OIL MANAGEMENT FOR COMMERCIAL REFRIGERATION SYSTEMS

Recent Good Practice Guides have covered the correct sizing of refrigeration pipework to ensure any oil circulating in the system is returned to the compressor. In this guide we will look at how an oil separator operates and the installation in both a simple and multi-compressor system.

Role of an Oil Separator

The oil separator is intended to be used in parallel with the correct pipe sizing to improve the operation of the system. It will not eliminate problems of oil circulation associated with poor system design.

The specific applications where oil separators are commonly used are:

- Systems with long pipe runs
- Low temperature systems as the oil tends to become thicker and more difficult to move around the system.

By removing oil from the discharge gas, the system efficiency is increased. Oil in a refrigeration or air conditioning system reduces the efficiency of the system by:-

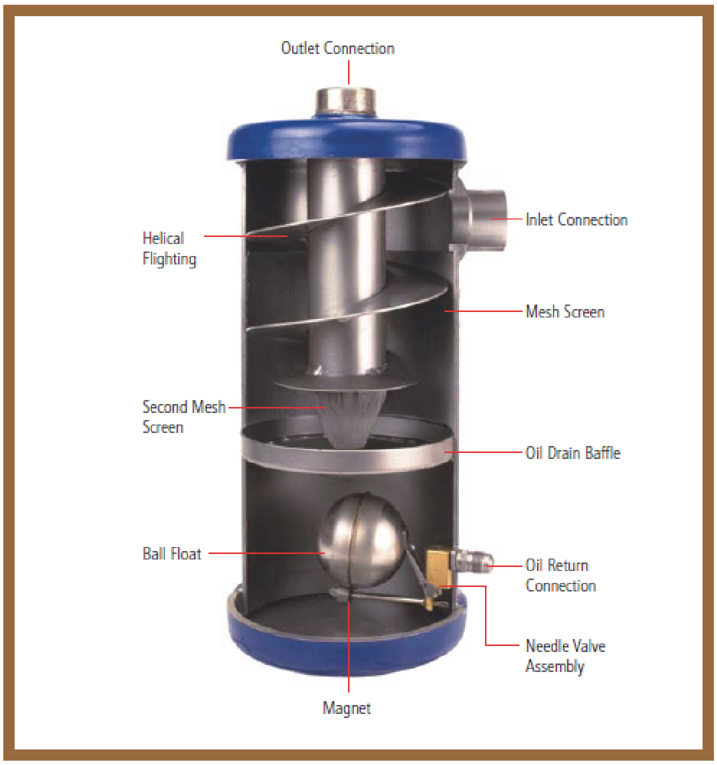
- A reduction in heat transfer due to oil coating of the condenser and evaporator walls.
- Displacing refrigerant volume resulting in an increase in system mass flow.

Oil does not change phase from liquid to gas and is therefore a very poor refrigerant! A minimal amount of oil flowing through the system is necessary to provide lubrication to valves.

Operation of an Oil Separator

Conventional oil separators consist of a vertical shell with inlet and outlet connections and a float operated needle valve at the bottom of the separator with a connection to allow oil to return to the compressor. The discharge gas containing the oil in a fine mist passes through an inlet screen causing the fine particles of oil to combine into larger particles which fall to the bottom of the separator. The refrigerant then passes through an outlet screen which removes further residual particles. Once sufficient oil has collected at the bottom of the shell to allow the float to rise, the needle valve opens and the oil is returned to the compressor under the effect of the pressure difference in the oil separator which is at discharge pressure and the compressor crankcase which is slightly above suction pressure.

Improvements have been made to oil separators in recent years and manufacturers now claim efficiencies of in excess of 90% when operating with a correctly designed system. Below is a cross section of a Helical oil separator manufactured by Henry Technologies.



Sectional View of a Helical Oil Separator

Oil Management (continued)

Refrigerant gas containing oil in aerosol form encounters the leading edge of the helical flighting. The gas/oil mixture is centrifugally forced along the spiral path of the helix causing heavier oil particles to spin to the perimeter, where impingement with a screen layer occurs.

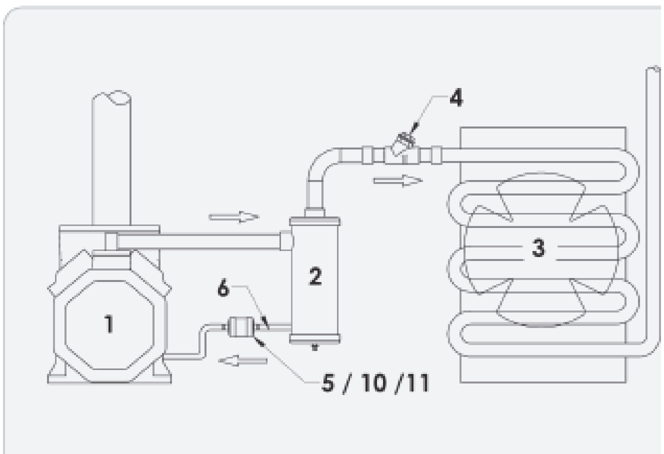
The screen layer functions as both an oil stripping and draining medium. Separated oil flows downward along the boundary of the shell through a baffle and into an oil collection chamber at the bottom of the separator. The oil drain baffle isolates the oil chamber and eliminates oil re-entrapment by preventing turbulence. The virtually oil free refrigerant gas then exits through a second screen fitting just below the lower edge of the helical flighting. A float activated oil return needle valve allows the separated oil to return to the compressor crankcase or oil reservoir. There is a permanent magnet positioned at the bottom of the oil collection chamber to capture any system metal debris, which could impair the operation of the needle valve.

