Temprite TECH NOTES

Refrigeration System Redesign: Opportunity for Long Range Savings for Supermarkets

Refrigeration contractors are uniquely positioned to improve the long-range reliability and efficiency of refrigeration systems.

New refrigerants mean that many systems will be reexamined, redesigned or replaced. This provides an opportunity to change components which critically affect overall system efficiency but are often overlooked.

Some of these components have new features at least matching the refrigerant improvements. The oil separators we produce at Temprite are a case in point. We now have products that are not only superior in confining oil but also efficient, preventing dirt particles from harming system operations.

Oil: High Damage Potential

Yes, oil is essential to refrigeration. But, oil must be confined to where it is needed. Since oil and refrigerant gas are miscible – or mutually attractive – the gas can carry oil throughout the system, with devastating results.

To be more specific, oil's sole purpose in a refrigeration system is to lubricate the compressor. Inadequate lubrication will eventually cause a compressor to seize up or burn out. Oil will, however, harm other system components and so must be confined to the compressor.

Unavoidably, all compressors pump oil into their systems, the amount being determined by several factors:

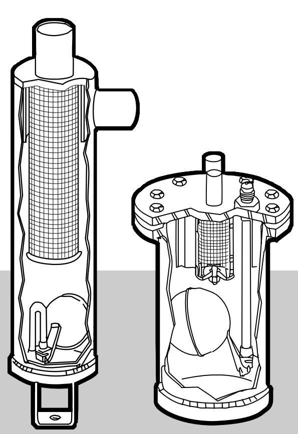
- Compressor design and configuration
- System design and operating conditions
- Miscibility of given oils and refrigerants
- Compressor age and wear.

In most systems, the pumping rate of oil to refrigerant can average from 3% to 15% of the total mass, with some systems having 25% to 75% of the mass flow as oil.

Oil and refrigerant in the condenser and liquid receiver will more readily mix in the high temperature phase of the refrigeration cycle. Lower temperature in the evaporator causes the oil and refrigerant to mix less readily, forcing the oil to precipitate and accumulate in the evaporator and robbing the compressor of its vital lubrication.

Oil's sole purpose in a refrigeration system is to lubricate the compressor.

From the condenser to the metering devise, refrigerant oils are soluble with liquid refrigerant. But, oil and refrigerant vapor do not mix readily. So, from the evaporator to the compressor suction inlet, oil and refrigerant



Temprite 900 and 920 Series coalescent oil separators stop solid contaminants from ruining delicate metering devices and causing undue wear on compressor parts.

Remove Harmful Solid Contaminants...

are not very mixable. Oil can be circulated through the system only if gas velocities are kept high enough to carry the oil along the piping and heat exchanger tubes.

The ability to retrieve or flush the oil from the evaporator or other locations, depends on:

- The miscibility of the oil being used
- The type of refrigerant
- System conditions — (temperatures and pressures)
- Velocity of the refrigerant through the evaporator and piping layout.

It was once believed that oil helped refrigerant make better contact … to the walls of heat exchangers.

A refrigeration system should have velocities high enough to carry the oil through the system and back to the compressor. These high velocities provide good oil return, but also cause pressure drop. This pushes the system to work harder to produce a given amount of refrigeration effect, requiring more energy or larger equipment — and rising costs. The oil is forced around the system but the lubricant's insulating effects reduce heat transfer efficiency.

Excess oil in the system initiates many problems. Worst case: a system with oil trapped in the evaporator and a higher load demand, with increasing refrigerant velocity. The higher speed may return all the oil to the compressor at once, causing an oil liquid slug and ruining the compressor.

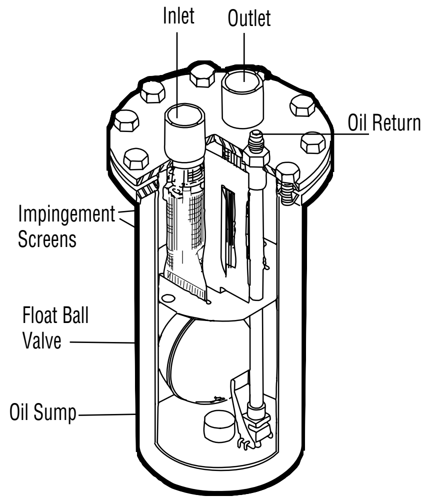


Fig. 1. In the best of applications, conventional-centrifugal separators are only 80 to 85% efficient in the removal of oil.

