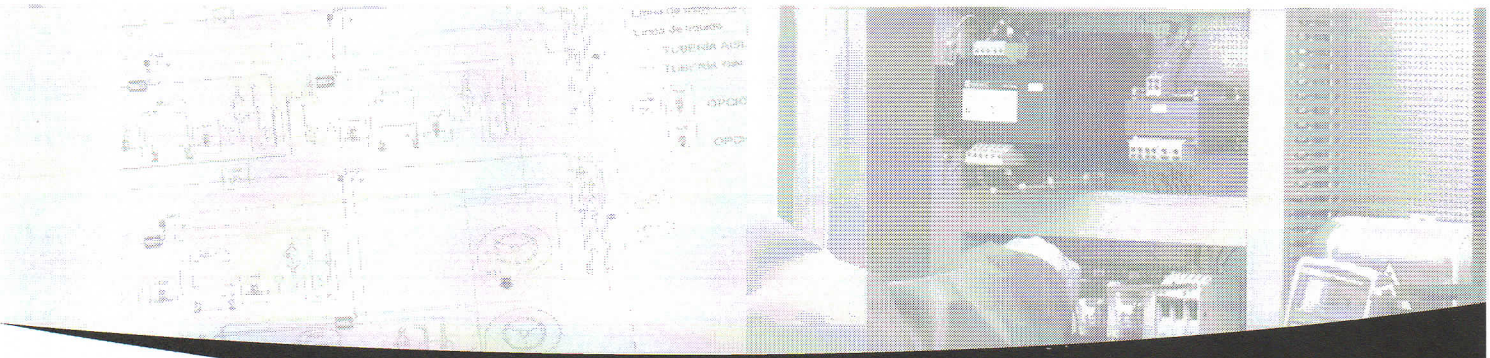
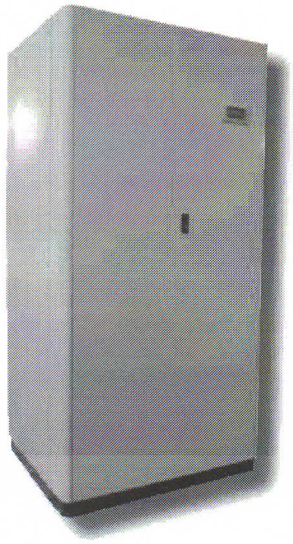
Installation, operating and maintenance

CCU - Piping design criteria



••• Providing IT Climate Technology



CCU-RPiping-IOM-0409-E

Design criteria for refrigerant piping

[Version 1.5]

Piping for refrigerating systems should be designed according to 3 main principles:

1. Reduction of the pressure drops to avoid significant decrease of the performances
2. Ensure correct oil return also at partial load, when the refrigerant speed is reduced. Please note that the pressure drop depends also on the surface friction between gas and pipe. Surface friction is the "engine" for the oil drag. The oil drag is much critical in the suction line because of the lower temperatures and of the consequent higher oil viscosity.
3. Avoid the making of "flash vapours" on the liquid line and consequent dysfunction of the expansion valve. Avoid having high liquid speeds to avoid pressure peaks when the solenoid valve is closing.

General Parameters

- minimum gas speed to ensure oil drag even in vertical piping, for discharge lines is 4 m/s
- minimum gas speed to ensure oil drag even in vertical piping, for suction lines is 5 m/s
- For liquid line, the miscibility between oil and refrigerant is 100 % (in our T field) so that no minimum speed is required.

In the following pages are shown the tables with all the most important parameters, for the whole range of models.

12. REFRIGERANT PIPES

On site piping has to be installed by professional workers using only CUB quality copper pipes. Take care in use of nitrogen during all brazing operations in order to avoid humidity and dirty in pipes.

