

Compressor Application Manual



 **Embraco**®

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Introduction

Dear refrigeration professional!

Since its incorporation in March 1971, Embraco has been doing its utmost to keep an ever closer relationship with its customers. This relationship has been translated in its commitment to continuously provide timely technical information that contributes further to the professional know-how of our refrigeration professional partners.

The purpose of this Manual is to facilitate your work. It is a valuable aid to solving problems in the refrigeration system. You will find that you rarely need to change a hermetic compressor. Generally the faults are in other parts of the system.

If, however, you do need to substitute the compressor, this Manual will help you do so step by step, even if you do not have all the equipment.

The Manual also gives some tips on how to prolong the working life of the hermetic compressor.

The information is easy to understand and useful.

Always keep this Manual in your pocket.

Wishing you success in your work... and many satisfied customers.

For further information, consult our site on the Internet, at the following address
www.embraco.com.br.

Refrigeration

Circuit



The following figure shows you the essential components for the operation of most refrigeration circuits.

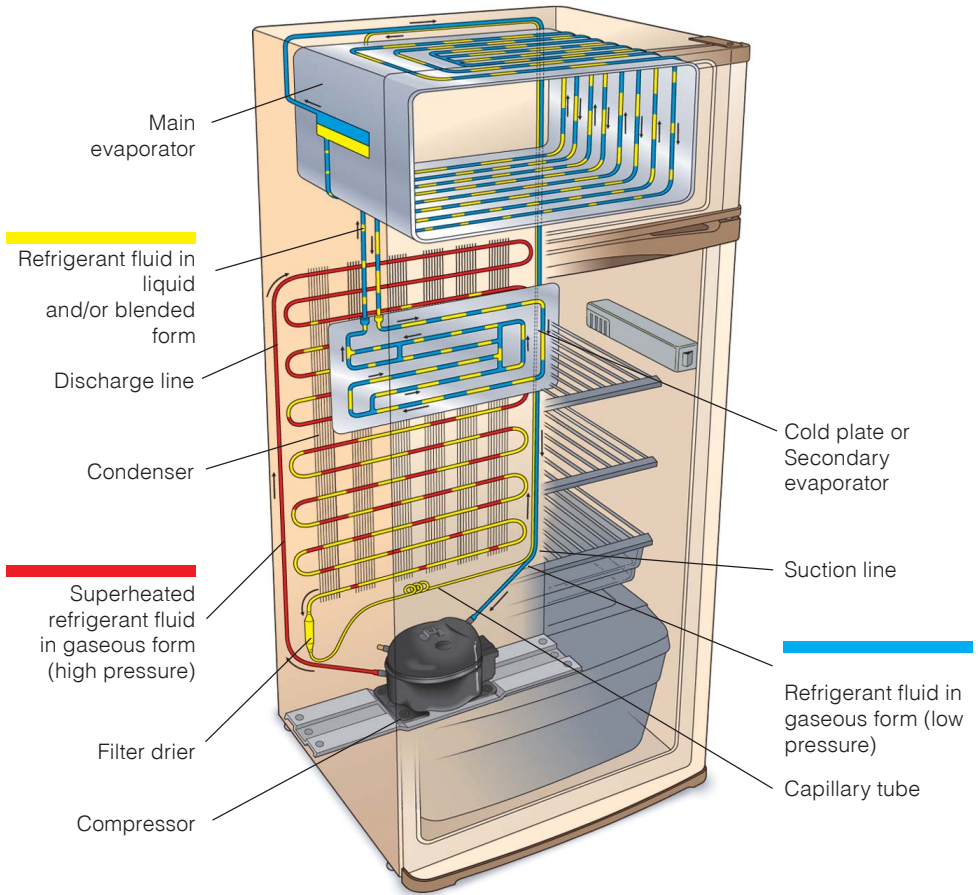


Figure 1 - Operation of a basic refrigeration system



We will show below how a basic refrigeration system works:

The compressor draws in the refrigerant fluid from the evaporator by reducing the pressure in this component. The fluid is compressed by the compressor and moves to the condenser. In the condenser the refrigerant fluid under high pressure releases heat to the environment and becomes liquid. The next component of the circuit is the control device, which may be a capillary tube or an expansion valve. The control element reduces the pressure of the liquid refrigerant which was formed in the condenser. This drop in pressure permits the refrigerant to evaporate at low temperatures and return to the gaseous state when passing through the evaporator.

The change from a liquid to gaseous state requires heat. So the refrigerant fluid removes the heat from inside the refrigeration system through the evaporator. The condenser releases this heat into the environment. The control element offers a certain resistance against the refrigerant's circulation, separating the high pressure (condenser) from the low pressure (evaporator) side.

The refrigeration system also uses a filter drier with desiccant to retain any water that may be left in the system.

The oil cooling tube that exists in some compressors is used to help reduce the compressor temperature.

Lastly, there are systems that use a suction accumulator to evaporate any residual liquid refrigerant, stopping it from returning through the suction line.

Hermetic compressor



The compressor is a very important item in the refrigeration circuit. Its function is to circulate the refrigerant fluid inside the circuit.

1 - Use of compressors

The choice of a compressor for certain refrigeration equipment depends on the following factors:

1.1 - Control Device

As mentioned above, every refrigeration system needs a control device. This may be an expansion valve or capillary tube.

In capillary-equipped circuits, the pressures on the suction and discharge sides are equal when the compressor is stopped. In this kind of circuit, the compressor is equipped with a low starting torque motor.

In an expansion valve circuit, however, refrigerant only flows through the valve when the compressor is switched on. So, the pressure between the suction and discharge are not equal when the compressor is stopped. In this case, the compressor is equipped with a high starting torque motor.



The compressor motors appropriate for these two systems are called:

LST – Low Starting Torque
used in capillary systems.

HST – High Starting Torque, used in
expansion valve systems.

Classification	Control System	Compressors Indicated	Example of Application
LST	Capillary	All Embraco compressors	Refrigerators, freezers and drinking fountains
HST	Expansion valve (or Capillary)	Only compressors with the letter X in the code of model e.g.: FFI 12BX, FFI 12HBX etc...	Commercial food counters, soft drink machines, Refrigerated food counters and displays and walk-in refrigerators

HST compressors may be used in systems using LST (capillary tube) compressors when the off cycles are shorter, not permitting equal equalized pressures. However, LST compressors cannot be used in expansion valve systems.

1.2 - Evaporation temperature

Another factor influencing the choice of the compressor is the evaporator temperature range required by the system. We now point out two extreme situations:

- Freezers that work at low temperatures, varying between -25°C (-13°F) and -35°C (-31°F).

- Dehumidifier that works at an evaporator temperature of over 0°C (32°F).



Heat absorption by the refrigerant will depend on the evaporator temperature.

A certain pressure corresponds to a certain temperature in the evaporator. The gas density is higher at low temperatures and, therefore, only a small quantity of heat may be absorbed during evaporation. If there is evaporation at a higher temperature, for instance, 0°C (32°F), the pressure and density will increase and more heat will be absorbed.

For this reason, we can conclude that the work required by the motor in a compressor for a high evaporation temperature will be more than that required by the same compressor at a low evaporation temperature.

Consequently, motors to be used in high evaporation pressure systems must have a higher operating torque.

The compressors can be classified according to their use as follows:

- HBP – High Back Pressure
High evaporation temperature
- MBP – Medium Back Pressure
Medium evaporation temperature
- LBP – Low Back Pressure
Low evaporation temperature



Depending on what kind of compressor model is involved, it may be used in a range from the LBP to HBP classification (see following table).

Classification	Evaporation Temperature	Example of Application
LBP	-35°C to -10°C (-31°F to +14°F)	Freezers & Refrigerators
L/MBP	-35°C to -5°C (-31°F to +23°F)	Refrigerated food counters and drinking fountains
HBP	-5°C to +15°C (+27°F to +59°F)	Dehumidifiers, soft drink machines and drinking fountains

When choosing the replacement model, it is very important to check the class of the original compressor. As you know, the compressor's operating conditions can vary according to each design. In this way, some drinking fountains may need an HBP while others use an LBP or MBP compressor.

1.3 - Type of refrigerant fluid

Embraco markets compressors for use with R 12 and/or blends, R 134a and R 600a refrigerant fluids.

These compressors differ from each other inside (motor, pump, oil type, displacement, etc.) in order to provide the best performance and guarantee a highly reliable product.

To facilitate identification, there are special labels on the compressor informing the refrigerant fluid used.

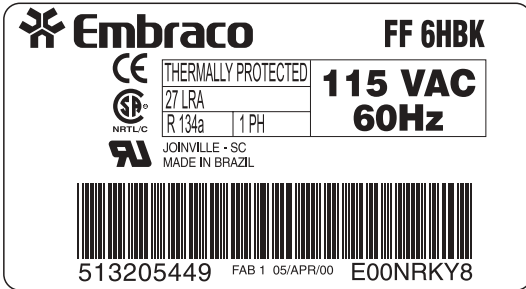


Figure 2 - Compressor label



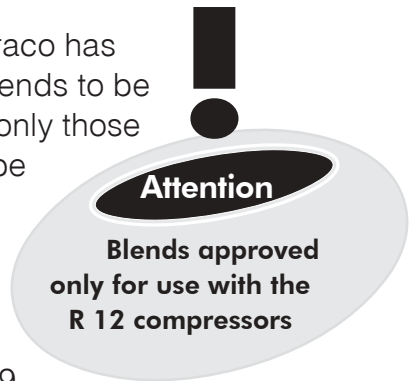
Figure 3 - Compressor label for R 600a refrigerant fluid

Figure 4 - Compressor label for R 134a refrigerant fluid



Since September 1997, Embraco has approved some refrigerant blends to be used in its compressors and only those with the respective label will be suitable for the blends.

The blends approved to be used in the Embraco compressors are FX 56, MP 39, MP 66 and ISCEON 49.



COMPRESSOR APPROVED FOR USE WITH R 12 OR BLENDS INDICATED BELOW

REFRIGERANTS	
ASHRAE	Commercial name
R 401a	SUVA® MP39
R 401b	SUVA® MP66
R 409a	FORANE® FX56
R 413a	ISCEON 49

Figure 5 - Label for Compressors that can use blends

Diagnosing the problem

Before changing any part of the refrigeration system, the good refrigeration professional undertakes a full diagnosis to identify the real cause of the problem.

The following table shows the most frequent failures in a refrigeration system and their possible causes.

For each problem presented, you will find its possible causes marked with a (•). The problems are listed in the upper part of the table. Follow the arrows and you will find a (•) on each possible cause. In the same line as each cause you will find the number of the item related to the necessary actions to correct the problem. Look in the Manual for the item corresponding to that action and proceed with care.

Example:**PROBLEM**

The refrigerator refrigerates too much
(1st column in Table of Main Refrigerator
Problems - Part 1).

POSSIBLE CAUSE

Wrong connection in connection box
(first (•) in 1st column).

STEPS

Item 2.2. When looking for this item in the Manual you will find:

Check the connections with the help of the refrigerator's electrical diagram. If the connections are correct, go back to the table and you will find another (•) in the 1st column.

This will be another possible cause of the problem:

Thermostat does not switch off. You will find the step to take in the same line (item 4.3). Look in the Manual under this item and the step will be there: Check if the thermostat bulb is correctly installed. Turn the thermostat button to the lowest point (least cold) and check if the compressor disconnects. If the problem continues, substitute the thermostat. If necessary, you will also find other possible causes for the problem, always accompanied by the necessary steps. Try for yourself. You will see that it is much easier than it looks.