Coalescent Oil Separators

An alternative high efficiency design of Oil separator is the coalescent type. In this design the higher efficiency separation is provided by glass fibre filtration. This causes the small droplets of oil to combine and form larger droplets which then drain to the bottom of the shell for return to the compressor as in a conventional oil separator.

Single Compressor Systems

A single compressor application has the most basic oil system as can be seen below:



The compressor discharge is piped to the inlet of an oil separator (2) and the outlet of the oil separator is piped to the condenser (3). A discharge check valve should be fitted (4). This prevents condensed liquid from the condenser entering the oil separator and then potentially back to the compressor crankcase. An oil return line (6) is connected from the oil separator through an oil strainer (5), oil filter (10) or oil filter-drier (11), to the compressor crankcase. An oil filter-drier is recommended for HFC/POE systems instead of individual oil strainers, where both filtration and moisture removal is required.

A float valve in the oil separator opens and feeds a small amount of oil by-passing the rest of the cooling system. The oil is returned under discharge pressure to the crankcase. The float valve prevents hot gas from bypassing to the crankcase by closing when the oil level falls.

It is recognised best practice to fit a solenoid valve, sight glass, and shut-off valve in the oil return line. The components are not shown in the diagram.

When installing a new oil separator it should be selected from manufacturer's data and based on the system capacity rather than the size of the oil separator connections.

Oil Management Systems for multiple compressor applications

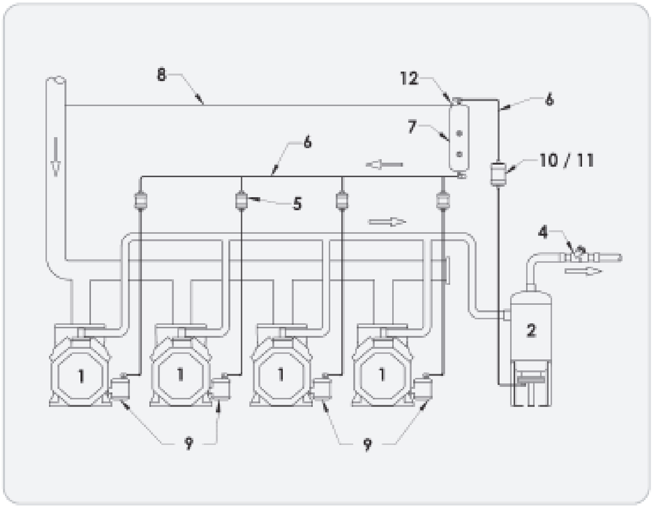
The majority of multiple compressor systems require an oil management system due to:

- Varying volumes of refrigerant flow in the system when operating with a different number of compressors.
- The need to maintain oil levels in each compressor

Traditionally these systems were of the Low Pressure type with mechanical regulators fitted to each compressor. These have been gradually superseded by the high pressure type as a result of development of electronic oil regulators. These are suitable for HFC/ POE oil systems.

Oil Management (continued)

Low Pressure Oil Management Systems

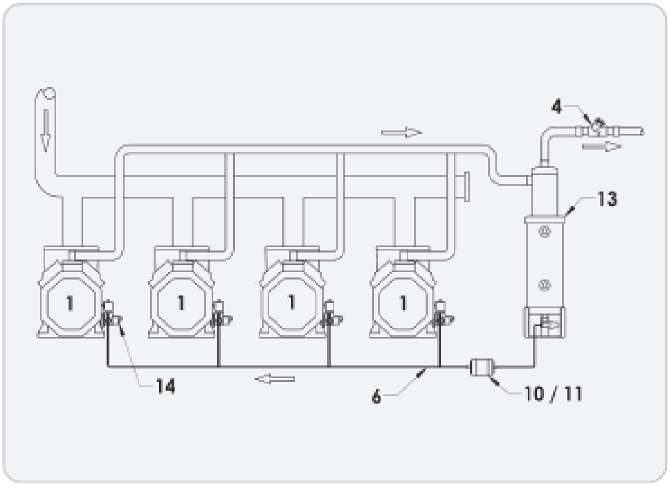


Low Pressure Oil Management System diagram

This diagram shows the system being used for parallel compressors and uses three main components: Oil Separator (2), Oil Reservoir (7) and Oil Level Regulators (9). The common discharge is piped to the inlet of the oil separator and the outlet of the oil separator is piped to the condenser via a discharge check valve (4). An oil return line is connected from the oil separator to the top valve of the oil reservoir (7). A vent line (8) is installed to the suction line, using a pressure valve (12), to reduce the pressure in the reservoir. This makes a low pressure system. The pressure valve will maintain the reservoir at a set pressure above suction. Although mechanical oil level regulators (9) are shown in the diagram, Electro-mechanical and Electronic oil level regulators can also be used.