Refrigerant		R410A	R410A	R410A
INNOV@ ENERGY Model		0281-0592	0130	0060
HP horizontal Gas line	[mm] [Inch]	15,88 5/8	12,70 1/2	9,53 3/8
Hp vertical Gas line	[mm] [Inch]	12,70 1/2	9,53 3/8	7,94 5/16
Liquid line	[mm] [Inch]	12,70 1/2	9,53 3/8	9,53 3/8

Table up to 10 m of pipe length

The declared performances are calculated for a max lines length of 10m, in the next table, the absorbed compressor power and the cooling capacity variation percentage for 20m lines, are showed:

INNOV@ ENERGY Model	0281-0592			0130			0060		
Frequency	30Hz	90Hz	110Hz	30Hz	90Hz	110Hz	30Hz	90Hz	110Hz
Cooling Capacity [%]	-0.43	-1.37	-1.80	-0.10	-1.05	-1.70	-0.10	-1.71	-2.86
Power Consumption [%]	+0.25	+1.59	+2.48	+0.54	+1.27	+1.72	+0.54	+2.35	+3.36

Standard Copper pipes

Diameter [mm]	Thickness [mm]	Minimum bending radius [mm]	System design pressure PS [bar]	PED Category	Max Copper σs [N/mm2]	Real copper σ [N/mm2]	Safety ratio
10	1	36	42	A3 P3	227	16.8	13.5
12	1	36	42	A3 P3	227	21.0	10.8
16	1	46	42	A3 P3	227	29.4	7.7
18	1	56	42	A3 P3	227	33.6	6.8
22	1,5	67	42	A3 P3	227	26.6	8.5
28	1,5	96	42	A3 P3	227	35.0	6.5
35	1.5	70	42	A3P3	227	44.8	5.0
42	1.5	84	42	A3P3	227	54.6	4.2
54	2.0	108	42	A3P3	227	52.5	4.3

13. REFRIGERANT CHARGE

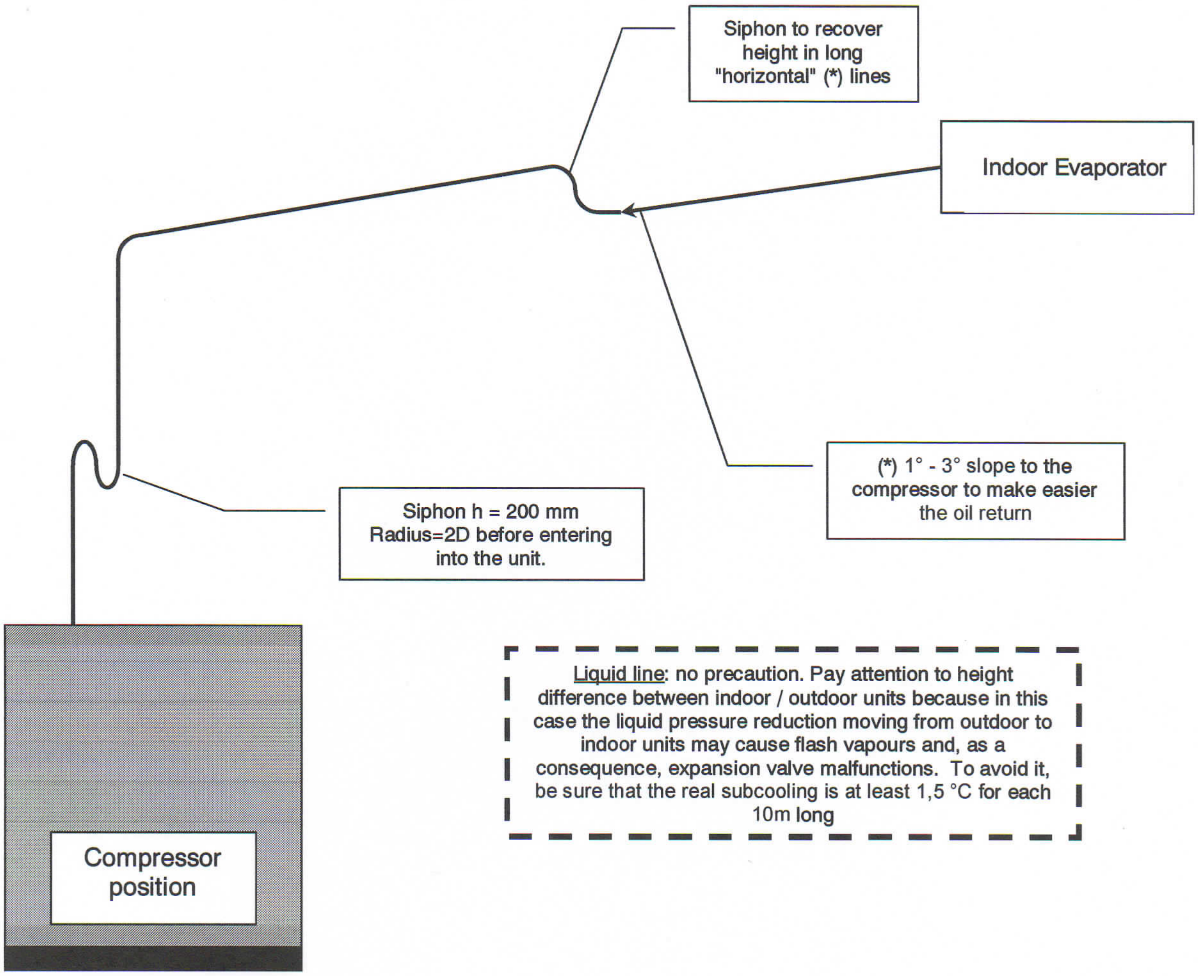
The following table gives an idea of the total refrigerant charge: this should be used just as first reference but the right charge should be performed on site by a qualified installer .
Note: The INNOV@ ENERGY units as well as the remote condenser are shipped filled with nitrogen or dry air.

