Oil management

Oil management

1) The oil in a refrigeration system

a : What is the function of oil in a refrigeration system?

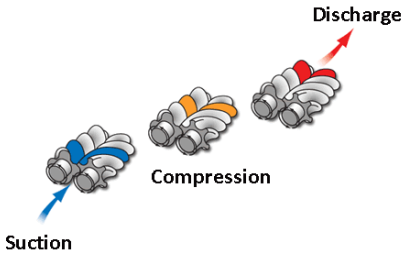
The oil has a key function in a refrigeration system because it contributes to ensure:

- Lubrication of the mobile parts of the compressor
- Evacuation of the heat due to frictions of the mobile parts
- Air tightness between the compression stages in rotative compressors.

b : What are the consequences of oil presence in the refrigeration system ?

All the oil does not stay in the compressor cranckase and a part is brought into the refrigeration system:

- During stages of start-up of the compressor, due to the sudden evaporation of the refrigerant dissolved in the oil
- By the piston rings in piston compressors
- By its close contact with the refrigerant in rotative compressors.



The volume of oil ejected by the compressor circulates with the refrigerant and has the following effects:

- Decrease in the oil level in the crankcase, which can lead to a mechanic breakdown

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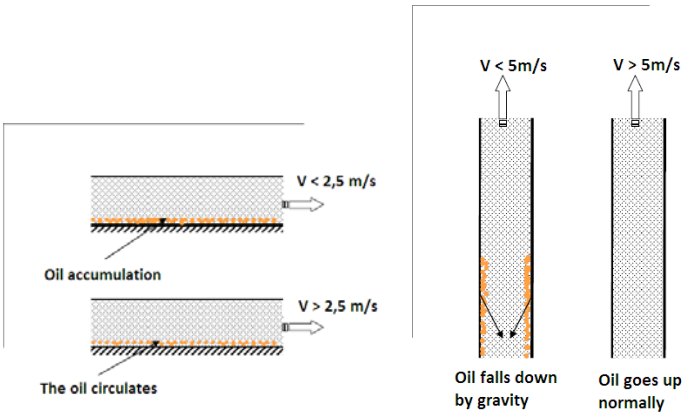
- Modification of the quality, physical and thermodynamic properties of the refrigerant
- Decrease in the efficiency of exchangers (evaporators and condensers); the lost of capacity can reach 30% with rabbet tube evaporators
- Oil retention in « oil traps » and low speed areas. This oil may return suddenly and generates a liquid hammer (slugging)
- The damage into the compressors are often irreversible.

2) What are the different techniques of oil separation?

To enable the oil ejected of the compressor to return to the crankcase, it is necessary:

- To respect the speed in the pipes in order to ensure the circulation of oil. Especially when the refrigerant is in gas stage as its miscibility with oil is low.



- To use an oil separator which function is to recover a substantial quantity of oil and to make it return to the compressor as soon as possible.

The four main techniques selected in the design and the manufacture of oil separators intended to refrigeration systems are:

- **Coalescence**: phenomenon into which two substances identical but separated, tend to concentrate.
- **Centrifugation**: this technique uses the centrifugal force in order to separate refrigerants with different densities.
- **Speed reduction**: this technique enables the heaviest molecules to follow their trajectory, by inertia, while the lightest molecules scattered into the internal volume of the oil separator.
- **Change of direction**: this technique, in association with the previous one, enables to improve the efficiency of droplet separation (heavy molecules) present into the steam (light molecules). The droplets keep their initial trajectory because of their mass and their initial speed, while steam is directed towards the outlet connection of the oil separator.

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The manufacturers of oil separators will select one or several separation techniques according to the level of efficiency researched.

Coalescence can be obtained with metallic sieves or coalescent cores which will be then necessary to replace regularly.

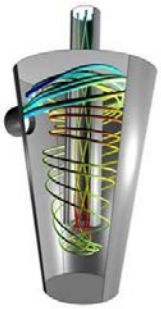
Metallic sieve

Coalescent cartridge

Centrifugation can be obtained with turbulators, helicoidal systems or special fitting in the separators (cyclone).

Turbulators

Helical system



Cyclone

The patented system of oil separation selected by CARLY for its oil separators **TURBOIL** has the advantage to combine several techniques:

- Coalescence with metallic brushes
- Centrifugation with the system of turbulators
- Speed reduction
- Change of direction.

The internal fitting of **TURBOIL** separators enables to differentiate the separation and oil reserve stages so as to limit the risks to carry over the oil stored.

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3) Conclusion

It is possible to optimize the oil management in a refrigeration system by respecting the 3 following rules:

- Respect of the rules in the dimensions of the pipes so as to enable the oil return by sufficient speeds
- Choice of a quality brand oil separator, which integrates well the different techniques of oil separation in the design of its products
- Correct selection of the oil separator.