Table of Main Refrigerator Problems - Part 1

EXCESSIVE REFRIGERATION				
INSUFFICIENT REFRIGERATION				
ELECTRICAL SHOCK				
NOISES				
EXTERNAL SWEATING OF THE CABINET				
INTERNAL SWEATING OF THE CABINET				
HIGH POWER CONSUMPTION				
DOES NOT WORK COMPRESSOR DOES NOT SWITCH ON/OVERLOAD PROTECTOR NOT WORKING				
DOES NOT WORK COMPRESSOR DOES NOT SWITCH ON/OVERLOAD PROTECTOR WORKING				
DOES NOT WORK COMPRESSOR SWITCHES ON/OVERLOAD PROTECTOR WORKING				
POSSIBLE CAUSES - ELECTRICAL ORIGIN			MEASURES See item in Chap. IV	
		•	No voltage at power supply	1.1.1
		• •	Very low voltage at power supply	1.1.2
		• •	Very high voltage	1.1.3
		•	Interrupted electric cable or wiring	2.1
• •	• •	• •	Wrong connection at the terminal board	2.2
	•		Wiring or electrical components touching metal parts	2.3
		•	Electrical components interrupting the current flow to the compressor	2.4
•	• •		Internal light does not switch off	2.5
		•	Inadequate transformer	2.6
	•		Inadequate grounding	3.1
		•	Thermostat switched off	4.1
		•	Thermostat with no current passing through contacts	4.2
•	• •	• •	Thermostat does not switch off	4.3
•	• •	• •	Thermostat adjusted to the maximum (coldest)	4.4
•	•		Thermostat adjusted to the minimum (least cold)	4.5
	•		Thermostat making noise	4.6
•	• •	•	Thermostat with loose bulb	4.7
• •	•		Thermostat with incorrect bulb position	4.8
	• •	•	Thermostat with failure or irregular operation	4.9
• •	•		Inadequate thermostat	4.10
• •	• •	• •	Incorrect overload protector	5.1
• •	•	•	Faulty overload protector	5.2
		• •	Incorrect starting relay / PTC	6
		• •	Faulty starting relay / PTC	6.1/6.2/6.3
		•	Incorrect starting capacitor	7.1
		•	Faulty starting capacitor	7.2
		• •	Compressor connected to a voltage different from the one specified	19.1
		• • •	Compressor winding interrupted or burned out	19.2
•			Compressor with current leakage to the housing	19.3
	•	•	Compressor with high amperage (high current)	19.9

Table of Main Refrigerator Problems - Part 2

EXCESSIVE REFRIGERATION			
INSUFFICIENT REFRIGERATION			
ELECTRIC SHOCK			
NOISES			
EXTERNAL SWEATING OF THE CABINET			
INTERNAL SWEATING OF THE CABINET			
HIGH POWER CONSUMPTION			
DOES NOT WORK COMPRESSOR DOES NOT SWITCH ON/OVERLOAD PROTECTOR NOT WORKING			
DOES NOT WORK COMPRESSOR DOES NOT SWITCH ON/OVERLOAD PROTECTOR WORKING			
DOES NOT WORK COMPRESSOR SWITCHES ON/OVERLOAD PROTECTOR WORKING			
POSSIBLE CAUSES - MECHANICAL ORIGIN			MEASURES See item in Chap. IV
•		Condenser improperly fixed - metal tubes touching	8.1
•	•	Partial blockage in tubes	8.2
•		Capillary blockage due to water / wax / paraffin	8.3
•	•	Dirty/covered condenser or no air circulation	8.4
•		Incorrect leveling of refrigerator or compressor base	9.1
•		Noise caused by other components	9.2
•		Compressor touching the wall or cabinet	9.3
•	• • •	Poor door sealing	10
•	•	Wrong location of the refrigerator	11
	•	Very high relative humidity (over 85%)	12
•	• • •	Refrigerator without freezer tray	13
•	• •	Refrigerator used in excess	14
•		Refrigerator used incorrectly	15
• •	• •	Wet Insulation (glass wool)	16.1
•	• • •	Deterioration of or no heat insulation	16.2
	•	Expansion of refrigerant in the evaporator	17.1
•	•	Excess refrigerant fluid charge in the refrigerator	17.2
•	•	No refrigerant fluid charge	17.3
•		Leakage of refrigerant fluid	17.4
	• •	Use of expansion valve	18
•		Incorrect compressor installation / fixation	19.4
•	•	Compressor inadequate for the system	19.5
•	•	Compressor with low capacity	19.6
•		Compressor with internal noise	19.7
	•	Compressor locked (stalled)	19.8

1 - Problems and Solutions

1.1 - Voltage

1.1.1 - No voltage at power supply

Check using a voltmeter or test lamp.

1.1.2 - Very low voltage at power supply

To eliminate problems of voltages below 103 V (115 V nominal) and 198 V (220 V nominal), at the end of the Manual we recommend the use of a voltage stabilizer.

When the compressor does not start, the problem can be solved most often by using the right starting capacitor.

1.1.3 - Very high voltage

To eliminate the problem of voltages above 132 V (115 V nominal) and 240 V (220 V nominal) we recommend the use of a voltage stabilizer.

2 - Electrical Parts

2.1 - Interrupted electric cable or wiring

Using a test lamp or ohmmeter, check if the cable or wiring is not interrupted. Also check the plug.

2.2 - Wrong connection at the terminal board

Check the connections using the refrigerator's electrical diagram.

2.3 - Wiring or electrical components touching metal parts

Check if there is a fault in the insulation of an electrical component that is touching metal parts. Correct the defect.

2.4 - Electrical components interrupting the current flow to the compressor

Defect in such components as thermostat, auxiliary transformer, timer, etc. Check.

2.5 - Internal light does not switch off

Check if the light switch has a problem, such as a poor contact, incorrectly installed, etc.

2.6 - Inadequate transformer

Check if the transformer is the one specified in the table in Chapter VI, item 4.

3 - Inadequate Grounding

3.1 - Electrical discharge

Check the ground connection.
If necessary, redo the grounding.

4 - Thermostat

4.1 - Thermostat switched off

Turn the thermostat button to maximum (coldest) and see if the compressor starts.

4.2 - Thermostat with no current passing through contacts

Install a bridge wire between the thermostat terminals. If the compressor starts, substitute the thermostat.

4.3 - Thermostat does not switch off

Check if the thermostat bulb is correctly installed. Turn the thermostat button to the minimum (least cold) and check if the compressor disconnects. If the problem continues, substitute the thermostat.

4.4 - Thermostat adjusted to the maximum (coldest)

Turn the thermostat button to the minimum (least cold) and check if the compressor disconnects within the range of use. Regulate the thermostat and instruct the user how to use it correctly.

4.5 - Thermostat adjusted to the minimum (least cold)

Regulate the thermostat to the correct position and instruct the user how to use it correctly.

4.6 - Thermostat making noise

Inform the user that a clicking noise is normal when the thermostat switches on and off. In any case, please check whether the thermostat is correctly installed.

4.7 - Thermostat with loose bulb

Correctly install the thermostat bulb.

4.8 - Thermostat with incorrect bulb position

Install the bulb according to manufacturer's specifications.

4.9 - Thermostat with failure or irregular operation

Substitute the thermostat.

4.10 - Inadequate thermostat

Check if the thermostat model used is recommended by the manufacturer. If necessary, consult the manufacturer of the refrigeration system.

5 - Thermal Protector

5.1 - Incorrect overload protector

Check if the overload protector is as recommended. If not, change the start relay and protector kit for that specified. If necessary, consult the authorized wholesaler or Embraco.

5.2 - Faulty overload protector

Thermal protector 3/4"

Check if there is oxidation at the terminals and if the bimetal thermal protector disk is not twisted. Also check if there is continuity between 3 in 1 terminals (fig. 6). In the case of damage or no current, substitute the protector and starting relay.

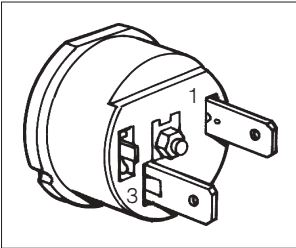


Figure 6 - Thermal protector 3/4" without lead

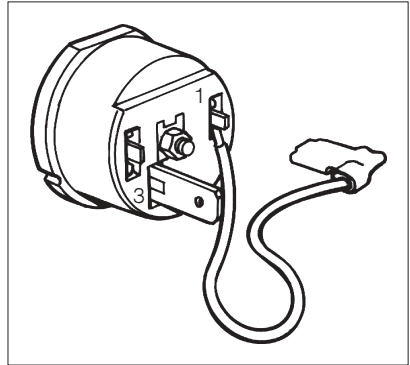


Figure 7 - Thermal protector 3/4" with lead

Thermal protector 4TM

Check if there is oxidation at the terminals (plug and socket) and if there is continuity between them. In case of damage or no current, substitute the 4TM protector (fig. 8).

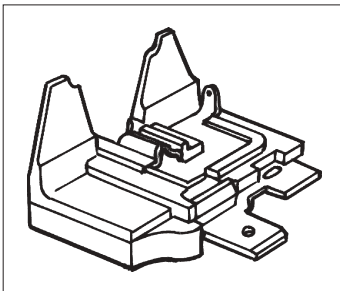


Figure 8 - 4 TM thermal protector

6 - Start Relay

Remove the compressor relay, check to see if the start relay is to specification. The relays for high starting torque compressors, models "X" (e.g., FF 8.5BX / FF 10BX and FFI 12HBX), must **not** have a bridge (copper wire) between terminals 11 and 13. This connection must be made through the start capacitor. For the other models, however, where the use of the capacitor is not obligatory, the relays must have a bridge connecting terminals 11 and 13.

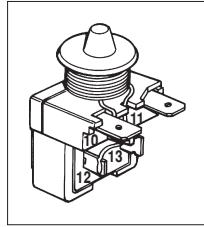


Figure 9 - Short Relay

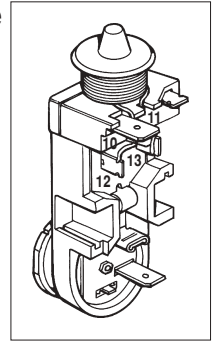


Figure 10 - Long Relay

6.1 - Electromechanical relay "F and PW"

6.1.1 - With the relay in the vertical position, coil downwards, check if there is continuity between relay terminals 10 and 11. If not, change the relay.

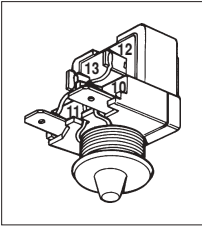


Figure 11 - Short F and PW relay

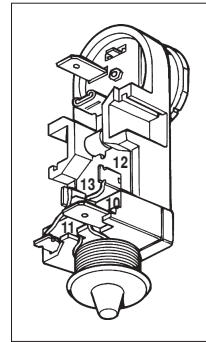


Figure 12 - Long F and PW Relay

6.1.2 - With the relay in the vertical position, coil upwards, check if there is continuity between relay terminals 10 and 11. If there is, change the relay and repeat item 6.1.1

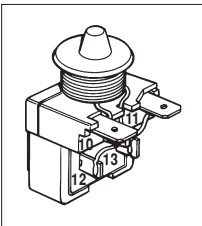


Figure 13 - Short F and PW Relay

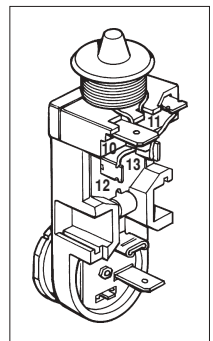


Figure 14 - Long F and PW Relay

6.2 - EM electromechanical relay

- 6.2.1 - With the relay in any position, check if there is continuity between relay terminals 1 and 2. If not, change the relay.

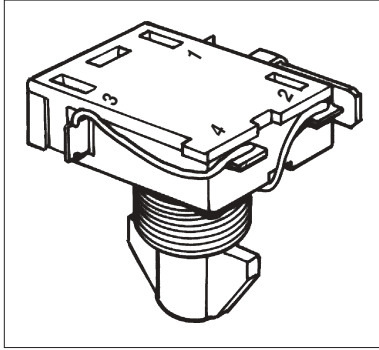


Figure 15 - EM relay

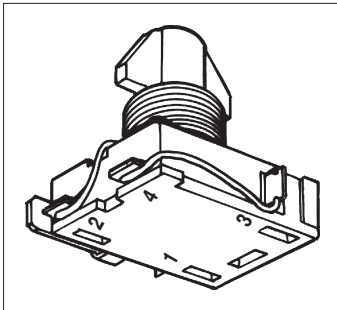


Figure 16 - EM relay

- 6.2.2 - With the relay in the vertical position, relay coil upwards, check if there is continuity between relay terminals 1 and 3. If not, change the relay and repeat item 6.2.1.
- 6.2.3 - With the relay in the vertical position, coil downwards, check if there is continuity between terminals 1 and 3. If there is, change the relay.

6.3 - PTC Relay

With the help of an ohmmeter, measure the ohmic resistance between terminals 2 and 3. At room temperature, the figures must be near those in the above table:

Relay – PTC*	Ohm Resistance (Ω = OHMS)
8EA1BX	2,8 a 5,2 Ω
7M4R7XXX / 8M4R7XXX / 8EA14CX	3,8 a 5,6 Ω
8EA4BX / 8EA3BX / 8EA21CX	3,5 a 6,5 Ω
8EA5BX	14 a 26 Ω
7M220XXX / 8M220XXX / 8EA17CX	17,6 a 26,4 Ω

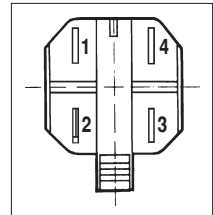


Figure 17 – PTC

* The (X) can be a number or a character.

EM relay with external electrical bridge

In the same way as with relays in the PW and F/EG groups, the EM compressor relays are suitable for using a start capacitor (fig.18).

A starting capacitor in applications where this component is required, must be used by removing the bridge between the terminals 3 and 4 and connecting the capacitor between these terminals (see fig. 18 and 19). This modification does not alter the performance characteristics of the relays.

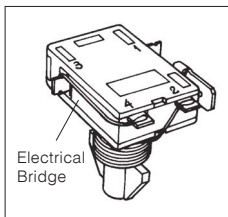


Figure 18 - Standard starting relay

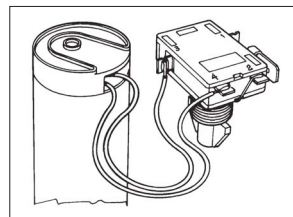


Figure 19 - With capacitor

7 - Starting Capacitor

7.1 - Incorrect starting capacitor

Check if the capacitance and voltage values are suitable for the compressor. Consult the Embraco Compressor Application Table or the manufacturer of the refrigeration system. If the capacitance value is wrong, change the capacitor for the one recommended.

7.2 - Faulty starting capacitor

Check that the voltage in the output is the same as that showing on the capacitor.