INNOV@ ENERGY Model		0281-0592*	0130	0060
Unit Charge	[kg]	3.080	2.190	1.210
Air Cooled Condenser Charge (standard unit)	[kg]	3.870	1.780	1.490
Air Cooled Condenser Charge (low noise unit)	[kg]	5.350	3.870	1.780
Charge for liquid line	[kg/m]	0.130	0.080	0.070

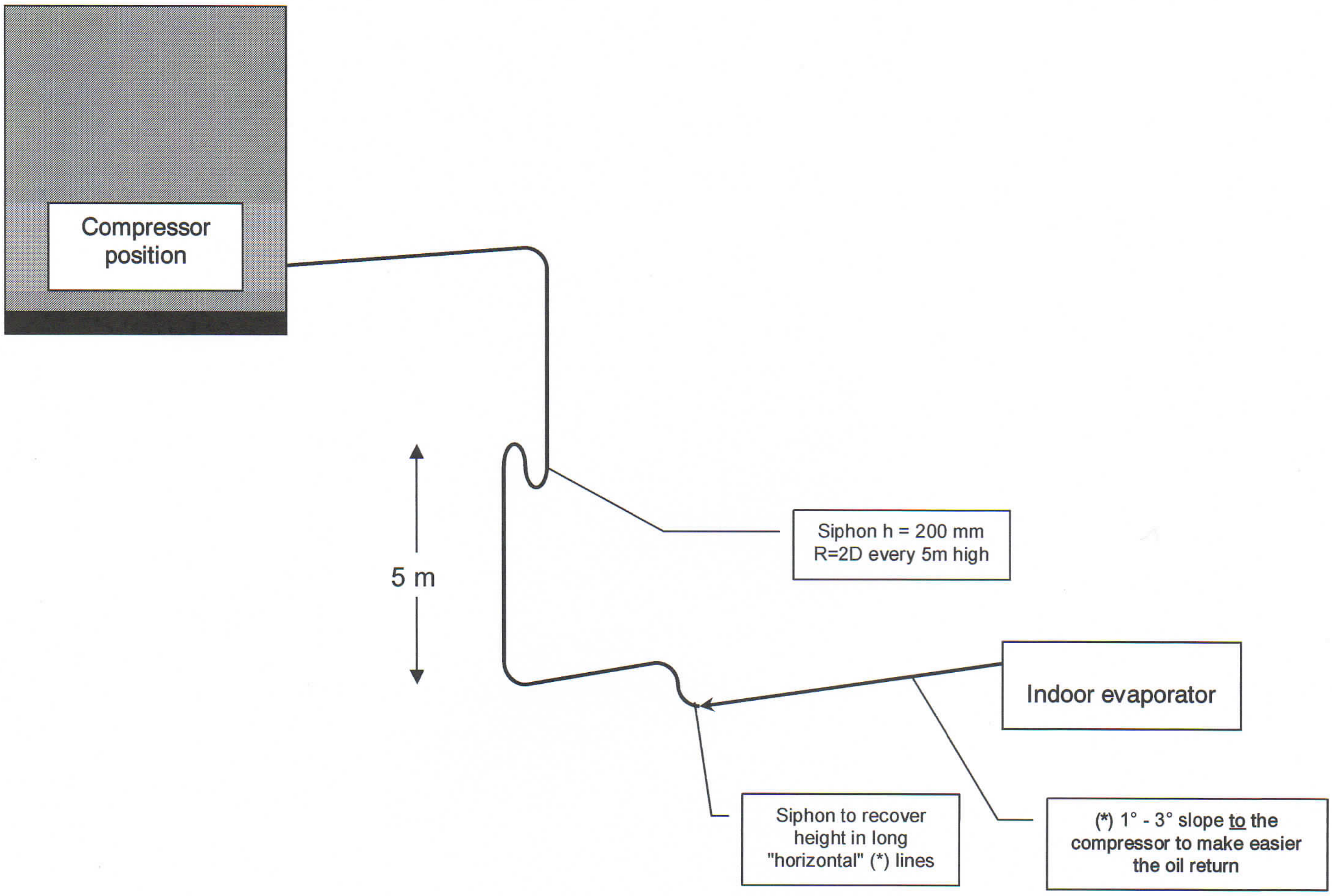
Note: approximated values (± 20%), to be verified on site.

(*) Values referred to each circuit

Installation of the suction line (Evaporator above condenser / compressor)