The bottom valve of the oil reservoir is piped to the oil level regulators mounted on the compressor crankcases. These regulators open to feed oil as the oil level drops and close as the oil level rises to the set level. In this way, the oil level in each compressor is controlled. An oil strainer (5) per regulator should be used to remove debris from the oil. One oil strainer is installed between the oil reservoir and each regulator. Alternatively, the oil strainers may be replaced by one oil filter (10) or an oil filter-drier (11). The oil filter or oil filter-drier must however be installed between the separator and oil reservoir. Due the scavenging nature of POE oil, it is recommended to install either an oil filter or oil filter-drier or a HFC/POE system instead of individual oil strainers.

High Pressure Oil Management System



High Pressure Oil Management System diagram

High pressure oil systems remove the need for a separate oil reservoir. This type of system also reduces the amount of pipework and fittings and consequently reduces the potential number of leak points in a system. This system uses an oil separator reservoir which consists of a normal oil separator and reservoir manufactured as one unit.

A high pressure oil system relies on the oil level regulators being able to operate with a high pressure differential. Mechanical oil level regulators should not be used on this type of system. The Electronic oil level regulator is normally used for this application. Electro-mechanical regulators can also be used provided this is approved by the manufacturer. High pressure systems are not suitable for HCFC/mineral oil systems due to potential foaming problems.

A discharge check valve should be fitted (4). An oil separator-reservoir (13) is fitted in the discharge line similar to an oil separator. The oil return connection, positioned at the bottom of the vessel, is piped to the oil level regulators. An oil filter (10) or oil filter-drier (11) should be installed between the oil separator-reservoir and the regulators (14).

It is recognised best practice to fit a solenoid valve, sight glass, and shut-off valve in the oil return line. These components are not shown in the diagram.

Oil Management (continued)

Components for Oil Control

Oil Separator – The function of an Oil Separator is to remove oil from the discharge gas and return it to the compressor, either directly or indirectly. This helps maintain the compressor crankcase oil level and raises the efficiency of the system by preventing excessive oil circulation. Oil separators are not 100% efficient, so installing an oil separator should not be viewed as a replacement for oil traps, accumulators, or good oil return piping practices..

Discharge Check Valve – The function of a Check Valve is to allow fluid flow in one direction only. This prevents condensed liquid refrigerant returning down the discharge line into the separator. If this check valve is not installed the separator can feed excessive liquid refrigerant to the compressor on start up. This can cause oil dilution, excessive foaming, erratic oil pressures and possible compressor damage. The check valve must be installed after the oil separator.

Oil Strainer – The function of an Oil Strainer is to remove system debris from the refrigerant oil. Their purpose is to protect compressors and oil level regulators from damage. For recommendations on HFC/POE systems, refer to section on oil filters and oil filter-driers.

Oil Reservoir – The function of an Oil Reservoir is to provide a holding charge of oil, as part of a Low Pressure Oil Management System. The amount of oil circulating in a system varies depending on a operating conditions. The oil reservoir caters for these fluctuations by providing additional storage capacity.

Mechanical Oil Level Regulators – The function of a Mechanical oil Level Regulator is to control the oil level in the compressor crankcase. This protects the compressors from damage. There are two main types of oil level regulators, fixed level and adjustable level. The fixed level regulators have an allowable oil pressure differential range of 0.35 to 2.1 barg. The adjustable level regulators have an allowable oil pressure differential range of 0.35 to 6.2 barg. Oil pressure differential is the difference between the crankcase pressure and the pressure in the oil reservoir. Gravity pressure head should be included also, if applicable. Some regulator models are fitted with an equalisation connection that enables the oil levels between several compressors to be balanced.

Oil Filter – The function of an oil filter is to remove system debris from the refrigerant oil. An oil filter is recommended for HFC/POE systems instead of individual oil strainers, where filtration only is required.

Oil Filter-Drier - The function of an Oil Filter-Drier is to remove both system debris and moisture from the refrigerant oil. An oil filter-drier is recommended for HFC/POE systems instead of individual oil strainers, where both filtration and moisture removal is required.

Pressure Vent Valve - The function of a Pressure Vent Valve is to maintain a positive pressure in the Oil Reservoir above the compressor crankcase pressure. Three different pressure settings are available; 0.35 barg, 1.4 barg and 2.4 barg. A higher pressure differential will increase the oil flow rate from the oil reservoir back to the compressors. The pressure setting should be selected taking into account the allowable oil pressure differential of the oil level regulator type.

Oil Separator-Reservoir - The function of an Oil Separator-Reservoir is to provide a Separator and Oil Reservoir in one unit. It is designed for high pressure systems and eliminates the need for a separate Oil Reservoir and its associated piping.

Electronic Oil Regulator – The function of the Electronic Regulator is to control the oil level in the compressor crankcase. This protects the compressors from damage. This regulator can be used on high pressure systems.

With acknowledgements to Henry Technologies for use of material and diagrams