It was once believed that oil helped refrigerant make better contact and adhere longer to the wall of heat-exchangers (condensers and evaporators), thus improving heat transfer. Actually, a thin film of oil carried by the refrigerant coats the inside of the system, acts as an insulator and isolates the refrigerant from direct contact with the heat-exchanger, retarding heat transfer efficiency.

In the condenser, temperatures are higher, so the oil film will be thinner. However, it can still measurably increase head pressure and temperature. Colder temperatures in the evaporator will thicken the film to the point where the oil is too viscous to flow. Lower heat coefficients in the evaporator lowers evaporating temperature and pressure. What happens in the condenser and evaporator directly affects compressor capacity and efficiency.

To make up for the heat-transfer losses, a system must have larger condensers, evaporators, compressors and other components. Systems not compensating for this loss of efficiency will have longer compressor run times, different pressure control settings and more required defrost periods - all wasting energy.

To sum up, oil's undoubted benefit to the refrigeration system is in constant danger of being offset by its potential for causing serious problems... problems which can cause downtime for the refrigerating system, higher operating costs, and, ultimately, spoilage of stored goods.

Combating the Oil Problem

The oil separator is a device specifically designed to remove oil from where it can harm the refrigerating system and to return it to the compressor where it is needed. Although there are several types of separators, let's focus on the two that seem likely to dominate the field in the near future. And, yes, we make them both at Temprite.

Conventional "impingement" separators (See Fig. 1) are the most commonly used today.

Improve Energy Efficiency

These units rely on centrifugal force and the expansion of gasses to remove oil. Superheated and oil-laden refrigerant gas enters the separator shell, where the oil passes through an inlet screen and is separated from the gas by adhering to the screen. Gravity pulls the oil to the separator's sump from which a float valve meters it back into the compressor.

The main drawback to this type of unit is its reliance on centrifugal force to accomplish separation. Centrifugal force only works effectively on relatively large oil droplets. This means that smaller droplets remain in the gas and are recirculated through the system.

This fact makes some manufacturers' claims for efficiency ratings of up to 99% with centrifugal units extremely questionable. It's more likely that, under actual operating conditions, conventional separators will function in the 80% to 85% range and even much lower in certain situations.

This raises a natural further question: Is there a better way to go? We believe there is: coalescing separators.

Real High Efficiency

Coalescing units (See Fig 2.) operate through a filter of exceptionally pure, extremely fine glass fibers which form a capturing matrix. This matrix excites the oil molecules, causing them to collide with each other and form larger droplets which are forced to the filter's outer drain layer. Gravity then pulls the droplets into the sump.

These units achieve their high efficiency by capturing the small oil droplets and a large percentage of atomized oil vapor that centrifugal and impingement separators miss.

Coalescing units are highly efficient, typically delivering between 95% and 99+% efficiency, depending on the grade of filter core used and the attention paid to design details.

Coalescent units have other advantages over alternative types of separators. For instance, they cause less pressure drop than conventional separators. As described previously, pressure drop produces negative effects – overworking the system and reducing heat transfer.

Unlike the centrifugal and impingement screen separators which are velocity-dependent, coalescers maintain efficiency over a system's entire load range rather than becoming less efficient with lower loads.

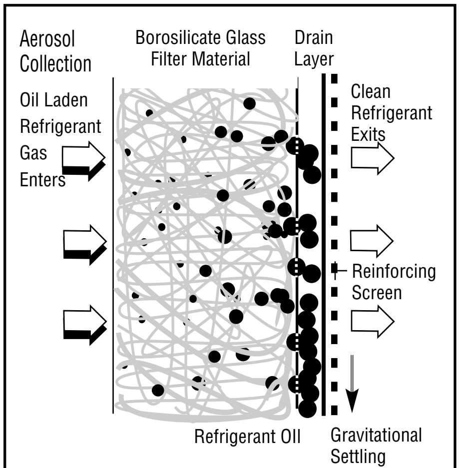


Fig. 2. Coalescent filter matrix is capable of separating 99.99% of all oil aerosol in the refrigerant mass flow.