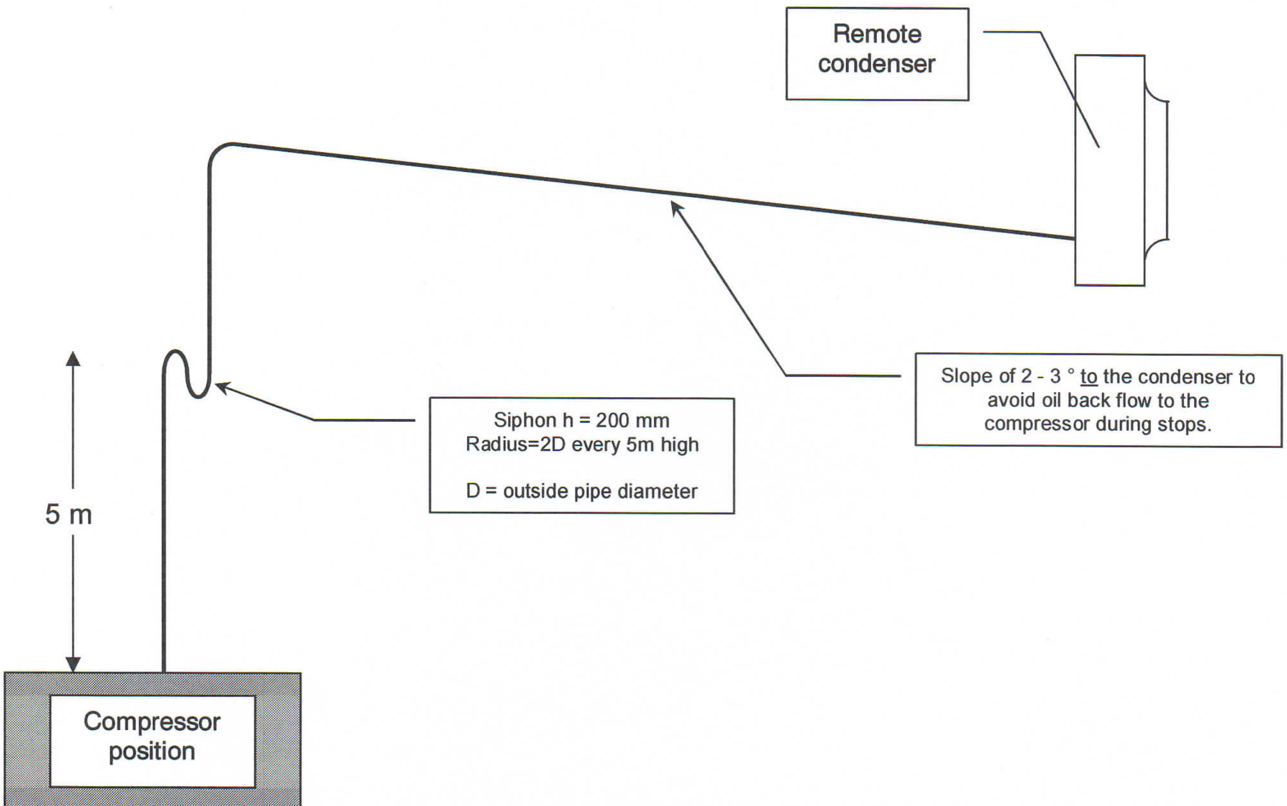


<u>Installation of the suction line</u> (Evaporator below condenser / compressor)