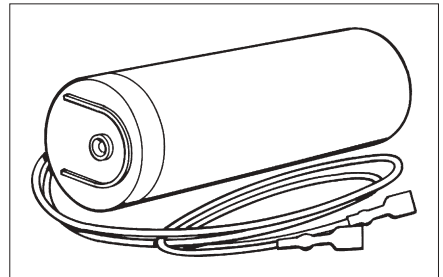
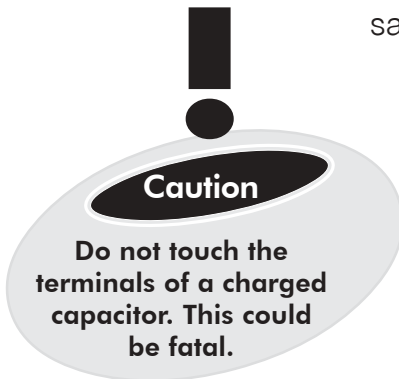


Figure 20 - Starting Capacitor

Next, connect the capacitor in series with a test bulb and observe:

- normal luminosity of the bulb: faulty. Capacitor plates short-circuiting.
- bulb does not light up: faulty. Capacitor plates open.
- bulb with less luminosity - the capacitor is OK.

If the capacitor leaks or has a crack, it must be changed.

8 - Pipes and Components

8.1 - Condenser improperly fixed - metal tubes touching

With the compressor in operation, check the metal parts in contact. For example, the capillary touching the filter dryer, condenser incorrectly installed in the cabinet etc. (fig. 21).

8.2 - Partial blockage in tubes

Blocked tubes generally occur as a result of incorrect brazing (excessive additional material), solid particles from deterioration of the filter drier desiccant or excessive bending in the tube.

Thorough investigation is required to solve this kind of problem.

Check the critical points, such as the filter drier (screens) and capillary inlet.

8.3 - Capillary blockage due to water / wax / paraffin

Check if ice has formed at the entrance to the evaporator. Warm this point and check if the refrigerant fluid starts circulating. If so, it is a sign that there is water in the system. In this case, you must remove the water from the circuit, replace the filter drier and put in a new refrigerant fluid charge.

(See the necessary procedures for changing the hermetic compressor from page 34 onwards in this Manual).

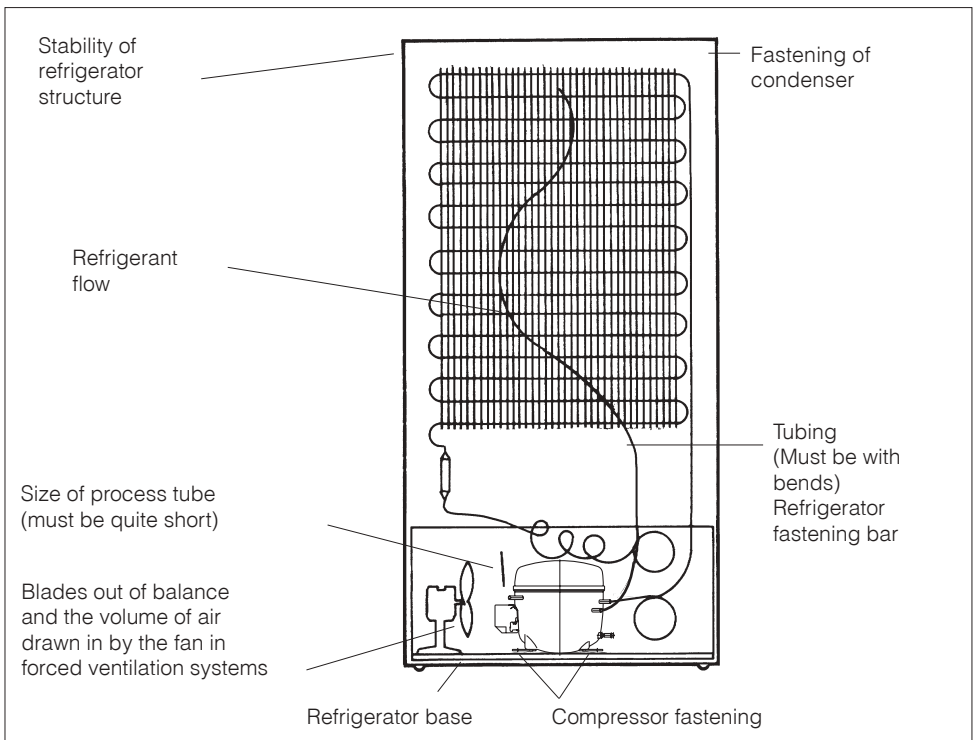


Figure 21 - Probable sources of noise in refrigerators

8.4 - Dirty / covered condenser or no air circulation

Clean the condenser and unblock the air passages.

9 - Noise caused by other Components or Problems

9.1 - Incorrect leveling of refrigerator or compressor base

If there is a noise, check if it disappears when the refrigerator is leveled.

9.2 - Noise caused by other components

Check if the noise starts in components such as: fan, thermostat, transformer, voltage stabilizer, etc.

9.3 - Compressor touching the wall or cabinet

If the compressor is in one of those conditions, its vibrations can become noisy. Move the compressor away and the noise should disappear.

10 - Poor Door Sealing

10.1 - Door or packing

Check to see if the door is fitting badly or if the gasket (rubber sealing strip of door) is damaged, unglued etc. Adjust the door and/or change the sealing strip.

11 - Wrong Location for the Refrigerator

11.1 - Ventilation and other causes

The refrigeration system must not be placed next to stoves, sun-exposed walls and places without ventilation. The refrigeration system loses its performance when in the aforementioned situations.

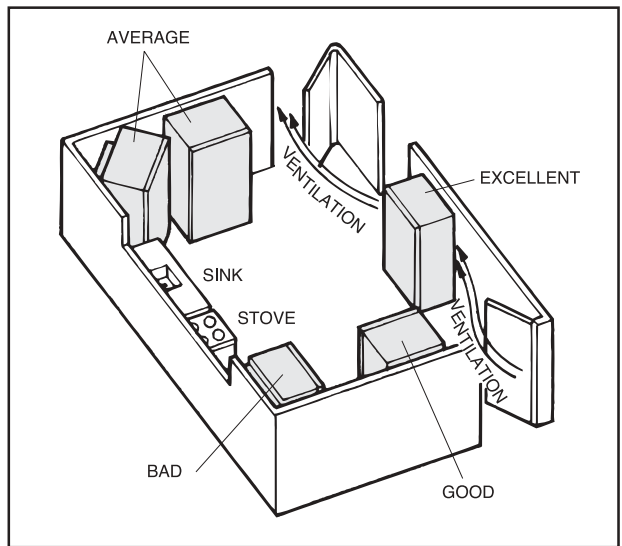


Figure 22 – Kitchen

12 - Very High Relative Humidity (over 85%)

12.1 - Climatic conditions

Explain to the customer that this is not a defect in the refrigerator but a characteristic of the regional climate.

13 - Refrigerator without Freezer Tray

13.1 - Missing or wrong use of the tray

Check if the dividing tray is being used and if it is installed correctly (in single-door refrigerators).

14 - Refrigerator Used in Excess

14.1 - Frequent door opening

Instruct the user not to open the door so frequently.

15 - Refrigerator Used Incorrectly

15.1 - Lack of internal air circulation

Instruct the user not to use plastic towels on the shelves, nor use the tray deflector in the defrosting position, etc.

16 - Thermal Insulation

16.1 - Wet insulation (glass wool)

Discover where the water enters and correct it.

16.2 - Deterioration of or no heat insulation

Locate and substitute or complete the thermal insulation.

17 - Refrigerant Fluid

17.1 - Expansion of refrigerant in evaporator

Explain to the customer that it is normal that there is a certain noise when expansion occurs. The noise level varies according to the type of evaporator and refrigerator.

17.2 - Excess refrigerant fluid charge in the refrigerator

Check if there is condensation on the suction line, outside the cabinet. If so, install the correct refrigerant fluid charge.

17.3 - No refrigerant fluid charge

An irregular layer of ice forms in the evaporator. Install a new refrigerant fluid charge in the system.

17.4 - Leakage of refrigerant fluid

Check the leakage point, remove it or change the part. Install a new refrigerant fluid charge.

18 - Use of Expansion Valve

18.1 - High starting torque

Check if the refrigeration system uses an expansion valve. If so, Embraco

compressors with the letter "X" (FF BX and FF HBX) in their name or FG compressors with the specific relay to change it to HST (see item 3.2 in Chapter VI) must be used.

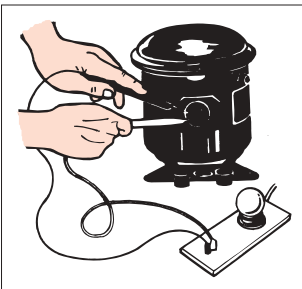
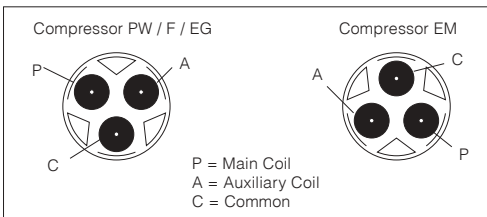
19 - Compressor

19.1 - Compressor connected to a voltage different from the one specified

Use a transformer or change the compressor.

19.2 - Compressor winding interrupted or burned out

With the help of an ohmmeter, measure the main and auxiliary coil resistances.



If the lamp goes on the main coil is not broken.

Important

The ohmic resistance can vary 8% one way or the other. If there is no ohmmeter available, then use a test lamp and check if there is any break in the coil. Place the test ends on the main and auxiliary terminals. If the lamp does not light up in either case, change the compressor.

Figure 23 - Compressor Coil Test

19.3 - Compressor with current leakage to the housing

Connect the megohmmeter terminals to the common pin of the hermetic terminal and grounding terminal of the compressor. With 500V/DC voltage, the reading should show a resistance of over $2M\Omega$. If there is no megohmmeter, use a test lamp as follows: connect one of the test points to the common pin of the hermetic terminal and another to the grounding terminal of the compressor. If the bulb lights up, change the compressor.

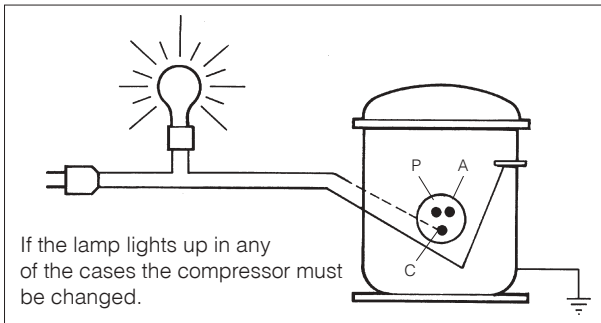


Figure 24 - PW/F/EG Compressor Coil Test

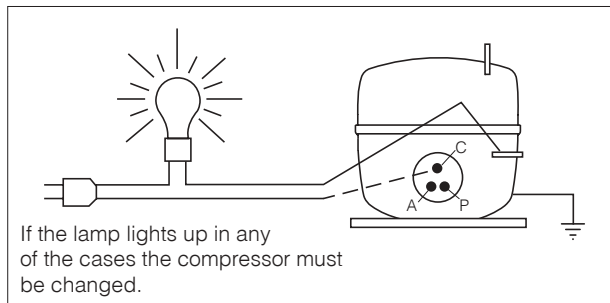


Figure 24.a - EM Compressor Coil Test

19.4 - Incorrect compressor installation / fixation

Check if the rubber grommets are too tight. If so, loosen them, otherwise this detracts from the vibration damping.

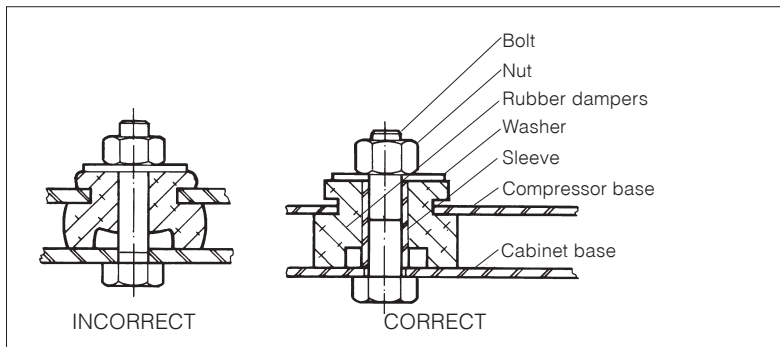


Figure 25 - Rubber Dampers

19.5 - Compressor inadequate for the system

Consult the Embraco Compressor Application Table. Change the compressor for the right model.

19.6 - Compressor with low capacity

This defect is not common. If you are not absolutely sure whether this is the defect, move on to the other possible causes. If none apply, then change the compressor.

**Important**

Do not mistake noises inside the compressor with noises from the refrigeration system (see items 8.1, 9.1, 9.2 and 9.3)

19.7 - Compressor with internal noise

If the noise continues after analyzing all the aspects described above, it might come from the compressor. In this case, change it.

19.8 - Compressor locked (stalled)

Check all possible causes described above. If necessary, change the compressor.

19.9 - Compressor with high amperage (high current)

Check all possible causes described above. If necessary, change the compressor.

**Important**

We can only consider high amperage if the thermal protector is working

Procedure for changing the hermetic compressor

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After completing all the analyses on possible faults in the refrigeration system, you will be able to decide whether the compressor really needs to be changed or not.

Before starting the change process, you must be sure that a compressor model is available with identical characteristics to the original system, refrigerant and compatible filter drier, in addition to the proper tools and equipment.