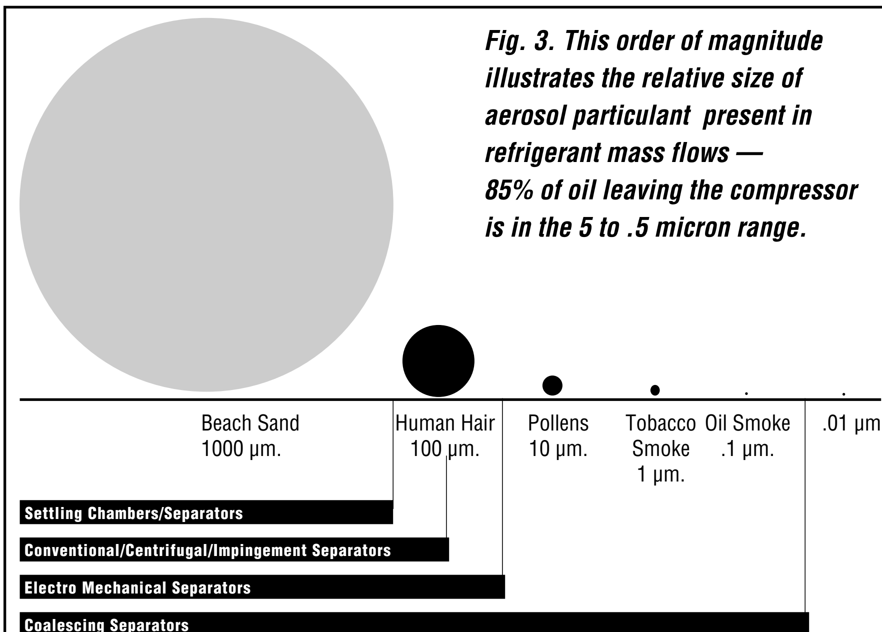


Fig. 3. This order of magnitude illustrates the relative size of aerosol particulant present in refrigerant mass flows — 85% of oil leaving the compressor is in the 5 to .5 micron range.

Cleaning with Coalescents

The new refrigerants have made system cleaning even more important than when CFCs' were the mainstay refrigerants. The replacement refrigerants (HFCs') and oils (POEs') are even better solvents than their predecessors.

So, it is significant that coalescing units capture solid contaminates, cleaning the system and preventing it from fouling metering devices. Equipped with accessible filters, coalescent units work particularly well during system start-up. And, they are especially effective during burnout, capturing the vast majority of resulting carbonized oil, winding lacquer and metal shavings. On average, a properly designed and sized coalescing oil separator has five times the filter area of the standard liquid line filter/drier and five times the filtering area of the suction filter that would be used on a system of the same capacity.

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The standard filter/drier used by the major manufacturers is 85% to 90% efficient at removing solid contaminates down to 40.0 microns in size. Some manufacturers are now offering special filters that are good for down to 20.0 micron contaminates. The standard grade coalescing oil separator filter core is 99.9% + efficient at capturing 0.3 micron solid contaminates and larger.

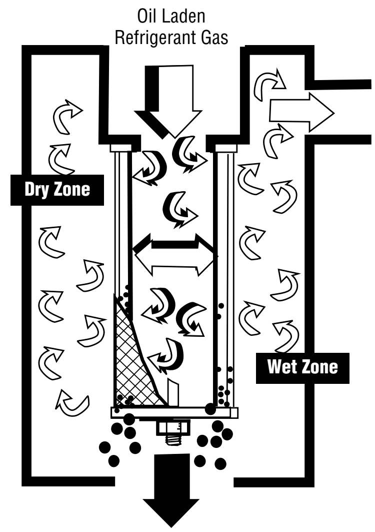

Fig. 4. This cross-section illustrates what happens inside a coalescent separator during operation.

The coalescing filter is larger and can catch smaller particles than the filter/dryers so it will clean up a system faster and more thoroughly.

Service organizations or supermarkets should realize enormous savings from coalescents' cleaning capabilities alone. These savings, combined with consistently higher separator efficiency, will quickly offset the 10% to 15% higher initial cost of the units as compared with conventional separators.

The Future

As indicated previously, we can certainly expect that conventional separators will continue to be widely used. Indeed, Temprite will continue to supply them.

Moreover, a strong case can be made for using an oil separator in almost every refrigeration — or air-conditioning — system. Separators not only enhance overall performance and address specific problems, but substantially improve efficiency and decrease energy costs.

Engineering system analysts say that with coalescent separators, 5% to 15% increases in system capacity can be expected.

But, most important, consider that the new refrigerants and their resulting system redesign present an excellent opportunity to ensure that your refrigeration system will be cost-efficient and reliable over the long haul.

For more information or a product catalog contact:

Temprite

1555 Hawthorne Lane
West Chicago, Illinois 60185 USA
FAX (630) 293-9594

1-800-552-9300
www.temprite.com

Printed in U.S.A.