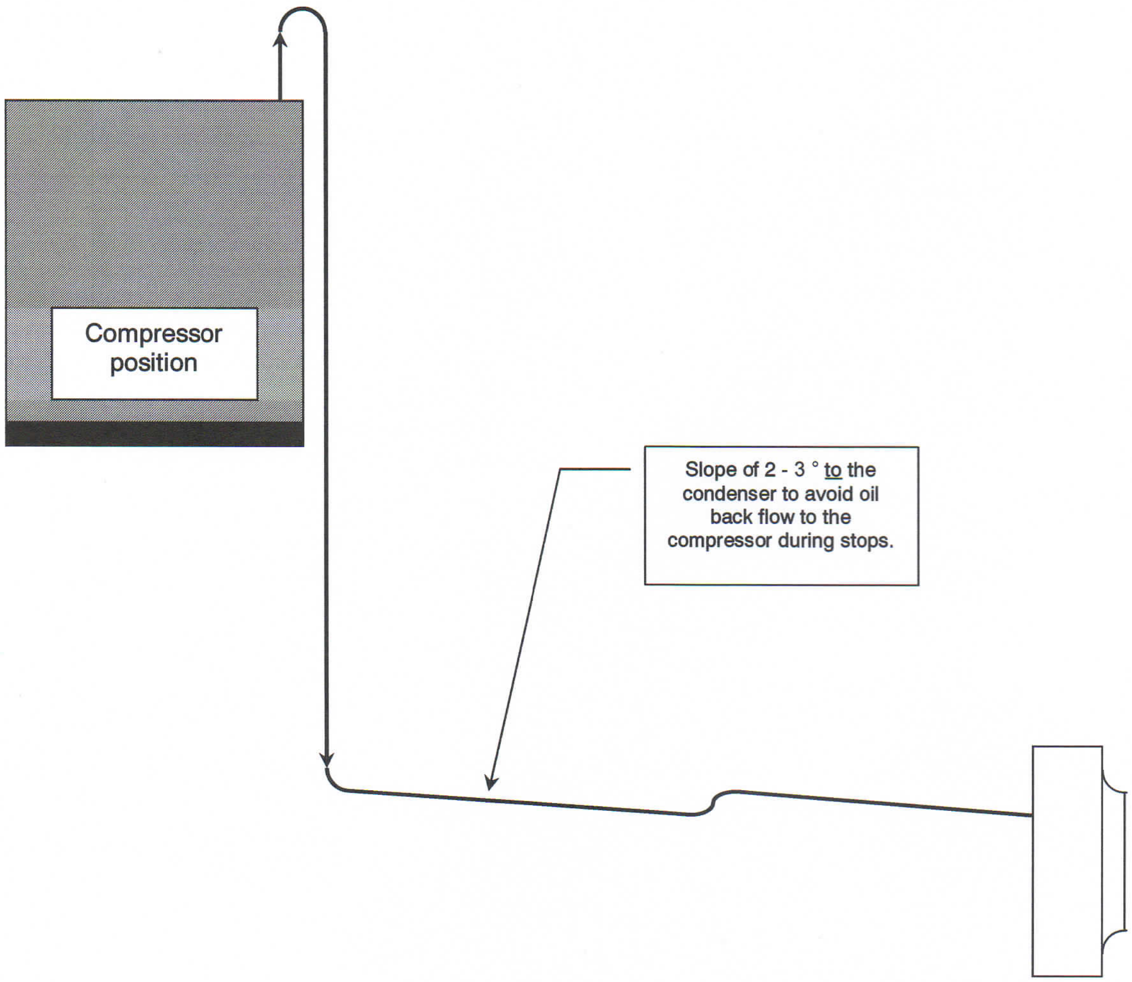
<u>Liquid line</u>: no precaution. Pay attention to height difference between indoor / outdoor units because in this case the <u>increasing</u> liquid pressure moving from the condenser to the evaporator/compressor, may cause opening for the safety valve on the liquid receiver (if present). **Max height difference 10mt**

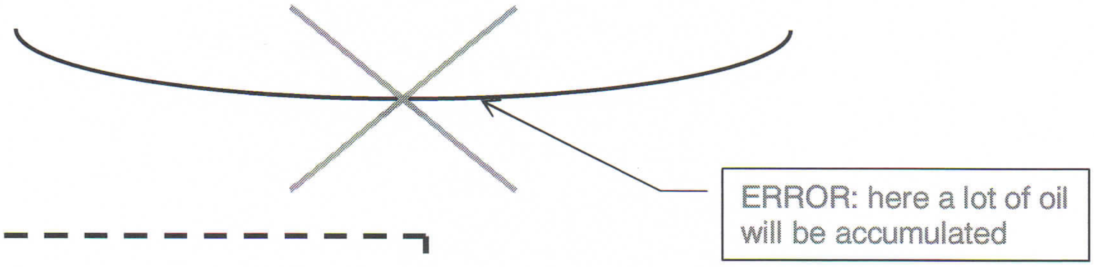
<u>Installation of the discharge line</u> (Condenser <u>above</u> evaporator / compressor)



<u>Liquid line</u>: no precaution. Pay attention to height difference between indoor / outdoor units because in this case the <u>increasing</u> liquid pressure moving from the condenser to the evaporator/compressor, may cause opening for the safety valve on the liquid receiver (if present - i.e. in J/T unit). In case of height differences greater than 10m contact the Technical office for the right selection of High pressure switches and remote condensers.

Installation of the discharge line (Condenser below evaporator / compressor)





Liquid line: no precaution. Pay only attention to the height difference between indoor / outdoor units because in this case the decreasing liquid pressure, moving from the condenser to the evaporator/compressor, may cause flash vapour on the liquid receiver. To avoid this, make sure to have at least 2°C of real subcooling, measured at the condenser outlet every 10m of increasing height.