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The oil management - continuation

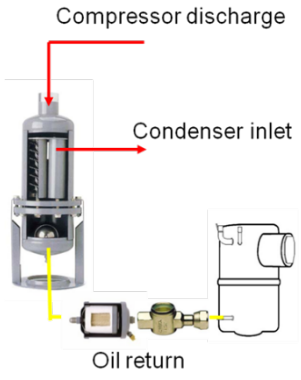
4) Management of oil return

The oil separator ensures the separation of the oil contained in the refrigerant.
The oil, retrieved in the separator, gets back to the crankcase(s) of the compressor(s) thanks to one of the following oil return management systems.

a : Mono-compressor circuit
b : Multi-compressors circuit
c : High pressure oil return

a : Mono-compressor circuit

In a thermodynamics system with only one compressor, oil separation is usually ignored.
But it is often necessary, especially when there is a long distance between the cold rooms (refrigerated cabinets) and the compressor.
The oil separator should then be connected to the discharge pipe of the compressor and the oil separated gets back directly to the crankcase of the compressor.



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This kind of assembly is easy and very efficient.
The wide range of CARLY TURBOIL enables to optimize their selection, for small capacities (< or = 80kW).

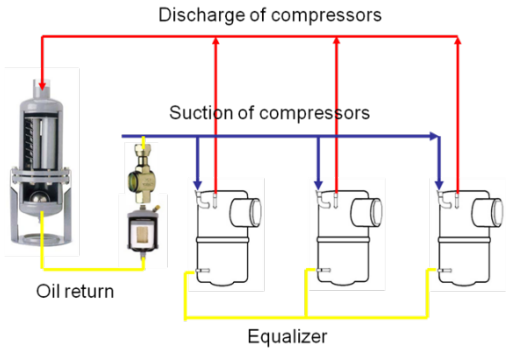
b : Multi-compressors circuit

In a circuit with several compressors in parallel (rack assembly), the oil management system must be designed according to the application.
For example, a multi-compressors installation for a supermarket will not work the same way as the installation of a refrigerated warehouse.
It is very important to take into account all the working parameters of the refrigeration installation in order to select the most suitable oil separator(s).

Some principles of oil return management are described hereafter.

b-1 : Oil return at suction

A common oil separator for all the compressors is connected to the discharge collector of the rack.
The oil return is made in the suction collector.



The oil present in the suction collector is sucked by the compressors.
The pressure drops in the suction pipes, between the compressors and the collector, are not exactly the same.
That is why the quantities of oil sucked by the compressors can be different from those that were ejected, and cause some differences in the levels of the compressors crankcases.
Some oil levels abnormally high or low can cause some damages, or even the breakage of the compressors.
It is possible to maintain the same oil level in the different compressors crankcases by installing a balancing pipe.
This pipe must have a section big enough to:

- Avoid siphoning phenomenon between the crankcases
- Ensure a balancing of the oil levels between the crankcases
- Ensure a balancing of the pressures between the crankcases. (Please refer to the recommendations of refrigeration compressors manufacturers)

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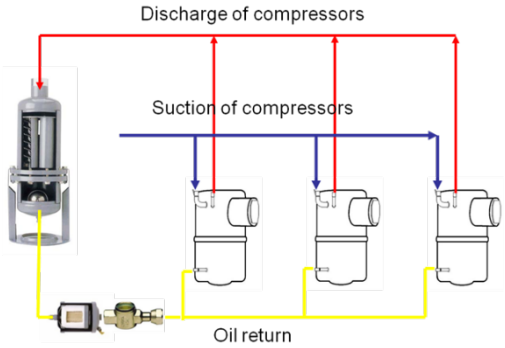
b-2 : Oil return to the crankcases

In order to minimize the differences in oil levels of the compressors crankcases, the oil return can be made directly towards the compressors thanks to the balancing pipe.

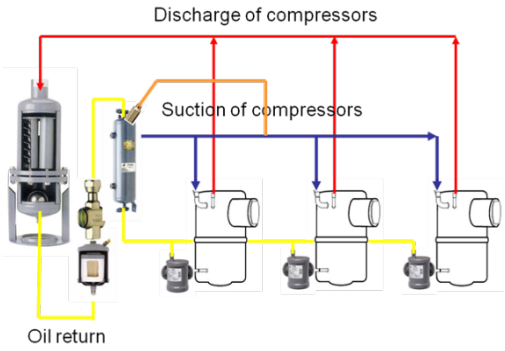


b-3: Centralized oil return

This assembly is the most frequently used as soon as the refrigeration rack:

- Supplies a big number of cold rooms or refrigerated cabinets
- Is located at a long distance from the condenser(s) and the evaporators.

When starting up the installation, it is often necessary to fill in the oil traps and the siphons.
It is also essential to have enough oil reserve.
The oil separated is returned towards an oil receiver.
The receiver enables to supply the oil level regulators, which function is to maintain the oil levels stable in the compressors crankcases.