When it is not possible to identify the compressor to be substituted, the new compressor may be chosen with the help of the Embraco Application Table or from information with the refrigerator's manufacturer.



Don't Forget

Before choosing the compressor, check the original refrigerant of the system and follow the instructions below:

Original System	Recommendation	Alternative
R 12	R 12	Blends
R 134a	R 134a	–
R 600a	R 600a	–

With regard to the use of hermetic compressors, extra care must be taken because this is a special component consisting basically of an electric motor, mechanical kit (compression pump), lube oil and the body with the whole hermetic kit (sealed).

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The compressor must not be switched on without its being properly installed in the refrigeration system!

When buying a new Embraco compressor, do not do unnecessary tests. The factory has already tested it, as you can see in the guarantee seal accompanying it.

Only remove the plugs from the compressor tubes at the time when it is installed in the refrigeration system. In this way you will prevent moisture and dirt from entering the compressor.

1- Essential equipment and tools to change a hermetic compressor, maintaining the quality and guarantee of the compressor's working life

- 01 - Vacuum pump (minimum of 1.2 cfm or more);
- 02 - Leak detector compatible with the refrigerant fluid used in the system;
- 03 - Devices for refrigerant charge;
- 04 - Precision scales, obligatory use for blends and charge-receiving cylinder;
- 05 - Charge cylinder with graduated band;
- 06 - Sandpaper;
- 07 - Recovery device for used refrigerant fluid;
- 08 - Copper tube crimper;
- 09 - Tubing cutter;
- 10 - Cylinder to receive used refrigerant fluid;
- 11 - Rubber plugs;
- 12 - Spanner;
- 13 - Tube perforating valve;

- 14 - Soldering rods;
- 15 - Brazing flux;
- 16 - Vacuum gauge;
- 17 - Oxy-acetylene or axi-gas welding equipment;
- 18 - Device for checking electricity range (multimeter, test lamp and others);
- 19 - Pressure/hose analyzer with retention valve;
- 20 - Connectors/fast couplings/hoses with manifold;
- 21 - Universal pliers;
- 22 - Small clamp

2 - How to remove a used compressor

- We recommend that the used refrigerant fluid is collected for later recycling or incineration, according to the following procedure:

First, install a perforating valve in the compressor process tube. Connect the perforating valve to the recovery equipment that is then connected to the receiving cylinder.

Now just connect the recovery equipment. Open the receiving cylinder valve and then the perforating valve.

It is very important to keep the recovery equipment operating as long as it is necessary to collect all refrigerant. The duration of this process will depend on the equipment used and refrigeration system.

- Loosen the points where the compressor is fixed to the system;

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- Undo the connections from the electrical starting and protection devices;
- Remove all oxidation and paint using sandpaper (fig. 26.a) in the brazing region, to facilitate brazing later;
- Warm the brazing region (fig. 26.b) in order to separate the compressor from the system's piping;
- After cooling, close off the compressor tubes and system's tubes with rubber plugs (fig. 26.c);
- Loosen the locks that fix the compressor base to the system.

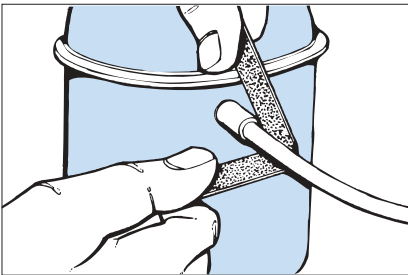


Figure 26.a - Sand papering the tube

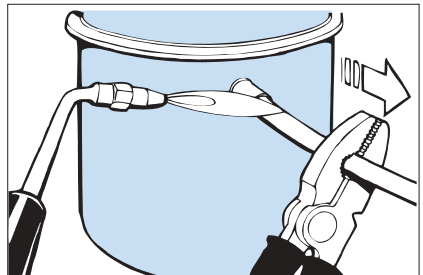


Figure 26.b - Separating the compressor from the system's tubes

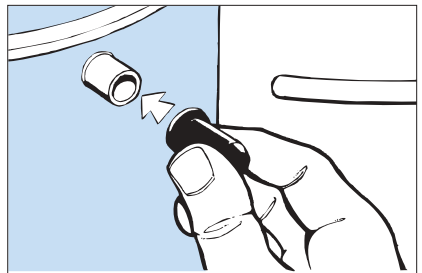


Figure 26.c - Closing the tubes with rubber plugs

3 - How to Remove the Filter Drier

Remember that changing the compressor also requires a change of the filter drier, in the order as follows:

Slowly warm the soldering region of the capillary with the filter dryer and, at the same time, pull the capillary with pliers, using moderate force not to break it inside the filter drier. Preferably, during the removal of the capillary, make nitrogen circulate to prevent the capillary end from blocking up.

After cooling, close off the end of the capillary tube with a rubber plug.

Important comments

- Another procedure that normally prevents blocking the capillary is to remove the end that had been brazed to the filter drier. Using a file, make a small groove around the capillary and bend it until it breaks. Nevertheless, in cases of successive re-operations of the same system, the shortening of the tube will significantly alter the capillary flow and jeopardize the performance of the refrigeration system.
- When removing the filter, you must not heat it unnecessarily otherwise water retained in it will enter the system piping.
- Emission of CFCs (R 12, R 11 etc.) into the air affects the ozone layer. Until a more effective solution appears for collecting, recovering, recycling and neutralizing the harmful effect of the refrigerant, please attempt not to release CFCs into the environment. Proper equipment is

available for refrigeration professionals to recycle used refrigerants. More information may be obtained from the refrigerant wholesalers.

- **Never** use alcohol or other byproducts as a solvent. They cause corrosion on the compressor tubes and metallic parts and the electric insulation becomes brittle.
- Only use filters with desiccants suitable for the type of refrigerant (see table 2, Chapter VI).

4 - How to Clean a used Refrigeration System

Not all compressor changes require cleaning the low and high pressure tubes.

Cleaning is recommended in cases where it is suspected that there are high levels of contamination of water and residues resulting from the burnout of the compressor winding. In these cases:

In R 12 systems, you should make the actual R 12 or R 11, or the degreaser R 141b, or VERTREL[®] XF circulate when it is liquid.

In systems operating with R 134a, you may use the R 141b degreaser or VERTREL[®] XF for cleaning.

To protect the environment and reduce expenses when changing compressors, fluid for cleaning the unit's components must circulate in closed circuits. At this stage when changing the compressor, the return line shall be disconnected from the compressor and the capillary disconnected from the filter drier.

To complete the cleaning operation, proceed as follows:

- Place a fast coupling on the return line and connect it on the cleaning machine's outlet side;
- Connect the capillary to the cleaning machine's suction side, leaving it operating for around 15 minutes;
- Blast some nitrogen into this circuit to remove any cleaning fluid residue.

Lastly, the condenser must be cleaned. To do so, you must repeat the previous operation, connecting one end of the condenser to the outlet side and the other to the cleaning machine's suction tube.

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Important

If it is not possible to use a blowtorch with proper capacity to braze the oil cooler tubes (TRO) in the system's tubes, proceed as follows: before placing the compressor in the refrigeration system, tip it to the opposite side from the TRO, braze approximately 50 mm (1.97") copper tube at each end of the TRO. With the TRO extended, it will certainly not be difficult to braze it onto the system's tubes.

5 - Installation of filter drier

- Make a small bend in the capillary to prevent it from going too far into the filter, approximately 15 mm (0.59");
- Using a clamp, open up the two sides of the filter drier when brazing;

Important

Only use filters that contain molecular sieve desiccants inside.

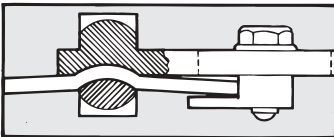


Figure 27 - Capillary tube

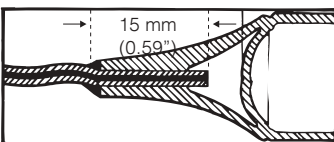


Figure 28 - Inserting the capillary into the filter drier

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- Braze the filter into the condenser and capillary. Do not unnecessarily heat the body of the filter dryer, and take great care not to block the tubes.
- Install the fast coupling to make a vacuum on the high pressure side;
- The filter dryer must be installed in the vertical position with the capillary at the bottom (see figure 29).

This position prevents the desiccant grains from rubbing and releasing residues. It also helps equalize a pressure faster (capillary systems).

Important

If the refrigeration system has not been designed to use the compressor's oil cooling tube (TRO), do not forget to connect it. Otherwise the compressor will have a shorter working life.

Important

Brazing - Do not forget to clean the surface to be brazed well.

Remember: blockage of the outlet tube will damage the compressor valve system.

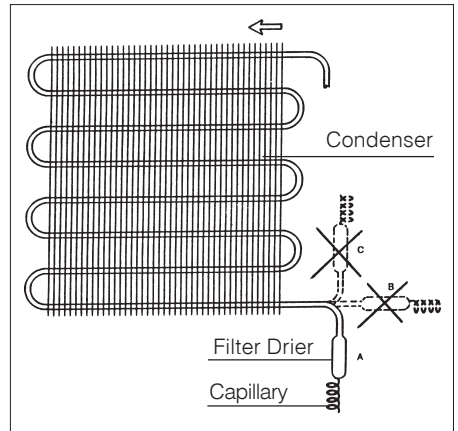


Figure 29 - Filter Drier

The system is now ready to receive the new compressor. Install it in the correct position and fix it to the base. Braze the suction and discharge tubes to the respective compressor tubes.

Also braze a tube of approximately 100 mm (3.94") to the process tube.

At the other end of this tube, install a fast coupling or similar register to make the vacuum and gas charge.

6 - Caution with Vacuum and Refrigerant Fluid Charge

Never use the new compressor as a vacuum pump. It may absorb dirt and water from the tubes, which will be detrimental to its operation and working life.

7 - Vacuum Pump

- A - Always use a high vacuum pump;
- B - Whenever possible, make a vacuum on the high and low side;
- C - Use a hose exclusively for each refrigerant: one for R 134a and another for each of the other refrigerants
- D - Apply a vacuum until 500 μm Hg (29.90" Hg), never less than 20 minutes at this level;
- E - It is recommendable to install a check valve at the inlet of the vacuum pump.

8 - Refrigerant Fluid Charge

In domestic refrigeration systems as with most work with little refrigerant fluid less than 350 g (12.35 ounces) - and use a capillary tube as a control element, the performance of the refrigeration system will very much depend on the refrigerant fluid charge used. Now, with alternative refrigerant fluids, it is even more important to proceed correctly and use proper equipment for this operation.

Example: a system with an internal volume of 280-300 liters normally operates with 90-120 grams (3.2-4.2 ounces) of R 12 refrigerant.

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With R 600a, the systems in this range of inside volume may only have 36-48 grams (1.3-1.7 ounces), that is, approximately 40% of the R 12 charge.

In relation to the original charge with R 12, the R 134a refrigerant fluid charge is approximately 90% and blends 80%.

This fact confirms the need for correct procedures and proper equipment for successfully charging a refrigerant fluid.

9 - Main equipment to Charge the Refrigerant Fluid in Domestic Systems

Refrigerant	Acceptable	Necessary	Ideal
R 12	Charge cylinder with graded scale/manifold		Precision scales/ charge receiving cylinder/ manifold
R 134a	Charge cylinder with graded scale/manifold		Precision scales/ charge receiving cylinder/ manifold
R 600a		Precision scales/ charge receiving cylinder/ manifold	
Blends		Precision scales/ charge receiving cylinder/ manifold	

10 - Main Procedures to recharge Refrigerant Fluid

10.1 - Discover on the system's name plate the type and quantity of refrigerant adopted by the manufacturer. If the system does not have this data, consult the manufacturer.

10.2 - If you are using scales and charge-receiver cylinder:

- a) Weigh the empty cylinder. The correct charge will be the quantity supplied by the manufacturer plus the weight of the empty cylinder;
- b) With the compressor switched off, connect the receiving cylinder to the process tube.
 - 1) Open the valve of the receiving cylinder and wait until the pressure has equalized (cylinder/sealed unit).
 - 2) Close the receiving cylinder valve and switch on the compressor.
 - 3) Gradually open the receiving cylinder valve.
 - 4) After removing the cylinder, weigh it to make sure that it is completely empty.

10.3 - If using a charging cylinder with graduated band:

- a) Write down the volume of the column relating to the refrigerant to be used.
- b) Connect the cylinder to the process tube. With the compressor switched off, open the register until the quantity stipulated by the manufacturer flows out or until the pressures in the refrigeration system cylinder are equal. If it equalizes before the charge is

totally empty, switch on the resistance of the charge cylinder to increase the pressure and release the refrigerant to the refrigeration system. If it is not possible to increase the pressure in the charge cylinder through the resistance, you may lock the register of the charge cylinder, switch the compressor on and then slowly open it until the correct refrigerant charge is transferred.

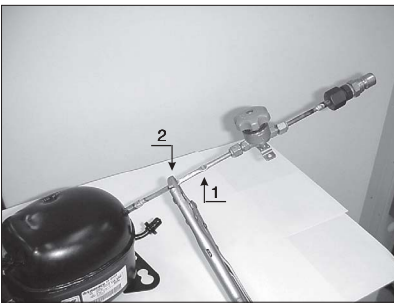
Caution

The system must be accompanied for the first hour after starting up!

This operation requires that the refrigeration professional takes great care. In the case of excessive refrigerant fluid, the compressor may draw in the liquid refrigerant fluid and break the cylinder joints or other components.

