Eliminate Problems Created by Oil Carry-Over and Sludge:

"Build-up of lubricating oil (carry over) in refrigeration and air-conditioning systems is, perhaps, the oldest unresolved problem vexing the industry"

This statement was published in the ASHRAE Journal as recently as April 1995. Oil related problems cost the industry millions in terms of service calls, energy costs and compressor burnouts. Evidence a statement by compressor rebuilders ***Fridgemotors Ltd.*** published in ***AC&R News***…"loss of lubrication is the largest single effect of compressor failure". It may be significant that no less than 49 companies are listed under "compressor rebuild/remanufacture" in the ***RAC Yearbook***.

Oil Carry Over…How much of a Problem?

The scale of oil carry-over is probably much greater than is generally realized. In a previous issue of ***Service Engineer***, Glen Moore highlighted that this is a serious problem even on new systems. Compressor seizures occur, due to lack of oil. In such cases the problem my be due to a number of causes: The system may not have been fitted with an oil separator. The oil separator fitted may have been wrongly sized for the system duty or just inefficient. The use of large diameter ring mains reduces the velocity of the gas/oil mixture (mass flow) preventing the oil from returning to the compressor. If oil carried over to the system is not replaced, the compressor will seize. The causes of oil failure are many and varied.

It pays to concentrate on eliminating oil carry over up front, rather than spend time and money to rectify the problem. Prevention is better than the cure.

What about Scrolls?

It is generally accepted that the carry-over rate on Scrolls is much less than on reciprocating compressors. However, ***Copeland*** warns that "oil leaves the compressor at start-up, regardless of the low oil carry over of the scroll".

The problem increases with multi-compressor systems subject to variable load conditions where compressors may be downloading on a regular basis. ***Copeland*** application guidelines highlight the potential for oil carry-over by recommending that the number of start-stop cycles be limited to 10 per minute. According to ***Copeland***, " a high cycling rate, will pump oil into the system and may lead to lubrication failure". So, oil carry-over is a problem even on new systems and Scroll compressors.

The Effects of Oil Carry-Over.

Clean Oil in a system insulates the evaporator and the condenser, thus reducing efficiency. This makes the compressor work harder which increases energy and maintenance costs and, subsequently reduces the life-cycle of the compressor. Too much oil in the pipework will return down the suction line and result in compressor failure. Installations with electric defrost systems are particularly at risk. Oil in the system cannot remain clean long, especially the new POE oils with their powerful solvent effect. Oil in the system quickly combines with moisture, acids, metal particles and other contaminants to produce sludge. This destroys the lubricating properties of the oil and results in compressor burnout. A major effect of dirty oil circulating in the system is that it quickly clogs up the pores of filter-driers and greatly reduces their capacity to do the job for which they were intended…to remove moisture and acids. Eventually, this results in "plating" of the crankshaft journals which will guarantee a compressor failure.

Understanding Oil Separation.

The process of oil separation is effected in two states. The oil/gas mixture leaving the compressor and entering the larger diameter oil separator body is allowed to expand. Its velocity is greatly reduced. All of those atomized oil droplets in the mass flow that are madly putting on the brakes collide into one another begin forming larger and larger droplets. These larger droplets then fall to the bottom of the oil separator through gravity. This process would take place in an empty can. The larger diameter the better. Smaller droplets in aerosol form require some sort of mechanical agitation to cause them to collide, grow larger and heavier before falling to the bottom of the separator. Refrigerant oils in aerosol form range from less than 0.1 to 40 microns in size. The majority of aerosols in the discharge gas are in the 0.4 to 10 micron range with more than 50% of the aerosols less than 1 μm (micron) in size. Oil in aerosol form is particularly difficult to remove. If this oil is not converted to droplets big and heavy enough to drop out through gravitational pull, it will be re-entrained. If velocity is too low, there will be insufficient forces to cause the smaller droplets to collide and drop to the sump.

The chart below shows the typical aerosol distribution exiting the compressor.

About Oil Separators.

Oil separators as we know them have been around for over 50 years. Efficiency of most separators on the market was pretty much the same. That is to say, around 60% to 80%. These were fine when systems were less complex. However, with the introduction of multi-compressor and dual temp systems, long pipe runs, electric defrost and floating head pressures, subsequent oil carry-over problems multiplied.

Conventional Oil Separators.

Conventional oil separators…and these include impingement screen, centrifugal, cyclonic, helical, etc., are dependant on velocity for their performance. It’s what makes them work. If velocity drops off, efficiency goes with it. The performance of conventional oil separators is unpredictable on systems subject to variable load conditions where separation efficiency fluctuates with the velocity. Go below 50% load and the separation efficiency becomes unreliable.