An excess pressure in comparison with compressors crankcases is maintained in the oil receiver, so as to enable a good oil supply of the oil level regulators.
A differential valve has the function to keep an excess pressure in the oil receiver and to eject the excess of pressure towards the suction collector.

b-4 : One separator per compressor

The oil separator is usually selected according to the maximal refrigerating capacity of the rack.

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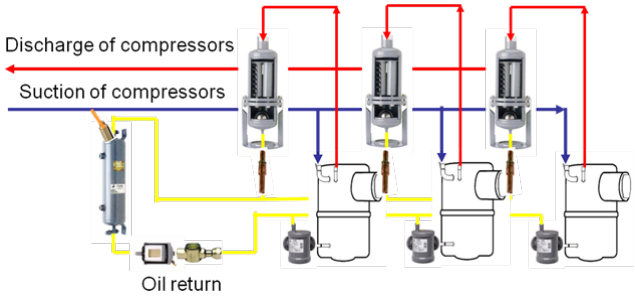
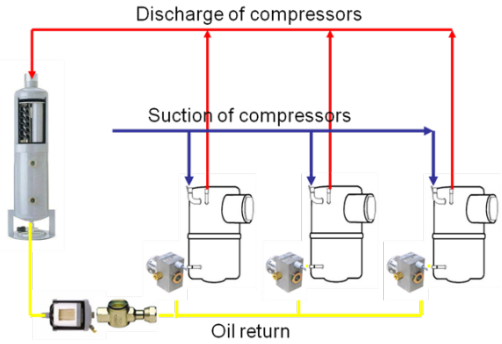
When the rack is fitted with more than 3 compressors and that only one compressor is working, the variation in the flow of refrigerant may make the efficiency of the oil separator decrease.
Then it is recommended to install one separator per compressor.
This assembly enables on the one hand not to be limited in the number of compressors installed in parallel, and on the other hand to be able to adapt to all kinds of installations.
The association compressor/oil separator is usually easier and the efficiency is always optimal.
According to the complexity of the installation, the oil returns of the separators will be made directly to the corresponding compressors or to an oil receiver.



c : High pressure oil return

This technology uses oil separators without floating device.
The oil separated is stored in the lower part of the oil separator and makes the oil reserve.
The oil gets back to the compressors crankcases through electronic oil level regulators.
Actually, the oil is stored in high pressure and cannot get back to the crankcases, neither directly, nor through mechanical oil level regulators.
Mechanical regulators cannot work with an oil return in high pressure because their working principle relies on an equilibrium of forces acting on the floating device.



According to the complexity of the installation, it might be necessary to use an additional oil receiver.
The receiver enables to store the quantity of oil necessary to fill in the siphons and the oil traps of the installations.

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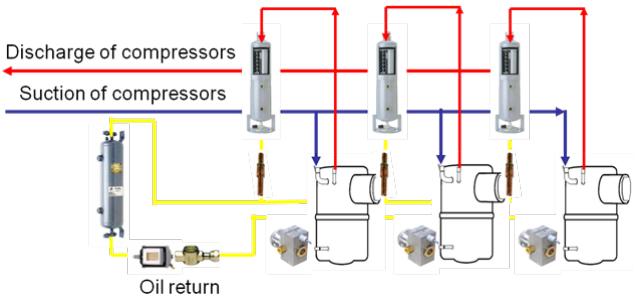

Nota

The efficiency of an oil separator never reaches 100%, whatever its technology.
Using an oil separator in a rack does not exempt the designer or the installer from respecting the common rules.
When selecting the oil separator and choosing an oil return circuit, it is necessary to take into account all the parameters of the refrigeration installation and its working.

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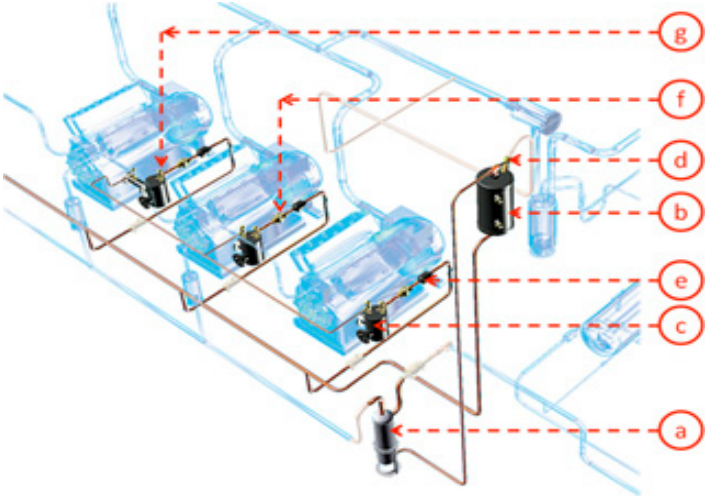
The oil management - continuation and end

5) Components of the oil return circuit



a : Oil separator TURBOIL

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The oil separator is connected to the discharge pipe of the compressor.
It ensures the separation of the oil contained in the refrigerant.
The oil, recovered in the separator, is stored in the lower part containing the mechanism valve / needle / float.
When the oil level is high enough to lift the float, the valve / needle system opens and allows oil to return to the compressor's crankcase.
The oil return is made naturally, due to the difference in pressure between the oil separator (HP discharge) and the crankcase (LP suction).