Any fault will detract from the system's good performance.

10.4 - Closing the sealed unit

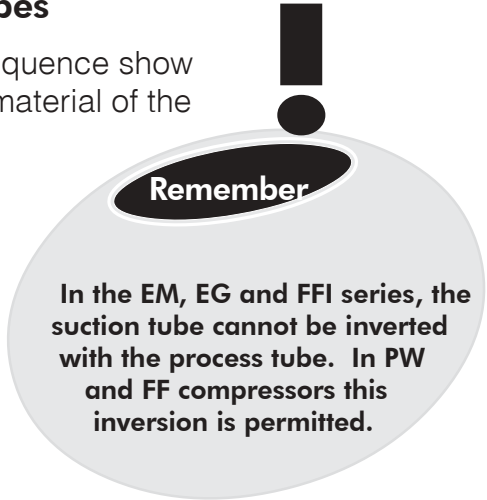


- a) With the compressor connected, flatten the process tube as close as possible to the fast coupling (1). Next, again flatten it, keeping the pliers fixed to the tube (2) and switch the compressor off.
- b) Break the tube at the first flattened point and check to see if there is any leakage. If not, solder the end of the tube. Remove the pliers and check to see if there is no leakage.

Further important recommendations

1 - Embraco Compressor Tubes

The drawings and tables in the sequence show the position, diameters and tube material of the compressors.



Oil Cooler Tube (TRO) Inside Diameter	
mm	inch
4.77 ± 0.17	0.188 ± 0.007
4.90 ^{+ 0.02} _{- 0.05}	0.193 ^{+ 0.001} _{- 0.002}
5.10 ^{+ 0.10} _{- 0}	0.201 ^{+ 0.004} _{- 0}
6.50 [±] _{0.09}	0.256 ± 0.004

Compressor	Material	Inside Diameter						Oil Cooler Tube
		Suction		Discharge		Process		
		mm	inch	mm	inch	mm	inch	
EM	Copper	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	Does not use TRO
		6.1 ^{+ 0.10} _{- 0}	0.240 ^{+ 0.004} _{- 0}	4.94 ± 0.08	0.194 ± 0.003	6.1 ^{+ 0.10} _{- 0}	0.240 ^{+ 0.004} _{- 0}	
F/EG	Copper	8.2 ^{+ 0.12} _{- 0.08}	0.323 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	See above table
		6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	6.5 ± 0.09	0.255 ± 0.004	6.5 ± 0.09	0.255 ± 0.004	
PW	Copper	8.2 ^{+ 0.12} _{- 0.08}	0.323 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	See above table
		6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	4.94 ± 0.08	0.194 ± 0.003	6.5 ± 0.09	0.255 ± 0.004	
EM - F - EG - PW	Copper- plated steel	8.2 ^{+ 0.12} _{- 0.08}	0.323 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	See above table
		6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	5.0 ^{+ 0.18} _{+ 0.06}	0.197 ^{+ 0.007} _{+ 0.002}	6.5 ^{+ 0.12} _{- 0.08}	0.255 ^{+ 0.005} _{- 0.003}	
		6.1 ^{+ 0.12} _{+ 0.02}	0.240 ^{+ 0.005} _{+ 0.001}	5.0 ^{+ 0.18} _{+ 0.06}	0.197 ^{+ 0.007} _{+ 0.002}	6.1 ^{+ 0.12} _{+ 0.02}	0.240 ^{+ 0.005} _{+ 0.001}	TRO

Please consult our sales team for other configurations/diameters.

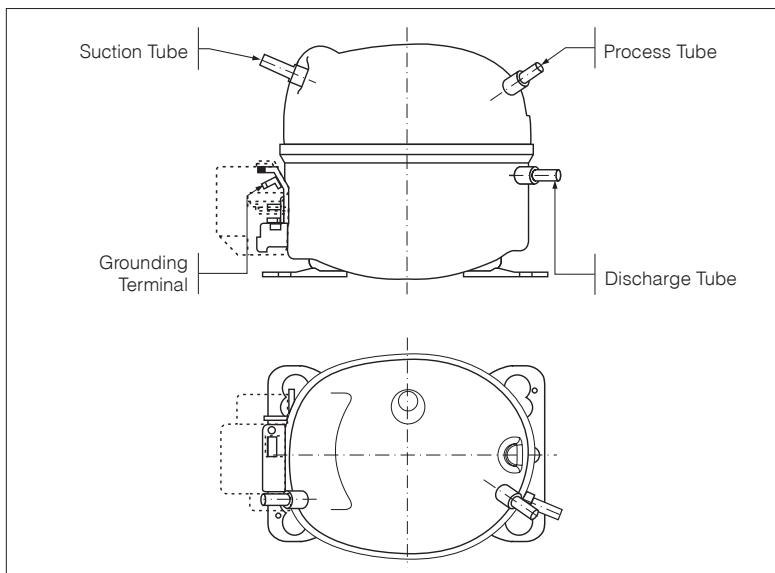


Figure 30 - EM Compressor with copper tubes

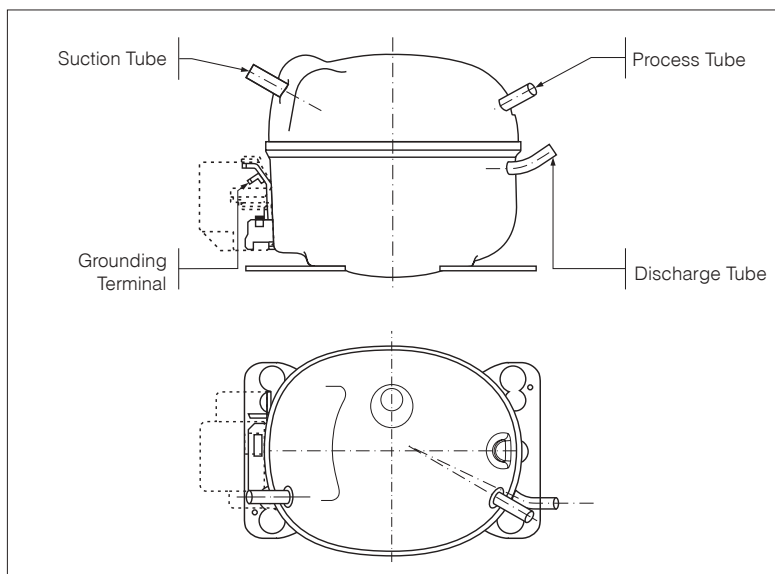


Figure 31 - EM compressor with copper-plated steel tubes

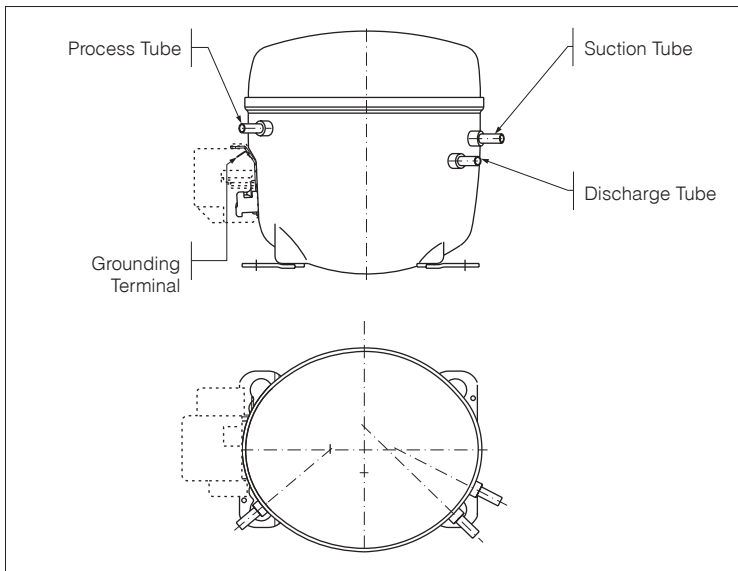


Figure 32 - F/EG compressor with copper tubes

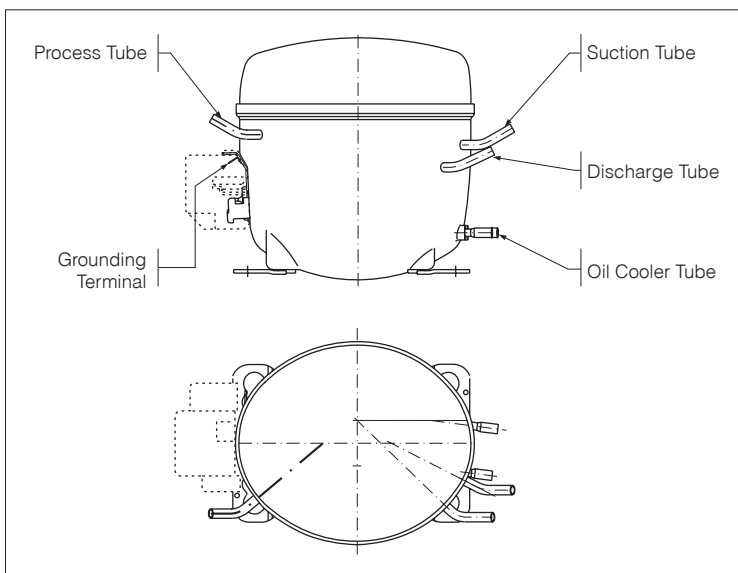


Figure 33 - F/EG compressor with copper-plated steel tubes

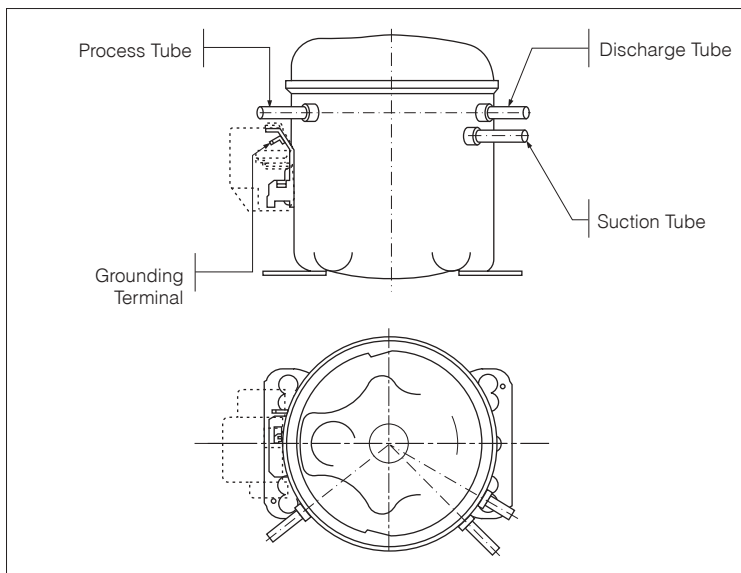


Figure 34 - PW compressor with copper tubes

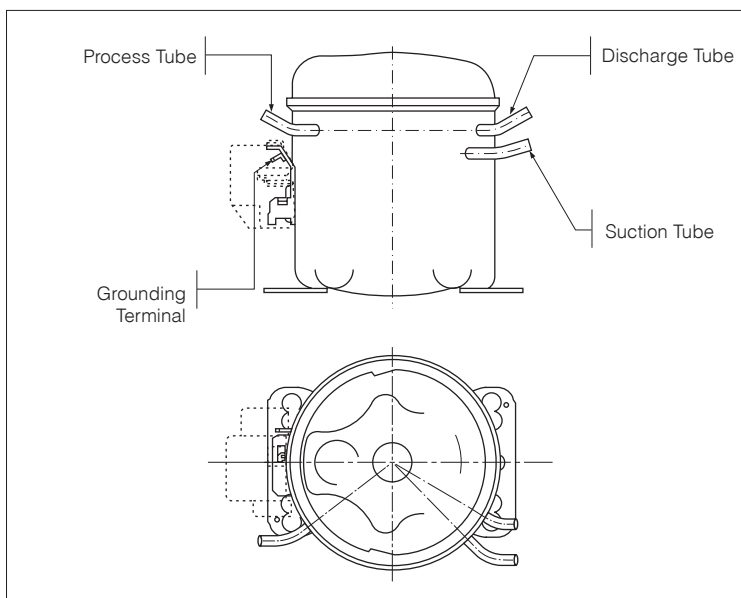


Figure 35 - PW compressor with copper-plated tubes

2 - Filter Driers

There are filter driers suitable for each refrigerant fluid. See the following table:

Refrigerant	Recommended Filter Drier
R 12	XH5, XH6, Universal (MS594)
R 134a	XH7, XH9, Universal (MS594)
R 600a	XH5, XH6, Universal (MS594)
Blends	XH9, Universal (MS594)

3 - Start Capacitor

EMBRACO compressors with an LST motor were designed to work without a start capacitor, under normal conditions of use.

However, when there are problems with the electricity distribution grid or unequal pressures at the start up, a starting capacitor can solve the problem. Use the specified starting capacitor, according to the following table.

The installation of a capacitor outside the specifications may worsen the start up.

Note: If the compressor is not working because there is no starting capacitor, changing it for the incorrect compressor may cause further damage. The operation of the thermal protector can be blocked or delayed to the extent of causing the compressor to burn out. The least damage would be serious damage to the working life of the compressor.