4. EVACUATION AND CHARGING OPERATIONS

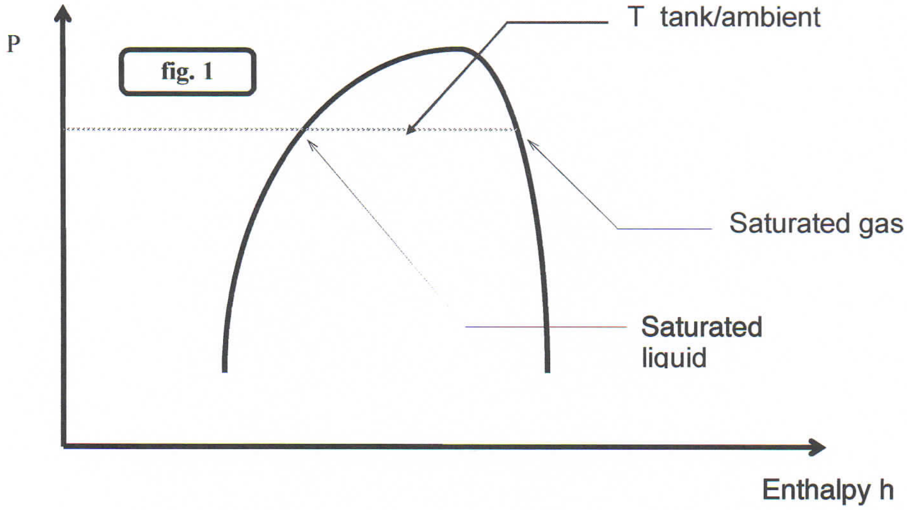
This type of work must be carried out by qualified personnel only trained to do their job in accordance with current laws and regulations.

4.1 Introductions

The contemporaneous presence of liquid and vapour requires for both to be in a state of saturation [Gibb's law], as shown in the **fig. 1.** In thermal equilibrated conditions, the pressure in the tank corresponds to the ambient temperature. Withdrawal of refrigerant from the tank has following effects:

- withdrawal of refrigerant charge ⇨ pressure drop inside the tank
- pressure drop inside the tank ⇨ T drop & change of status
- T drop & change of status ⇨ evaporation of part of the liquid, causing a cooling down of the liquid
- cooling of liquid ⇨ thermal exchange with ambient air, further evaporation of remaining liquid; the original pressure in the tank will be restored after a certain period of time

fig. 1

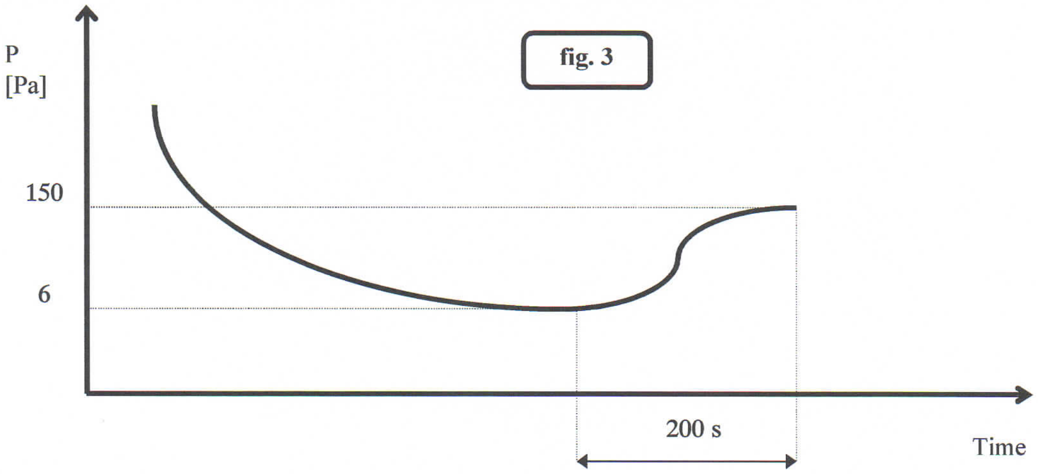


4.2 Vacuum and charging machine

Vacuum cycle

In general it is better to apply a "long" rather than a "hard" vacuum: reaching a low pressure too abruptly may in fact cause that any remaining humidity evaporates instantaneously, thus freezing part of it.