Several types of oil separators can be proposed:

- **TURBOIL** « welded », for mono compressor or small capacity installation.

- **TURBOIL-F**, « flanged», for all types of installations, they are particularly suitable for multi-compressors racks.
  The removable part is the float / valve / needle mechanism, which is the most vulnerable part because it is subjected to vibrations and dirt.
  It may thus be cleaned or replaced if necessary.

- **TURBOIL-R** « receiver », they integrate the function of oil receiver and haven't got the float / valve / needle mechanism.
  The oil return is thus realized in high pressure:
  - Directly to the electronic oil level regulators
  - Via a pressure regulator, when using a mechanical oil level regulator.

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b : Oil receiver HCYR

The complex refrigeration installations require systems of production's capacity variation (speed control, cascade compressor control)
Siphons can be necessary in the installation's circuit and oil traps may be created. Therefore, oil in the refrigerant can then be trapped.
The oil receiver allows ensuring the compressor's oil supply, during the startup phase and/or during low power operation.
The oil receiver volume is determinate by the number of compressors arranged in parallel and their swept volumes.

c : Mechanical oil level regulator LEVOIL

The oil level regulator is installed instead of the compressor's sight glass and makes it possible to:

- View the oil level in the compressor's crankcase
- Maintain a level of oil in accordance with the prescriptions of the compressor's manufacturer.

Le oil level regulator got a float/valve/needle system which insures the oil supply into the crankcase as soon as the level is below the nominal value (generally in the middle of the oil level sight glass).
The stability of the oil level in the crankcase is achieved by maintaining a constant pressure difference between the oil inlet of the regulator and the crankcase.
The pressure difference must be compatible with the regulators features, for example between 1 bar and 4.5 bar for the **LEVOIL** range.
When the fastener of the compressor's sight glass doesn't match the LEVOIL's flanges, some adapters (HCYN 1A) may be used (**see page 51.6 of technical catalog**).
There are 3 families of LEVOIL:

- **LEVOIL 22** and **LEVOIL 23**, universel regulators
- **LEVOIL 23 BO** and **23 SC**, specific regulators
- **LEVOIL 33 RE**, adjustable regulato.

d : Differential valve HCYCT / HCYCTR

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The differential valve permits to maintain an overpressure into the oil receiver, in order to ensure constant oil distribution to the oil level regulators.
It is attached to the oil receiver and is usually connected to the suction line.
The calibration of the valve permits to relieve the excess pressure of the oil receiver to the suction manifold and to maintain a constant pressure difference between the oil supply pressure of the oil level regulator and the compressor's crankcase.
The calibration of the valve can be set in our factory (**HCYCT 1** = 0.35bar, **HCYCT 3** = 1.4bar and **HCYCT 4** = 3.5bar) or adjusted on site (**HCYCTR** : 0.35 bar δ P δ 3.5 bar)

e : Oil filter HCYF / HYDROIL 163 / HCYBF

The oil filter allows catching the impurities which are into the oil, before its reintegration into the compressor's crankcase.
The oil filter is usually connected between the oil separator and the compressor or between the oil receiver and the oil level regulator.
The use of an oil filter is particularly recommended when an oil level regulator is connected.
The oil filter may contain a stainless steel mesh sieve (**HCYF**), a synthetic fiber filter associated with a desiccant (**HYDROIL 163**) or a replaceable core (**HCYBF**).
The **HYDROIL 163** is particularly recommended when using at the same time HFC refrigerant and POE oil, which is very hygroscopic.
The addition of drying agents (molecular sieve) makes it possible to catch the moisture contained in oil before its return in the compressor's crankcase, and so to delay or even to cancel the creation of acidity.

f : Oil sight glass HCYVP

The oil sight glass permits to visualize the oil presence and its aspect.
It can be connected either:

- On the oil output line from the separator. In that case, it makes it possible to check if the oil separator works well.
- On the oil level regulator input. In that case, it makes it possible to check the oil presence.

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g : Isolation valve HCYVI

The isolation valve is intended for the mechanical oil level regulator.
It makes it possible to isolate the regulator in order to facilitate the oil line maintenance operations, without requiring the complete oil change of the circuit.