



**GUIDE FOR THE USE OF HCs REFRIGERANTS
R600a AND R290**



embraco

R290 / R600a SERVICE PROCESS



SYSTEM
DESIGN



SAFETY &
PRACTICAL




COMPRESSOR
REPLACEMENT

R600a and R290 are hydrocarbon refrigerants. They have consistent differences versus the HFCs or CHFCs that must be considered for designing, producing, testing, handling, storing, installing, repairing and disposing the applications, as well as for the workplaces and storage, with particular care to the flammability aspects and their consequences. A complete risk assessment of the use of HCs refrigerants must be carried out considering all the above points. It is also important to carefully consult the in use equipment manual. Only competent technicians trained on the safe use of flammable refrigerants are allowed to open refrigerant circuit or equipment housing of hydrocarbon systems. Technicians using HCs must have available and know the meaning of the applicable Material Safety Data Sheets (MSDSs) and act accordingly.

INTERNATIONAL SAFETY STANDARDS

STANDARD	TITLE	VALIDITY FOR	ALLOWED MAX REFRIGERANT CHARGE
IEC and EN 60335-2-24	Applications for household refrigerators, ice cream appliances and ice makers	Household appliances	≤ 150g
IEC and EN 60335-2-89	Commercial applications with incorporated or remote condensing units	All Commercial applications	≤ 150g
EN 00378	Refrigerating systems and heat pumps safety and environmental requirements	All refrigerators / freezers, air conditioners, heat pump; household, commercial, industrial	Variable, according to the application and to the installation location

 **NOTE:** Limit of 150g is for each separate refrigeration circuit. No restrictions in room size and occupancy category.

SAFETY STANDARDS FOR ELECTRICAL APPLIANCES

STANDARD	TITLE
IEC 60079-15	Electrical apparatus for explosive gas atmospheres Part 15: construction, testing and marking electrical components for use in explosive atmospheres

For more information on these equipment and parts requirements, look at these two standards online. Always refer to local legislation as well.

HCs R600A AND R290 GENERAL INFORMATION AND CHARACTERISTICS

ACCORDING TO EN378	R600A	R290
Chemical Name	Isobutane (2-methylpropane)	Propane
Molecular Formula	C ₄ H ₁₀	C ₃ H ₈
Safety Class ⁽¹⁾	A3	A3
PED fluid group	1	1
Practical Limit [kg/m ₃] ⁽²⁾	0.0089	0.008
ATEL/ODL [kg/m ₃]	0.0024	0.09
LFL [kg/m ₃]	0.038	0.038
Vapour density 25°C, 101.3 kPa [kg/m ₃]	2.38	1.8
Molecular Mass [g/mol]	58.1	44.0
Normal Boiling Point [°C]	0	-42
ODP	0	0
GWP [100 years ITH]	4	3
Autoignition temperature [°C]	365	470
Critical Temperature [°C]	134.66	96.74
Critical Pressure [kPa abs]	3629	4251.2

(1) Highly flammable substances are defined by a flammability limit of less than or equal to 0.10 kg/m³ at 21°C and 101 kPa or a heat of combustion greater than or equal to 19 kJ/kg; (according to ANSI/ASHRAE 34).

(2) Practical limit according to EN 378-: it is used if the HC refrigerant of the system can leak into an occupied ambient.

 **NOTE:** HC refrigerants are classified in A3 Safety Class - lower toxicity, higher flammability, (according to ANSI/ASHRAE 34).

R600A AND R290 IDENTIFICATION AND WARNING SYMBOLS

The Embraco compressors for R600a and R290 have on the nameplate label - or as separate label - a warning symbol for flammable substances, even if they do not contain any refrigerants when delivered from Embraco factories.



The refrigerant to be used is printed on the compressor label, also the compressor model includes a code identifying the refrigerant to be used. The R600a and R290 Embraco compressors are certificated by recognized testing agencies and adopt overload protectors and starting devices complying with the EN 60079-15.