Coalescent Oil Filter Separators.

The process of separation by coalescing filter is employed in the petrochemical and industrial gasses industries, where product purity must be maintained. The diagram shown below shows how the process works.

Separators designed around the coalescing filter principal have the ability to remove 99.997% of the oil droplets greater than 0.3, removing virtually all of the oil from the mass flow. Because it’s totally non-velocity dependant the separation efficiency is guaranteed across the systems full range of operating conditions. It remains 98% or more efficient even at 10% of the systems rated capacity. The graph below compares the efficiency of different oil separators.

Oil Filtration at 0.3 microns

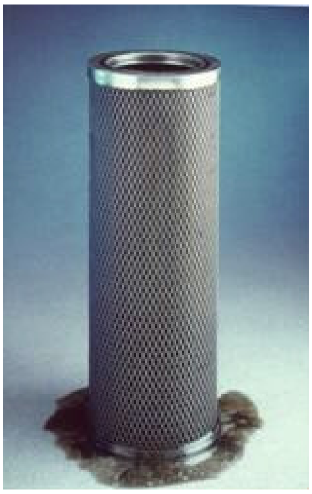
Every system should have a filter of at least 10 microns. One major compressor manufacturer voids their warranty if this condition is not met. The coalescing filter element is designed to remove all solid contaminants to 0.3 μm. In contrast, a suction line filter can only pull out 30 to 50 microns. This adds a higher level of protection to all components in the system. This especially true for compressors and metering devices. This level of filtration exceeds that of any other component ever built into a commercial system. This filtration is a by-product of the coalescent separator’s efficiency, effectively killing two birds with one stone.

Coalescing Filters.

The photograph below shows a typical filter element in “as new” condition.   In a correctly designed system, the pressure drop (Δp) across the filter element will be negligible.   Remember, the separator filter element is 90% void material. It’s made of exceptionally pure borosilicate glass fibers frozen in place by a binder specially designed for refrigeration applications. Even when the filter element is 50% plugged with contaminants, there’s only a minimal 5 pound Δp.

Retrofitting *Temprite* 920 Series Coalescent Oil Separators to an Existing System.

Fitting a coalescing filter separator is recommended as part of any regular maintenance programme. During a refurbishment programme in a US supermarket, a coalescing oil separator was retro-fitted to an existing system. This particular system had been plagued with poor performance due to excess oil carry-over and sludge. Within the first 48 hours, service techs pulled over 100 litres of oil out of the system. Compressor run time was reduced from 19 to 13 hours per day. And after a total of three filter changes, the oil was restored to its original color. The photograph below shows a coalescent oil filter after being removed from a retro-fit that had had a compressor burn-out.



A coalescent separator will clean up even the dirtiest system, even after a burn out. It may take more than one filter change, but compared with alternative methods, it will achieve the best results with the lowest cost and the least mess. Moreover, the original system efficiency will be improved, running and service costs will be reduced and the life cycle of the compressors greatly extended.

On New Systems

Coalescing oil separators eliminate many problems associated with oil carry-over in new systems. Because separation efficiency is so high, the need to continually check oil levels and top-up reservoirs after commissioning is greatly reduced. Filtering out all solid contaminants to 0.3µm keeps the drier cores clean for moister and acid removal. Oil logging in low-lying pipework and large diameter ring mains ceases to be a problem. Less time is necessary in designing pipe layouts and where to fit oil traps. Systems subject to variable load conditions, long pipe runs, floating head pressures and electrical defrost, etc., are protected from oil return down suction lines, which can be potentially fatal to compressor operation.

"Best Thing We Ever Did."

The following comments come from a major UK pack builder who incorporated coalescing separators into his system over three years ago: "Radford adopted the ***Temprite*** [920 Series] coalescing oil separation system in conjunction with our own (***Radford's***) High Pressure Oil Management Control some three years ago. During this period we have manufactured compressor sets using approximately 3500 compressors. For this same period compressor losses [have] been in the order of less than one percent. Some of the earlier sites have undergone cabinet refits. Engineers have reported oil-free liquid and suction lines…even in low level pipe work. ***Temprite*** [920 Series] coalescing oil separators are also installed at our testing laboratories in Chew Stoke. Once again, we have encountered oil-free refrigerant pipelines when the cabinets have been uninstalled after testing. We have not encountered any service issues or operating problems. Best thing we ever did."

-- Mark Lawson at ***Radford Retail Systems***