fig. 3



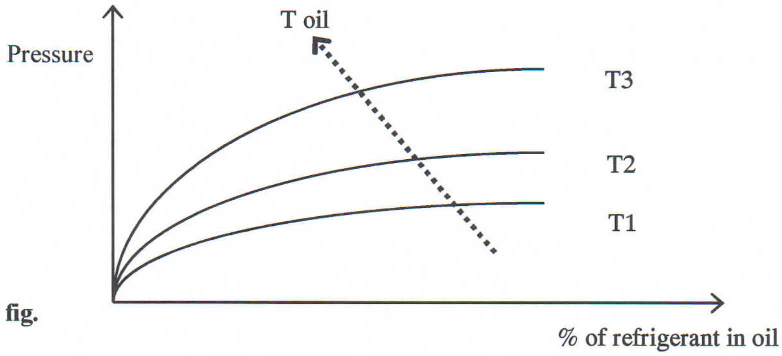
The **fig.3** represents a vacuum cycle and an optimal subsequent pressure rise for the refrigeration devices we manufacture.

Generally in bigger refrigeration systems or if there is a suspicion of an extensive quantity of humidity in the refrigeration circuit, the vacuum needs to be "broken" by using anhydrous nitrogen. Then the steps of evacuation need to be repeated as described before. This operation facilitates the removal of remaining and/or frozen humidity during the evacuation process.

4.3 Evacuating a circuit "contaminated" with refrigerant

The first step is to remove the refrigerant from the circuit. To do this a specific machine is necessary with a drying compressor in order to recover the refrigerant.

Refrigerants all tend to dissolve in oil [compressor sump]. The "**Oil**" figure illustrates a specific property [Charles' Law] of gases, which are more soluble in liquids as the pressure increases but less soluble as the temperature increases.



"Oil" fig.

If the oil in the sump is held at a constant pressure, an increase in temperature will significantly reduce the amount of refrigerant dissolved in it, thus ensuring that the lubricating function desired is maintained. The problem of inadequate lubrication occurs if the crankcase is not duly heated, above all after seasonal interruptions when, due to the suction effect of the compressor, there is an abrupt drop in pressure inside the sump, which results in considerable evaporation of the refrigerant previously dissolved in the oil. If heating elements were not installed, this phenomenon would cause two problems:

The release of refrigerant from the cooling circuit tends to cool down the oil and thus actually creates the opposite effect by keeping more refrigerant dissolved in the oil: for this reason, it is advisable to switch on –if available- the crankcase heater during the evacuation process.

If a high % of refrigerant gets in contact with the Pirani gauge (vacuum sensor), it may "mislead" this sensitive sensor and misinterpret the value for a certain period of time. For this reason -if no machine for recovering refrigerant is available- it is nonetheless advisable to switch on the crankcase heater and to avoid full vacuum before the circuit has been adequately purged of refrigerant. The refrigerant may in fact dissolve in the oil of the vacuum pump, reducing its performance for a long time (hours).

4.4 Charging position (single point)

The best position to charge the unit is the section between the thermostatic valve and the evaporator. Take care to avoid the fixing of the thermostat bulb until the operation is completed. It is important to ensure that the valve orifice remains open in order to allow the passage of refrigerant also towards the condenser / liquid receiver.

If possible, avoid the charge of refrigerant into the suction line of the compressor as this may cause excessive dilution of the lubricant.
In any case verify first the necessary volume of the crankcase and compare it with the required charge volumes.

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