HCs System Components

SYSTEM	Must have refrigerant identification and "Risk of fire" label
CONDENSER	Same as R404A / R134a system or slightly smaller
EVAPORATOR	Same as R404A / R134a system <i>In case of roll bond evaporator, check supplier's specifications.</i>
PIPING	Same as R404A / R134a system



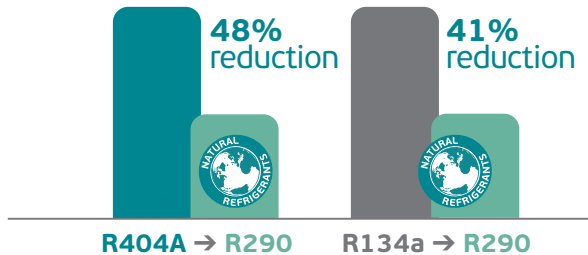
5mm tubes or MCHE could help to minimize refrigerant charge

FILTER DRYER	Same as R404A / R134a system (XH-9)
CAPILLARY	Same as R404A / R134a or slightly longer (10-15%)
EXPANSION VALVES	Specifically to R290. Heat Exchangers with smaller channels can help to minimize refrigerant charge under 150 grams
FAN MOTOR	Has to be spark free (shaded pole or ECM)
FAN BLADES	Must be made in plastic or aluminium material
OTHER ELECTRICAL COMPONENTS	Have to be approved according to IEC 60079-15 (2005)

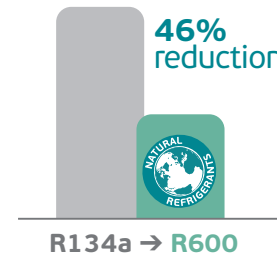
Refrigerant Charge

MAX CHARGE 150g

R290 vs R134a/R404A



R600a vs R134a



NOTE: Values are just indicative; the proper refrigerant charge depends on the system design.

- ⚠️ **Common sense and staying alert** will go a long way towards working safely with flammable refrigerants.
- ⚠️ Always conduct a **risk assessment** to determine whether it is appropriate to use a flammable gas refrigerant in the particular workplace.
- ⚠️ Hydrocarbon refrigerants do not have an odorant, so leaks can't be identified by smell. **A quality combustible gas leak detector is mandatory** for HC service work.
- ⚠️ The work area must be free from sources of ignition such as naked flames and sparking electrical devices.
- ⚠️ Assure the presence of fire extinguisher equipment.
- ⚠️ ***This safe zone also applies around a vacuum pump because it could discharge some residual HC gas during evacuation.***

General precautions for service

- ⚠️ **Always wear appropriate safety glasses and gloves** when working with HCs and while brazing/unbrazing tubing.
- ⚠️ **The work area must be monitored with a hydrocarbon detector**, located at low level, because HCs are heavier than air.
- ⚠️ **Good ventilation** is essential to reduce the potential of a flammable mix.



The sensor should provide an audible and visual alarm of HC in the air, well before there is enough to form a flammable mix (approximately 2% of HC in air by volume).

For internal areas forced ventilation is required by a fan rated for explosives atmospheres



SPECIFICATION OF TOOLS AND EQUIPMENT



Use only tools and equipment certified for use in hazardous areas.

(i.e. vacuum pump, electrical components and parts, original replacement parts).

Normal vacuum pumps can be used if outside the flammable zone but the on/off switch must not be used, as this is usually the only ignition source in most pumps. It is anyway recommended to have a HC specific pump.

Use leak detectors rated for combustible gas, if the leak cannot be located with a electronic detector, remove the charge, purge and fill with nitrogen and use a micro leak detector spray.



Wear an antistatic-electricity tag.



Use recovery machines specifically designed for HCs (they can also be used with HFCs).

STANDARD RECOVERY MACHINES FOR HFCS MUST NOT BE USED WITH HC REFRIGERANTS BECAUSE OF SOURCES OF IGNITION SUCH AS SWITCHES, HIGH AND LOW PRESSURE CONTROLS AND RELAYS.



Recovery cylinders: be specific for HC (pressure rating and the compatibility of valve seals, etc).



Always check local requirements for handling, storage and transportation.

REPLACEMENT OF ELECTRICAL PARTS



In case of replacement of electrical parts inside the cabinet (i.e. neon lamp, thermostat, etc.):

Sweep the worksite with the HC gas detector

Disconnect the main electrical supply

Open the refrigerator doors and keep them open for a few minutes

Replace failed components using original equipment parts

Close the doors and connect the refrigeration equipment to power source



NOTE: HCs are heavier than air, so if there is an internal leakage, there could be a high concentration of refrigerant in the bottom of the cabinet, creating a flammable mix.

LEAKAGE

Internal of cabinet



HC leaks from evaporator to the internal compartment can form a flammable mixture. Any source of ignition (thermostat, on/off switches, etc.) may produce a flame or explosion.

All electrical devices must be encapsulated or fire and explosion proof.







External of cabinet



The possibility of HC leakage external of the cabinet forming a flammable mix with air is remote, considering the small charge.

“Built-in” systems inside another structure are more susceptible to this possibility.

