Using a real-time performance monitoring system while simultaneously distilling the refrigerant, one can optimize the evaporator to save significant operating and maintenance dollars," says Kevin Zugibe, P.E., CEO at Hudson Technologies, Pearl River, N.Y., a company that provides reclamation services across North America. Some chiller manufacturers support that a small percentage of oil (concentration of 0.5 percent by weight) may assist in foaming; however, any concentration above this initial amount should be avoided.

Although it is common knowledge that oil buildup occurs, the significant impact on the system's capacity and extreme energy costs only now are being realized. There are studies that note the importance for chiller owners and service contractors to recognize and address this problem (see sidebar).

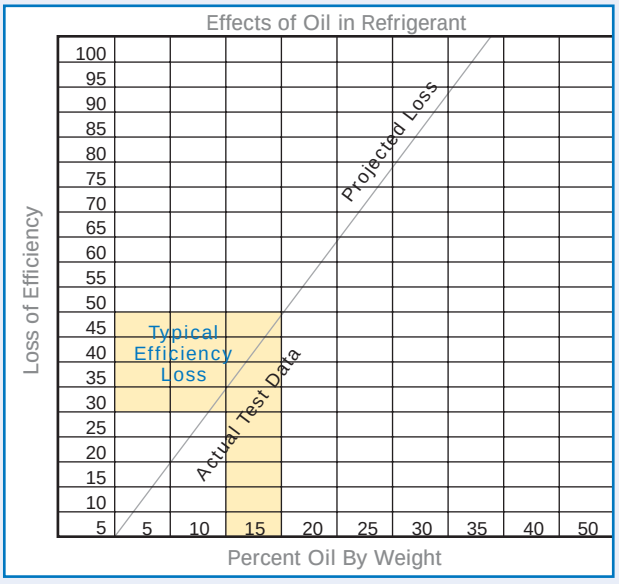
## Remedies

Solutions to this costly problem include chiller charge reclamation and an oil-, acid- and moisture-purging system. Once an existing chiller is oil logged, a refrigerant reclamation service company such as CFC Refimax, with offices in Marietta, Ga., Houston and Orlando, can recover and reprocess the refrigerant charge onsite, complying with ARI 700-95 standards. When called in by a mechanical contractor, the reclamation service will pull the entire charge, process

# Studies Show Oil in Refrigerant Reduces Heat Transfer

Several studies note the importance for companies and service contractors to recognize and address the problem of oil buildup in a chiller system.

ASHRAE performed a study titled, "Effects of Oil on Boiling of Replacement Refrigerants Flowing Normal to a Tube Bundle, Part I: R-123 & Part II: R-134a." Part 1 of this study reads, "Conclusion: Flow boiling results have been obtained for the low-pressure refrigerant, enhanced boiling tube in the presence of R-123. The effects of oil on local and average boiling heat transfer coefficients have been given. This enhanced tube shows a marked decrease in heat transfer with the addition of even a small amount of oil throughout various heat loadings. Even at 1 percent to 2 percent oil, the heat transfer coefficient is reduced by one-third from its no-oil baseline. At substantial oil content (5 percent to 15 percent), a 40 percent




Studies supported by ASHRAE (which also cite other studies) and statements of a major chiller OEM indicate that oil in refrigerant reduces heat transfer and therefore efficiency. Oil content of 1 percent (by weight) produces a reduction of 3 percent efficiency. Up to 15 percent oil buildup produces a reduction of 40 percent to 50 percent in efficiency. The reduction in efficiency tends to be consistent for different refrigerants.

to 50 percent reduction is noted.... This study was supported by ASHRAE Research Contract RP-751."

Part 2 of this study obtained a similar conclusion, "Flow boiling results have been obtained for a newer enhanced boiling tube with R-134a. The effects of oil on local and average boiling coefficients have been given. This enhanced tube shows a decrease in heat transfer with the addition of even a small amount of oil throughout various heat loadings. Even at 1 percent (by weight) oil, the heat transfer coefficient is reduced by 25 percent from its no-oil baseline. At higher oil content, a 30 percent reduction has been typically measured. This study was supported by ASHRAE Research Contract RP-751."