3.1 - FF BX and FF HBX compressors

For FF BX, FFHBX or other compressors with the letter "X" in their name, the starting capacitor must be used, as shown in the following tables:

Compressor	Capacitor to be used in capillary systems	Capacitor to be used in expansion valve systems
FFI12BX 115V60Hz	378 to 454 μ F (115VAC) or 233 to 280 μ F (150VAC)	378 to 454 μ F (115VAC)
FFI12BX 220V60Hz	124 to 149 μ F (180VAC) or 64 to 77 μ F (250VAC)	124 to 149 μ F (180VAC)
FFI12HBX 115V60Hz	378 to 454 μ F (115VAC) or 233 to 280 μ F (150VAC)	378 to 454 μ F (115VAC)
FFI12HBX 220V60Hz	124 to 149 μ F (180VAC) or 64 to 77 μ F (250VAC)	124 to 149 μ F (180VAC)
FF8.5BX 115V60Hz	270 to 324 μ F (115VAC)	270 to 324 μ F (115VAC)
FF10BX 115V60Hz	270 to 324 μ F (150VAC)	270 to 324 μ F (150VAC)
FF10HBX 115V60Hz	282 to 339 μ F (180VAC)	282 to 339 μ F (180VAC)
FFI12HAX 115V60Hz	378 to 454 μ F (150VAC)	378 to 454 μ F (150VAC)

The relays of the aforementioned compressors have the following characteristics:

- terminals 11 and 13 are longer than normal to permit the capacitor's connection;
- it does not have the copper wire bridge between terminals 11 and 13. The compressor, therefore, will only start if the corresponding capacitor is installed.

3.2 - FG AK and FG HAK compressors

FG AK and FG HAK compressors, LST version, instead of using electromechanical relays (as those used in F models), use a PTC type relay and thermal protector.

One of the power leads must be connected to the thermal protector and the other to the terminal 2 of the PTC (see fig. 36).

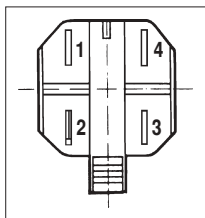


Figure 36 - PTC relay

In addition to being more efficient, the FG compressors can also be used in applications requiring a high starting torque (HST), that is, in expansion valve systems.

To do this, you only need to substitute the PTC with the mechanical relay and thermal protector specified for the FG model for the HST application, together with the recommended starting capacitor, as in the following table:

Compressor	Voltage & Frequency	Relay Code (HST)*	Protector Code (HST)	Start Capacitor
FG 70AK	115V 60Hz	513506082	13554048	243-292 μ F (150VAC)
FG 70AK	220V 60Hz	513506090	13554056	72-88 μ F (250VAC)
FG 80AK	115V 60Hz	513506104	13554080	243-292 μ F (150VAC)
FG 80AK	220V 60Hz	513506112	13554064	72-88 μ F (250VAC)
FG 65HAK	220-240V 50Hz	513506597	13534209	64-77 μ F (220VAC)
FG 75HAK	220-240V 50Hz	513506600	13554471	64-77 μ F (220VAC)
FG 85HAK	220-240V 50Hz	513506619	13554072	64-77 μ F (220VAC)
FG 95HAK	220-240V 50Hz	513506341	13554170	64-77 μ F (250VAC)

* To use FG AK/FG HAK compressors in the HST status, ask Embraco to provide the relay/protector shown in the table above.

Comments:

- a) FG compressors for HST applications make it obligatory to use the starting capacitor and must be installed according to figure 38;
- b) The FG compressor relay for HST applications is different from that used in FF compressors with regard to the following aspects:

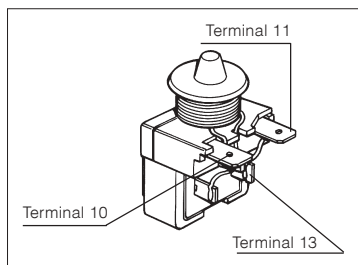


Figure 37 - Short relay without capacitor

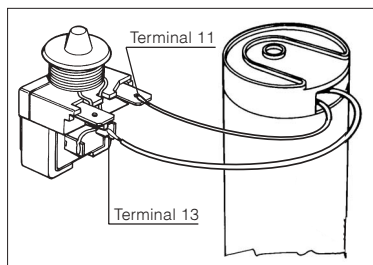


Figure 38 - Short relay with capacitor

- terminals 11 and 13 are longer than normal to permit capacitor's connection;
 - it does not have the copper wire bridge between terminals 11 and 13. The compressor, therefore, will only start if the corresponding capacitor is installed. In the start relay in figure 37, one power lead must be connected to the thermal protector (terminal 3) and the other to terminal 10 of the relay;
- c) the use of a different capacitor from those recommended in the previous table may affect the performance of the thermal protector and cause the motor to burn out.

3.3 - EM compressors

EM compressors have been designed to operate without a starting capacitor. However, if the use of a capacitor is necessary, you only need to remove the copper wire (electric bridge) between terminal 3 and 4 and connect by soldering the starting capacitor's terminals, as shown in the figures below.

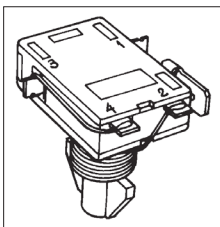


Figure 39 - EM relay without capacitor

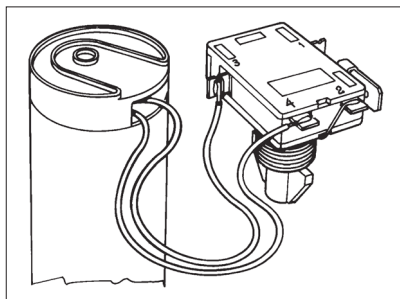


Figure 40 - EM relay with capacitor

4 - Transformer and Voltage Stabilizer

The capacity of this equipment must be according to the motor to which it applies. Otherwise, instead of improving or guaranteeing the normal operation of the compressor and its electrical components, it may damage it (see following table).

Compressor	Type of Motor	Minimum Sta- bilizer Capacity	Minimum Trans- former Capacity
PW, EM	LST	1000 VA	1000 VA
FF BK, FF HBK	LST	2000 VA	2000 VA
FG AK, FG HAK	LST/HST	2000 VA	2000 VA
FF BX, FF HBX	LST/HST	2000 VA	2000 VA

5 - Water

A little water in the sealed unit can cause freezing and block the capillary outlet. The blockage, although partial, will hamper the operation of the refrigeration system. Moreover, water reacts chemically with the refrigerant to form acids. These acids attack the metal parts of the compressor and destroy the motor insulation, causing a short circuit and burnout.

6 - Antifreeze

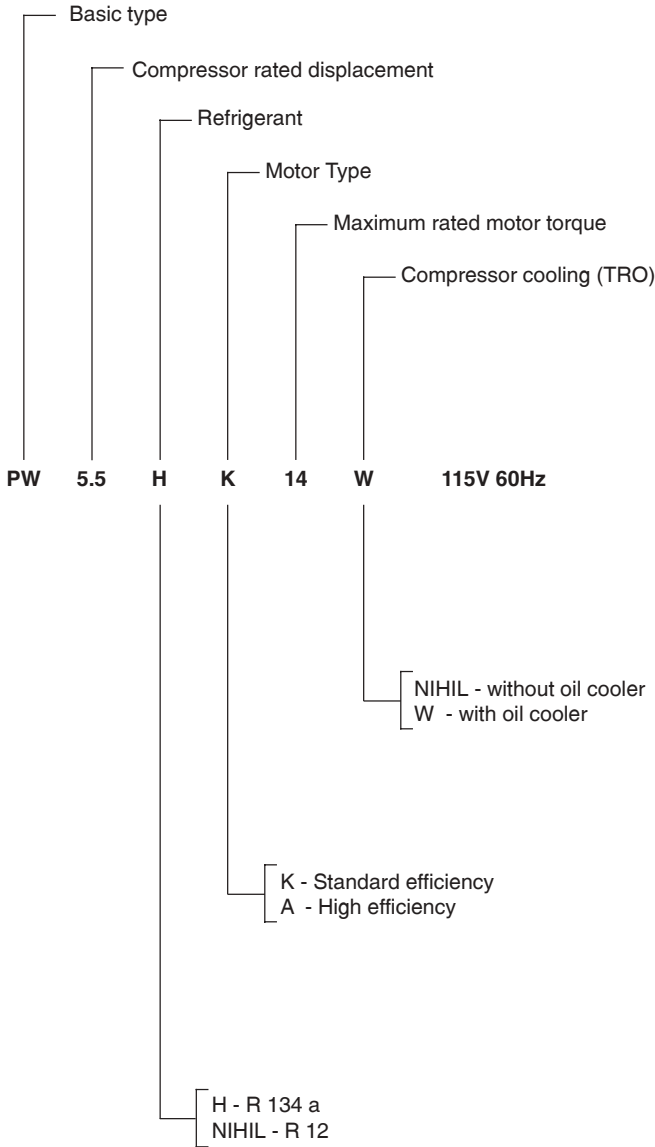
Methyl alcohol or any other antifreeze is extremely harmful to the refrigeration system. Alcohol and its byproducts, also react with the refrigerant to form acids that are detrimental to the compressor, as described in the preceding item. Antifreeze does not insulate or eliminate the water from inside the sealed unit and only lowers the water's freezing point, to prevent ice from forming at the outlet of the capillary to the evaporator.

Antifreeze in the presence of heat and water reacts with the refrigerant and lube oils to produce acids that attack (perforate) the aluminum evaporators and inside components of the compressor, such as electrical insulation and coil wire varnishes.