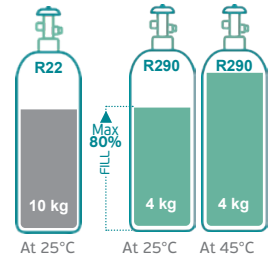
Refrigerant Removal

- 1
Disconnect cabinet from electrical supply.

- 2
Remove the protective cover to access the compressor.

- 3
Remove all the compressor electrical components.

- 4
Fit a needle valve on the service tube.

- 5
Connect a schrader valve in order to start the venting procedure.

- 6
Remove the refrigerant by venting it in the atmosphere in an outside ambient away from heat and ignition sources.




WARNING:

During the refrigerant recovery (and generally when filling a vessel) take care to the amount (weight) of Refrigerant put in the vessel and to the weight of the vessel itself. Due to the different density of HCs Vs HCFCs/HFCs refrigerants, it's possible to fill the same cylinder (same volume) with only 40% of HCs vs HCFCs/HFCs.



System evacuation

- 7 Remove the needle valve and insert a schrader valve (to get a larger port).
- 8 Make a 1st vacuum for at least 5 minutes. Fill the system with Nitrogen (OFDN) at 6 bar pressure (1st washing).
- 9 Release the nitrogen and make a 2nd vacuum for 5 min. Fill the system with nitrogen at 6 bar (2nd washing).
- 10 Release the nitrogen and make vacuum for 5 minutes. Fill the system with nitrogen at 6 bar (3rd washing). Release the nitrogen. Unsolder the line tubes at the compressor suction/discharge: this operation must be done immediately after.



Installation of new compressor

- 1 Remove old compressor and place the new one.
- 2 Braze, on the compressor service tube, a tube, approx 15 cm long, with a schrader valve on its end. Schrader valve plug must be removed while brazing.
- 3 Braze the suction/discharge line tubes to the corresponding compressor tubes.
- 4 Fill the system with nitrogen at 6 bar.
- 5 Check system leakages.

Refrigerant charge

6 Release the nitrogen and make a proper vacuum.

7 Always use refrigerant that is labeled "R290" and never just Propane.



R290 labeling insures purity and no odorant or moisture, a 1% degradation in purity can lead to a 3-6% degradation in system performance.

Charge the refrigerant and measure carefully the amount of refrigerant filled in the system, in order to be sure to charge the same quantity originally charged by the cabinet producer, as specified on the cabinet label.



NOTE: due to the small amount of the HCs refrigerant charge (max 150 g), an accurate weighting of the HC charged in the system is mandatory to assure proper performance of the repaired cabinet.

8 Install and connect new electrical components using only factory original parts.

9 Check electrical connections using the spec sheet and verify that the compressor and the unit are properly grounded.

10 Reinstall the terminal cover.

11 Check leaks by using a specific leak detector for hydrocarbons.

Start up and check the repaired cabinet

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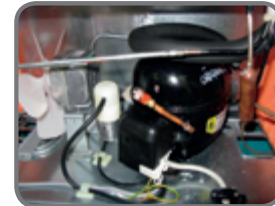
Close the Schrader valve with its nut (put sealing glue on the threads). Optionally: grip the service tube by a grip pliers, eliminate the schrader valve and close the tube with a Lockring connection.

13

Connect the cabinet to the electrical supply line.

14

Perform a final inspection of the cabinet and be sure all guards and access panels are reinstalled. Check the cabinet working conditions.



Troubleshooting and service chart

The operational failures effecting the compressors that may happen to the refrigeration system, can be, in most cases, identified and eliminated by consulting Table 12.1 of our Compressors Handbook. This Troubleshooting Chart is not comprehensive and does not intend to replace the instruction provided by the producer of the refrigeration system.

The listed failures in Table 12.1 are among the most common to be found in established applications. For other possible defects which do not appear in the list or for running problems in the design phase of the applications, contact Embraco Technical support team. It is recommended (before verifying the cabinet working conditions, analyze the deviation from normal conditions and define the problem root causes), to start from a check list like:

- Visual check of the electric boards, wiring, fuses etc.
- Check that the compressor electrical components are the ones specified by EMBRACO.
- Check their assembly compared with the electrical corresponding diagram as indicated in Chapter 6.1 of the Compressors Handbook.
- Check settings and proper operation of all safety and protection devices.
- Check pressure and other switches, if installed.
- Check that all valves (eventually installed) are in the correct position for the running conditions.
- Check the system for leaks, starting from the most critical points.

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