The attached graphs illustrate the findings in an additional ASHRAE Study titled, "ASHRAE Research Project 601-TRP." In this study, 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 percent (enough to significantly degrade performance) to as high as 23 percent.

| | Chiller Refrigerant Charge by Weight in lb | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 |
| % Oil | Pounds of Oil Refrigerant Charge Based on % by Weight | | | | | | | | | | | |
| 1% | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 2% | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 3% | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
| 4% | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 |
| 5% | 5 | 10 | 15 | 20 | 20 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| 6% | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
| 7% | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 |
| 8% | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96 |
| 9% | 9 | 18 | 27 | 36 | 45 | 54 | 63 | 72 | 81 | 90 | 99 | 108 |
| 10% | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
| 11% | 11 | 22 | 33 | 44 | 55 | 66 | 77 | 88 | 99 | 110 | 121 | 132 |
| 12% | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 |
| 13% | 13 | 26 | 39 | 52 | 65 | 78 | 91 | 104 | 117 | 130 | 143 | 156 |
| 14% | 14 | 28 | 42 | 56 | 70 | 84 | 98 | 112 | 126 | 140 | 154 | 168 |
| 15% | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 |
| 16% | 16 | 32 | 48 | 64 | 80 | 96 | 112 | 128 | 144 | 160 | 176 | 192 |
| 17% | 17 | 34 | 51 | 68 | 85 | 102 | 119 | 136 | 153 | 170 | 187 | 204 |
| 18% | 18 | 36 | 54 | 72 | 90 | 108 | 126 | 144 | 162 | 180 | 198 | 216 |
| 19% | 19 | 38 | 57 | 76 | 95 | 114 | 133 | 152 | 171 | 190 | 209 | 228 |
| 20% | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 |
| 21% | 21 | 42 | 63 | 84 | 105 | 126 | 147 | 168 | 189 | 210 | 231 | 252 |
| 22% | 22 | 44 | 66 | 88 | 110 | 132 | 154 | 176 | 198 | 220 | 242 | 264 |
| 23% | 23 | 46 | 69 | 92 | 115 | 138 | 161 | 184 | 207 | 230 | 253 | 276 |
| 24% | 24 | 48 | 72 | 96 | 120 | 144 | 168 | 192 | 216 | 240 | 264 | 278 |
| 25% | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 |
| | Oil Weighs Approximately 7 lb/gal<br>60 lb Is Approximately 8.5 gal | | | | | | | | | | | |

According to ASHRAE study 601-TRP, the average chiller has 12 percent oil by weight in its refrigerant charge. A 500 lb refrigerant charge at 12 percent by weight contains 60 lb, or 8.5 gal of oil.

While the studies do show some slight variance, they all strongly support each other in the fact that oil finds its way into a chiller's refrigerant charge and significantly increases the amount of energy required to run the chiller. This increased energy consumption drastically increases a chiller owner's electric utility bill (or increased energy consumption and thus increased costs from other energy sources). On top of that, the system is losing a significant amount of capacity, and a harder working system increases its potential for earlier wear and tear breakdown or servicing.

the refrigerant to remove all oil, moisture (even excess water from a ruptured tube), acid, air and other contaminants, and recharge the ARI-spec refrigerant back into the machine.

Doug Romine, president at CFC Refimax says, "The facility operators are usually astonished at the dramatic improvement in performance…moisture and oil collect in the evaporator where the moisture turns to ice and the oil turns to sludge and impedes heat transfer. Air collects in the condenser and additionally cuts the efficiency of the process.

Hudson Technologies Inc., Pearl River, N.Y., uses its real-time performance monitoring system while simultaneously distilling the refrigerant to optimize the evaporator, reducing operating and maintenance costs for this particular chiller owner.

"While the benefit of improvements in a process cooling system usually has a dramatic effect on the productivity of the process, if the condition of the refrigerant is ignored, moisture will interact with the refrigerant to form hydrochloric acid and one will quickly begin to experience problems much more severe than just reduced efficiency. After CFC Refimax reclaimed one chiller's refrigerant charge, the customer was able to turn off 3,000 tons of cooling that was no longer needed because the system was working more efficiently than it had

## OAM-Purger Installatons

OAM-Purger installed at the University of Missouri.

Ron Summerhays, Service Foreman , Johnson Controls (Anchorage, Alaska) installed OAM-Purgers at BP and Frontier Towers facilities.

ever worked before."

Redi Controls Inc., Greenwood, Ind., offers an oil-, acid- and moisture-purging system.

"The unit's main purpose is to remove oil from a chiller's refrigerant charge and automatically restore the oil to the chiller's oil sump, returning the clean refrigerant to the system," says Mark Key, vice president of sales and marketing for Redi Controls Inc. "Acids and moisture also are removed from the refrigerant and oil during the process. Because the system operates 24 hours a day, regardless of chiller operating status, the refrigerant is maintained in a virtual oil-free state. This allows the chiller owner to regain lost capacity." **PCE**

## For more information...

**Redi Controls Inc.**
Call (317) 865-4130.
Visit www.redicontrols.com.
**Hudson Technologies**
Call (800) 501-4376.
Visit www.hudsontech.com.
**CFC Refimax**
Call (800) 406-2292.
Visit www.refimax.com.

## OAM-Purger Installatons

Professional Heating & Cooling, Inc. (Norfolk, VA.) Service Technician, Buddy Green, installed the OAM-Purgers at Norfolk Southern Towers.

For engineers who specify cooling equipment, components and materials.
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