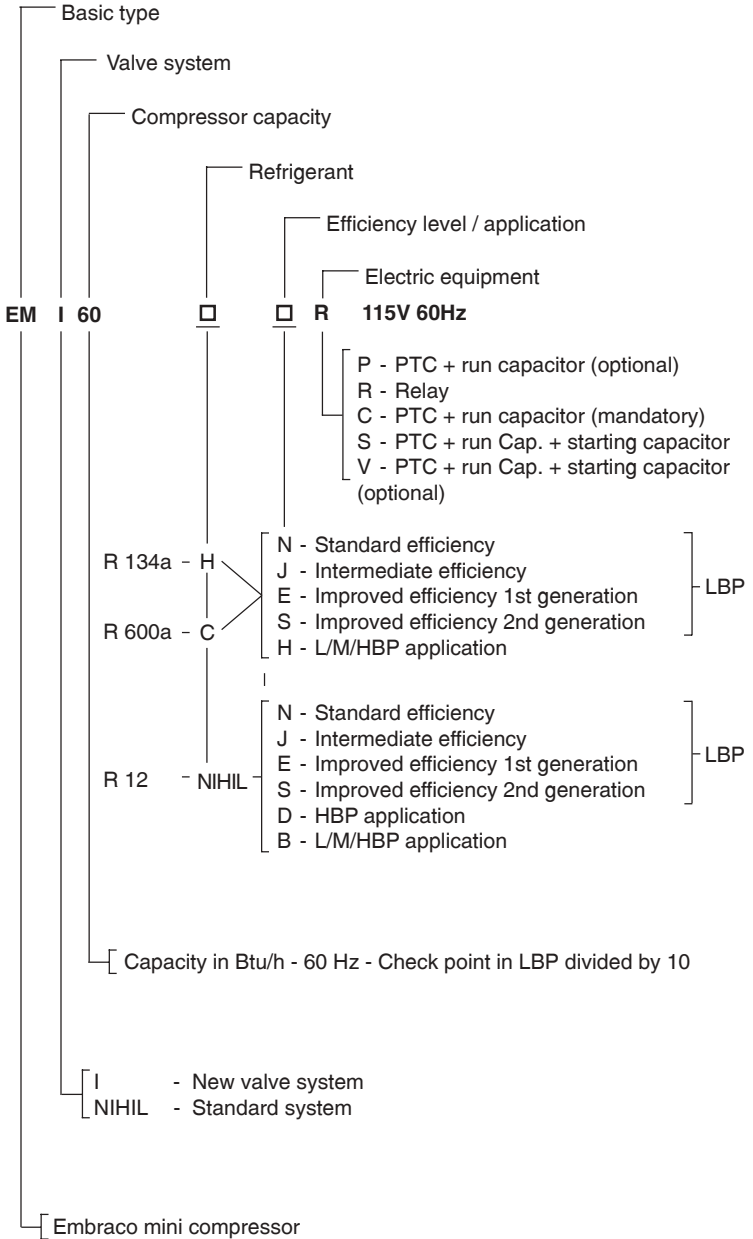
7 - Models of Compressors

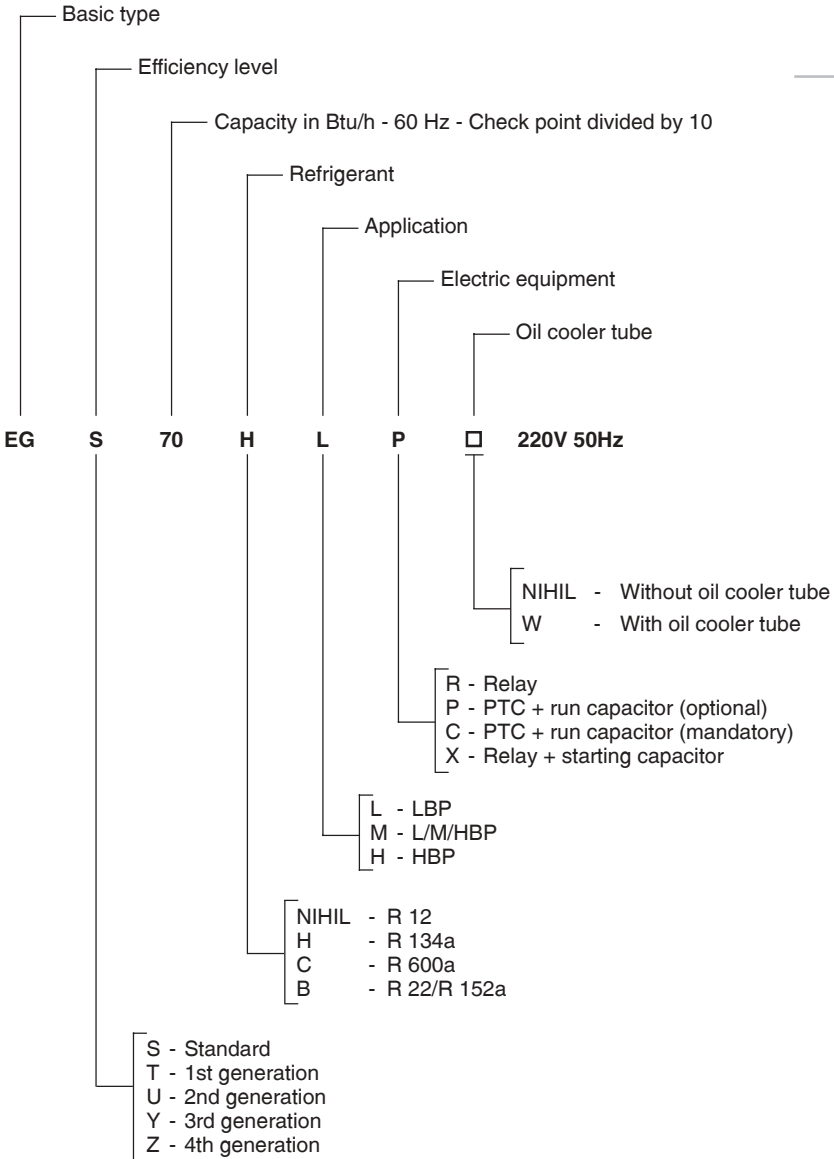


PW

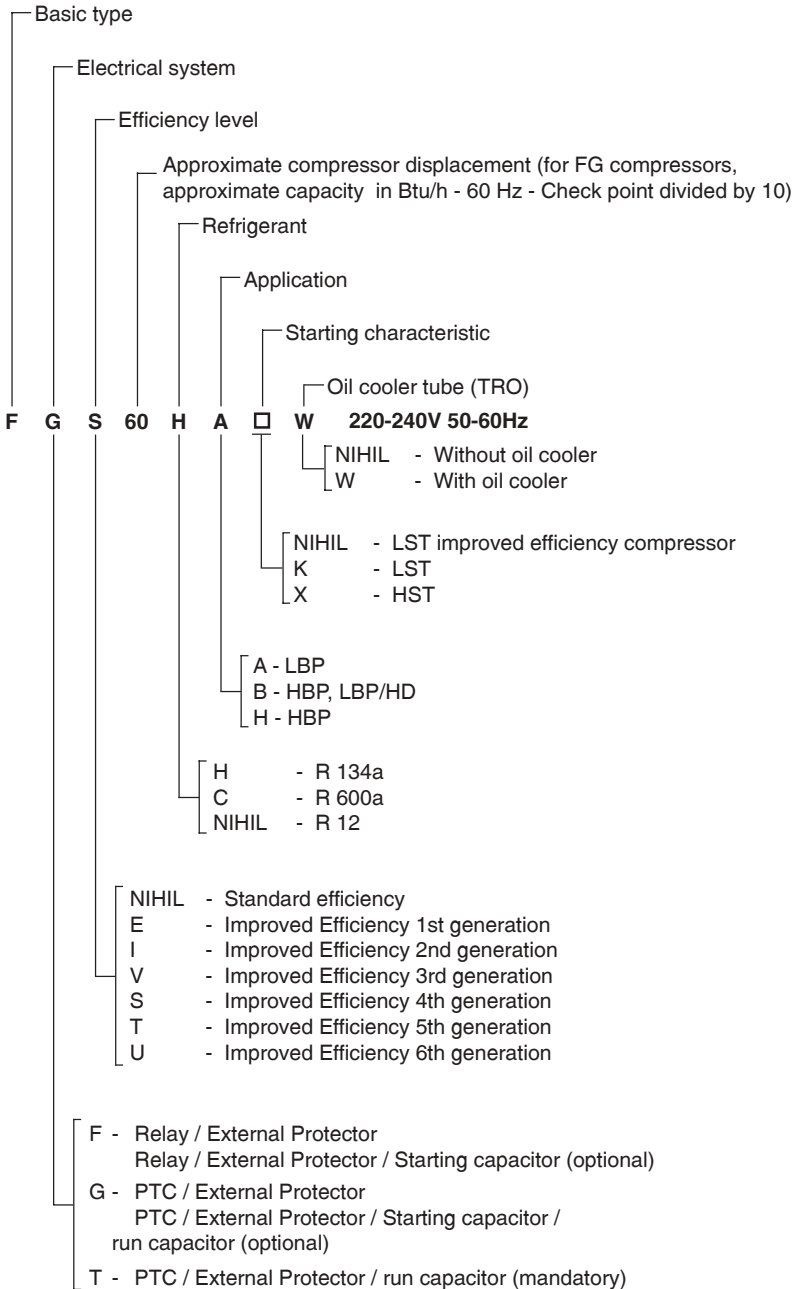


EM

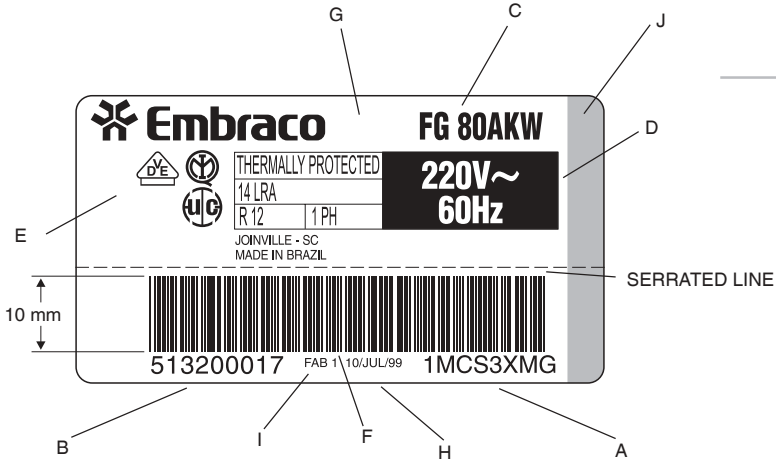




F



8 - Compressor Label



- | | |
|--|---|
| <p>A - Traceable serial number</p> <p>B - Compressor code / Part number</p> <p>C - Compressor designation</p> <p>D - Locked rotor amperage - LRA
 Frequency - Hz
 Refrigerant - R 12
 Number of phases - 1 PH</p> <p>Nominal voltage of compressor - VAC
 Voltage indication: (115V white background
 220V black background)</p> | <p>E - Logos indicate institute approval of compressor</p> <p>F - Bar code 39 (ratio 3:1 and 6.5 mils)</p> <p>G - Paper: White
 Graphics: Black
 Size: 70 x 38 mm (2.76" x 1.50")</p> <p>H - Date of manufacture</p> <p>I - Manufacturing plant</p> <p>J - The orange band is the visual identification used only for 220V compressors.</p> |
|--|---|

9 - General Information for Use of R 134a and R 600a compressors

- Compressors with the letter "H" (e.g. EMI 30HER) in their name have been designed to be used with the R 134a refrigerant fluid.
- Compressors with the letter "C" (e.g. EMI 30CEP) in their name have been designed to be used with the R 600a refrigerant fluid.

- The compressors cannot undergo starting or high voltage tests under vacuum conditions. All Embraco compressors have already undergone a one-second 1650 V high voltage test.
- The compressors cannot be charged with antifreeze agents because they are harmful to insulation materials (see item 5).
- The use of antifreeze agents, traces of grease, mineral oil, impurities in R 134a or the presence of chlorinated substances causes the compressor warranty to be null and void (see item 6).
- Compressors cannot be tested unless they are connected to the refrigeration system.
- **The system to which the compressor will be installed must be designed and properly prepared to use R 134a and ester oil, that is, free of alkaline traces, chlorides, water, wax, grease and paraffin.**

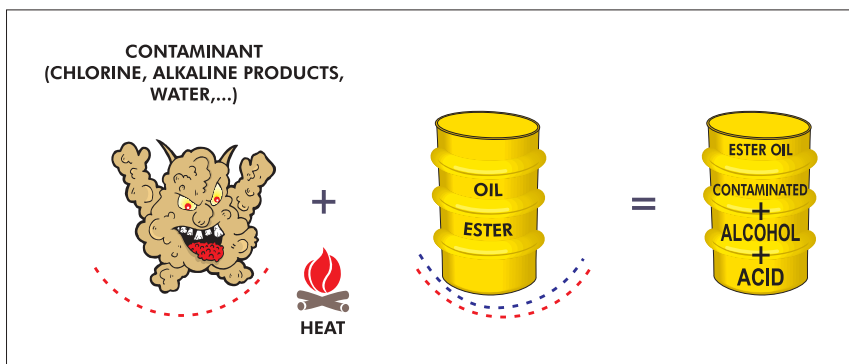


Figure 41 - R 134a chemical reaction between contaminants and ester oil

- Due to the sensitivity of the ester oils used in R 134a compressors, the following recommendations are necessary (which also apply to any other refrigerant):
 - It is recommended that one system only be connected to each vacuum pump;
 - It is recommended that a vacuum be made on both sides of the system, with the vacuum level below 0.6 mbar (500 $\mu\text{m Hg}$);
 - It is preferable that the vacuum pumps be installed at the same level or below the compressor;
 - Use hoses as short and with as large a diameter as possible;
 - The vacuum level must be measured in the refrigeration system and not in the pump;
 - Use R 141b or VERTREL[®] XF as a removal agent for cleaning the systems;
 - Refrigerant charging and vacuum equipment must be for the exclusive use of R 134a, to prevent contamination by chlorine residues;
 - The halogen leak detectors currently used in R 12 system are not efficient for R 134a. This kind of leak detector reacts with chlorine, a halogen, which is missing from R134a. This is why it is recommendable to use equipment with helium-based detectors.
Compact electronic leak detectors compatible with R 134a refrigerant are available in the market;

- To prevent excessive water in the compressor, the tubes must be kept sealed at all times. The rubber plugs must only be removed immediately before brazing the tubes to the system's tubes (as short a time as possible, never more than 15 minutes).
- Refrigeration system manufacturers, who use inflammable refrigerants, such as R 600a, are recommended to develop a correct charging method, leakage test, etc., to guarantee that all necessary safety procedures are adopted. The same care/procedures must be adopted by the refrigeration professional who may eventually operate R 600a systems.

Further information

VII

1 - Impacts

1.1 - Water

In a refrigeration system using a compressor that operates with R 12 (compatible with mineral and synthetic lube oils), a little water means an enormous hazard to the whole system.

In a refrigeration system using a compressor that operates with R 134a, the negative impacts caused by water are even greater. The lube oils for R 134a compressors are highly hygroscopic (water-absorbing) and unstable esters. In addition to the damages mentioned above, it is common for the capillary tube to become blocked due to acid residues.

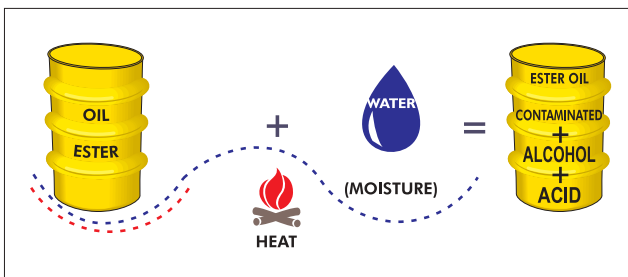


Figure 42 - Chemical reaction between ester oil and water

In the event of partial blockage, the system's performance drops in proportion to the size of the blockage. If completely blocked, this prevents the circulation of the refrigerant and consequently it stops working.

1.2 - Antifreeze

Antifreeze is extremely harmful to the refrigeration system, especially for the compressor.

Firstly, because of its corrosive characteristics and high water content. Some of the main effects are: oxide formation (carbon) on the valve plates, weakening and destroying the motor insulation and corrosion of the aluminum evaporators.

Secondly, because it does not have the power to neutralize the effects of the water.

Antifreeze only prevents the capillary from being blocked by ice, because it lowers the freezing temperature of the water.

Thirdly, because it attacks the desiccants of the filter drier.

1.3 - Hygroscopicity

A property characterizing the affinity of a product with water. Ester oils (used in compressors that use R 134a refrigerant) are hygroscopic and consequently have a high water-absorbing capacity when compared to the naphthene mineral oil and synthetic oil (alkylbenzene) used with R 12 or R 600a.

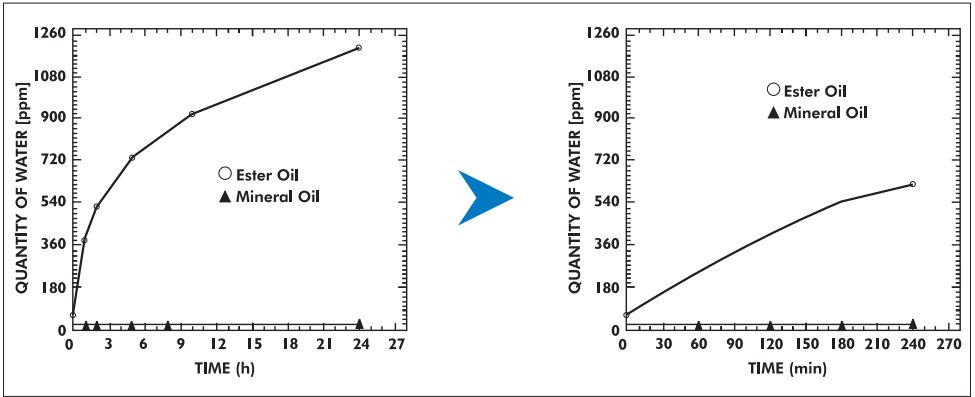
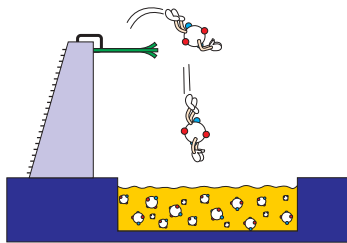


Figure 43 - Graphs comparing hygroscopicity between ester oil and mineral oil

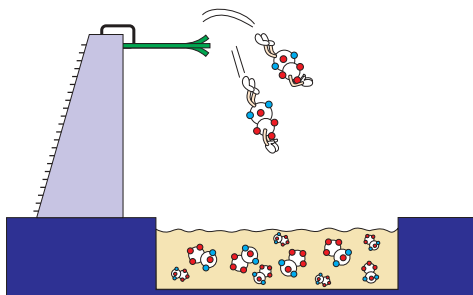
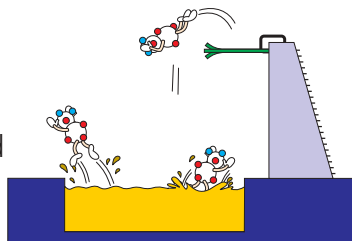
1.4 - Miscibility in Lube Oil

R 12 blends in mineral or synthetic oil (perfect miscibility).



VII

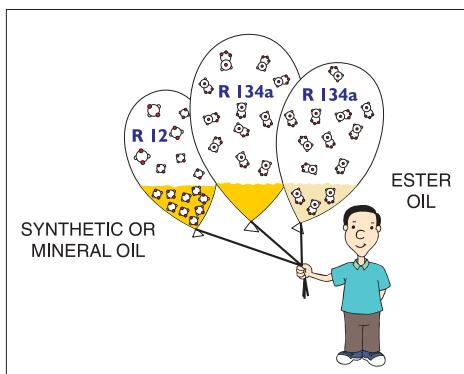
The R 134a does not blend with mineral or synthetic oils (non-miscible).



Ester oils have been specially developed to work with R 134a (acceptable miscibility).

1.5 - Equalizing Pressure

Considering the same refrigerant fluid and oil charge, the equalizing pressures will be:



1.6 - Chemical Compatibility

1.6.1 - Non-miscible Residue

Non-miscible residues are those that remain dissolved in the ester oil blend and R 134a at temperatures above -35°C (-31°F).

The main potentially non-miscible products belong to the families of:

Wax, Grease and Oils

Silicone and paraffin are the most undesirable components in the composition of the aforementioned products.

These products dissolve in ester oil at high temperatures (as in the compressor and condenser), and can be drawn by R 134a through the refrigeration circuit. In low temperature regions (such as in the evaporator and at the capillary outlet), these non-miscible products separate and solidify, then becoming elements of risk, principally in terms of "blockage".

1.6.2 - Incompatible residues

Incompatible residues are those that may act on the ester oil to reverse the reaction of forming ester oil.

The main incompatible products are:

Water, Alkaline and Chlorinated Products.

The presence of these products can cause an increase in the acidity of the oil that, in its turn, will react with metal or plastic components. The outcome of this reaction are compounds that will represent potential problems for the refrigeration systems, some of which are: possible blockage of the capillary, premature failure of the compressor's mechanical components and also weakening of insulation material in the motor and plastic components.

2 - Ozone - Formation Process / Destruction

The ozone is formed when the oxygen molecules (O_2) absorb part of the ultraviolet rays from the sun,

causing the separation of the molecules in two oxygen atoms.

These atoms, in their turn, bond with other oxygen molecules to form ozone (O_3), which contains three oxygen atoms.

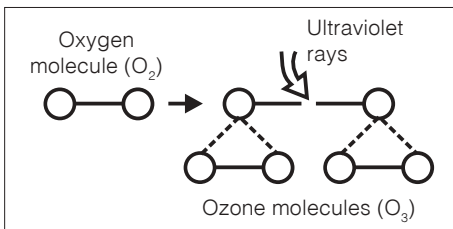


Figure 44 - Ozone molecule

Approximately 90% of the Earth's ozone is located in a natural layer immediately above the Earth's surface, known as the stratosphere.

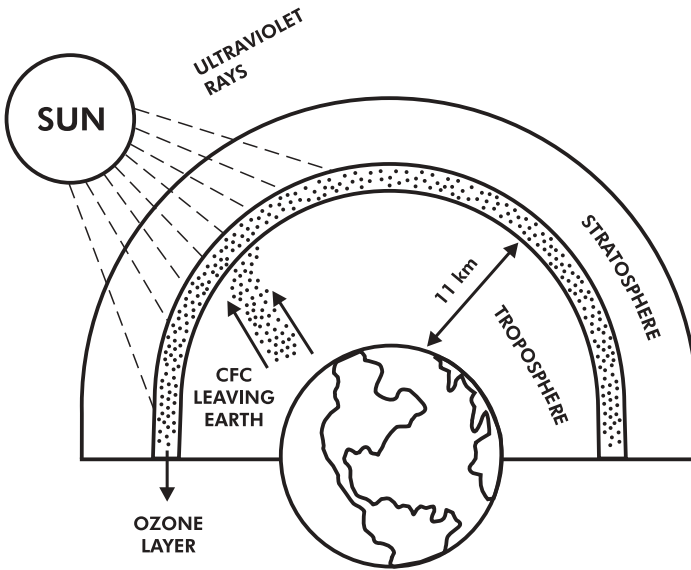


Figure 45 – Schematic of the atmospheric layers that envelope the earth.

This natural layer formed by the ozone acts as a protective shield against the ultraviolet rays. The primary concern about the probable destruction of the ozone layer by the CFCs was raised when the theory was published that chlorine atoms released by the CFCs could migrate as far as the stratosphere and destroy the ozone molecules (Molina & Rowland, 1974).

Some CFCs can live in the atmosphere for more than 120 years, that is, they do not dissociate in the lower atmosphere (troposphere). As a result, the CFCs slowly migrate to the stratosphere where they are affected by higher levels of radiation, releasing the chlorine, which once free, repeatedly bonds with ozone molecules to cause the separation of the oxygen atoms from the molecule in question.

With the destruction of the ozone, higher levels of radiation tend to penetrate the Earth's surface.

Moreover, as CFCs in the atmosphere have a long life and as a chlorine atom can repeatedly destroy thousands of ozone molecules, it will take many decades for the ozone layer to return to its original concentration levels, even after the CFCs have been completely eliminated.

From the time when the theory of the destruction of the ozone layer was published for the first time, scientific research has demonstrated general concern with the increase of chlorine concentration in the stratosphere, which, after destroying the ozone, results in health and environmental hazards, for instance:

- Increase in the number of skin cancer patients;
- Increase in the number of cataract patients (ocular);
- Crop damage;
- Damage to aquatic organisms (marine algae);
- Increase in environmental temperature.

2.1 - How is the ozone destroyed?

CFC molecule.

At the 1st stage, ultraviolet rays breaks the link of a chlorine atom in the CFC molecule.

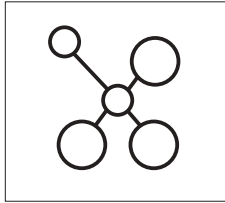


Figure 46 - CFC molecule

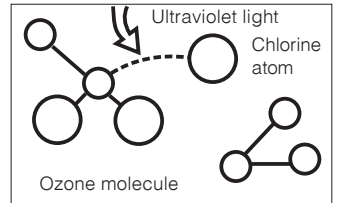


Figure 47 - CFC molecule with separation of chlorine

CFC molecule with chlorine separation.

Next, the chlorine atom attacks the ozone molecule (O_3), breaking the link between the atoms.

A common oxygen (O_2) and chlorine monoxide molecule are formed.

Split in the link and formation of new molecules.

Chlorine monoxide is unstable, has its link broken and forms free chlorine again, which will attack and destroy another ozone molecule, repeating the process.

Cl-O splitting to form O_2 and frees chlorine to continue reacting.

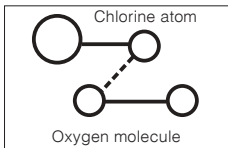


Figure 48 - Break in the connection and formation of new molecules

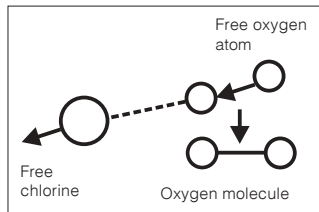


Figure 49 - Cl-O breaking, forming O_2 and free chlorine, that reacts again.

3 - Maintenance of domestic refrigeration system

3.1 - Blends

Normally consisting of two or three refrigerant fluids of the HCFC type (hydrochlorofluorocarbons), or HCs (hydrocarbons) have the following main characteristics:

- Ozone Depletion Potential (ODP) less than R 12.
- Its components do not completely blend and this is why they are called non-azeotrope refrigerants.
- Developed to be used in compressors currently manufactured for R 12. Some have restrictions regarding lube oil and may not be used with mineral oil. In such cases, the oil should be replaced by synthetic oil (alkylbenzene).
- By the fact that its components do not blend completely, any leakage at the gaseous stage may affect the performance of the refrigeration system. This occurs due to the different properties among the refrigerants, so that those with less density escape first, altering its composition.

- Due to problems of chemical compatibility, the filter drier normally used for a system that operates with R 12, shall be substituted by one compatible with the blend (see Chapter VI, item 2).
- Refrigerant fluids (blend) in the system shall only be charged at the liquid stage, due to the aforementioned differences in density.

4 - Alternative refrigerant R 134a

Chosen to replace the R 12 because it has properties similar to it and does not have the power to destroy the ozone layer (ODP = 0).

Comments:

- Leakage will cause little (R 134a has GWP) environmental impact.
- Only recommended for use in new systems specially designed for its use. The main reasons are:
 - It may require an alteration in the capillary tube to maintain the system's performance, when compared to the use of R 12.

- It requires all components of the system to be free from contamination (alkaline substances, grease, wax, water, paraffin, silicone, chlorinated residues, etc.), due to the characteristics of the compressor to be used. To date, there is no definition of a sufficiently effective cleaning method that is reliable and reasonably uncomplicated and which guarantees the simple substitution of the R 12 of a domestic refrigeration system with R 134a.
- R 134a may only be used in compressors specially designed for its use due to the slightly higher operating pressures in relation to the applications with R 12. These characteristics required a new electric motor design and chemically compatible materials employed in its manufacture. Compressors produced to use R 12, however, have materials used in their manufacturing process that are not compatible with the ester oil used in the same R 134a.
- Due to problems of chemical compatibility, it will be necessary to use a special filter drier for the R 134a.
- Due to the high hygroscopicity of the ester oil used in the compressors specifically for R 134a, we recommend that the compressor or system does not remain open to the air for more than 15 minutes. The vacuum process using a pump is mandatory.

If after these instructions you still have doubts, please do not hesitate to call us.

Write to Embraco:

Process and Product Technology Group

Group for Assistance in Application

Rua Rui Barbosa, 1020 - Caixa Postal 91

CEP 89219-901 - Joinville - SC - Brazil

Note: After replacement, the compressor and its accessories must have proper processing, and the components must be recycled according to the material group (ferrous, non-ferrous, polymers, oils, ...) directives. These recommendations are intended to minimize the adverse impacts that may be caused to the environment.

Disclaimer of Liability

The compressors here into introduced were designed for strictly use and application according to their respective specifications. Any change or use different from these specifications requires Embraco's previous written consent.

Embraco specifically disclaims and excludes any liability to the maximum extent legally permitted, in relation to compressors improperly used.

Improper use means:

(1) application of the compressors not compliant with their designs and specifications; and (2) use of the compressors without observation of the respective safety warnings informed by Embraco's Technical Bulletin. Damages and losses generated by improper use of the compressors manufactured by Embraco will be borne exclusively by the incautious user. Eventual damage to Embraco's image will be reimbursed by the non-compliant user.

Within the material technical boundaries that have to be taken into consideration, but not limited to, Embraco outlines the running temperatures, voltage and frequency supply, type of the refrigerant, type and specifications of the starting device and overload protector.

In case you have any concerns and/or doubts, please do consult compressors's accompanying documentation, or contact Embraco for further information.

The use of certain refrigerants may have been forbidden or restricted use in some countries, demanding the use of alternative refrigerants. We advise you to check the specific regulations of your country.



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