Application Engineering

HFC-134A Refrigerant Guidelines

BULLETIN NO: AE4-1295 R1

Contents

COPELAND

Safety

Important Safety Information

Those involved in the design, manufacture, and installation of a system, system purchasers, and service personnel may need to be aware of hazards and precautions discussed in this section and throughout this document. OEMs integrating the compressor into a system should ensure that their own employees follow this bulletin and provide any necessary safety information to those involved in manufacturing, installing, purchasing, and servicing the system.

Responsibilities, Qualifications and Training

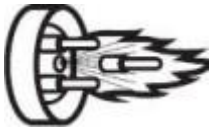
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• OEMs are also responsible for ensuring that all product, service, and cautionary labels remain visible or are appropriately added in a conspicuous location on the system to ensure they are clear to any personnel involved in the installation, commissioning, troubleshooting or maintenance of this equipment.

• Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission, troubleshoot and maintain this equipment. Electrical connections must be made by qualified electrical personnel.

• Observe all applicable standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment.

Terminal Venting and Other Pressurized System Hazards



If a compressor's electrical terminal pin loses its seal, pressurized oil, refrigerant, and debris may spray out. This is called "terminal venting".

The ejected debris, oil, and refrigerant can injure people or damage property. The oil and refrigerant spray can be ignited by electrical arcing at the terminal or any nearby ignition source, producing flames that may project a significant distance from the compressor. The distance depends on the pressure and the amount of refrigerant and oil mixture in the system. The flames can cause serious or fatal burns and ignite nearby materials.

Each compressor has a terminal cover or molded plug that covers electrical connections. The cover or plug helps to protect against electric shock and the risks of terminal venting. If terminal venting occurs, the cover or plug helps contain the spray of refrigerant and oil and reduces the risk of ignition. If ignition occurs, the plug or cover helps contain the flames. However, neither the terminal cover nor the molded plug can completely eliminate the risk of venting, ignition, or electric shock.

See copeland.com/terminal-venting for more details about terminal venting. Additionally, a compressor's refrigerant lines keep refrigerant and oil under pressure. When removing or recharging refrigerant from this component during service, this can pose a pressurized fluid hazard.

Flammable Refrigerant Hazards

If flammable refrigerant is released from a system, an explosive concentration can be present in the air near the system. If there is an ignition source nearby, a release of flammable refrigerant can result in a fire or explosion. While systems using flammable refrigerant are designed to mitigate the risk of ignition if the refrigerant is released, fire and explosion can still occur.

See copeland.com/flammable-refrigerants for more information on flammable refrigerant safety.

Electrical Hazards

Until a system is de-energized, and capacitors have been discharged, the system presents a risk of electric shock.

Hot Surface and Fire Hazards

While the system is energized, and for some time after it is deenergized, the compressor may be hot. Touching the compressor before it has cooled can result in severe burns. When brazing system components during service, the flames can cause severe burns and ignite nearby combustible materials.

Lifting Hazards

Certain system components may be very heavy. Improperly lifting system components or the compressor can result in serious personal injury. Use proper lifting techniques when moving.

POE Oil Hazards

This equipment contains polyol ester (POE) oils. Certain polymers (e.g., PVC/CPVC and polycarbonate) can be harmed if they come into contact with POE oils. If POE oil contacts bare skin, it may cause an allergic skin reaction.

Precautions

• Always wear personal protective equipment (gloves, eye protection, etc.).

• Keep a fire extinguisher at the jobsite at all times.

• Keep clear of the compressor when power is applied.

- IMMEDIATELY GET AWAY **if you hear unusual sounds in the compressor. They can indicate that terminal pin ejection may be imminent. This may sound like electrical arcing (sizzling, sputtering or popping). However, terminal venting may still occur even if you do not hear any unusual sounds.**

• Never reset a breaker or replace a blown fuse without performing appropriate electrical testing

- **A tripped breaker or blown fuse may indicate an electrical fault in the compressor. Energizing a compressor with an electrical fault can cause terminal venting. Perform checks to rule out an electrical fault.**

• Disconnect power and use lock-out/tag-out procedures before servicing.

- Before removing the terminal cover or molded plug, check that ALL electrical power is disconnected from the unit. Make sure that all power legs are open. (Note: The system may have more than one power supply.)

- Discharge capacitors for a minimum of two minutes

- Always use control of hazardous energy (lock-out/tag-out) procedures to ensure that power is not reconnected while the unit is being serviced.

• Allow time for the compressor to cool before servicing.

- Ensure that materials and wiring do not touch high temperature areas of the compressor.

• Keep all non-essential personnel away from the compressor during service.

• For A3 refrigerants (R290) remove refrigerant from both the high and low sides of the compressor. Use a recovery machine and cylinder designed for flammable refrigerants. Do not use standard recovery machines because they contain sources of ignition such as switches, high- and low-pressure controls and relays. Only vent the R290 refrigerant into the atmosphere if the system is in a well-ventilated area.

• Never use a torch to remove the compressor. Only tubing cutters should be used for both A2L and A3 refrigerants.

• Use an appropriate lifting device to install or remove the compressor.

• Never install a system and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.

• Always wear appropriate safety glasses and gloves when brazing or unbrazing system components.

• Charge the system with only approved refrigerants and refrigeration oils.

• Keep POE oils away from certain polymers (e.g., PVC/CPVC and polycarbonate) and any other surface or material that might be harmed by POE oils. Proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. Handle POE oil with care. Refer to the Safety Data Sheet (SDS) for further details.

• Before energizing the system:

1. Securely fasten the protective terminal cover or molded plug to the compressor, and

2. Check that the compressor is properly grounded per the applicable system and compressor requirements.

Signal Word Definitions

The signal word explained below are used throughout the document to indicate safety messages.

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Introduction

HFC-134a is a chlorine-free fluorinated refrigerant designed as a non-ozone depleting replacement of CFC-12. Originally developed for automotive air conditioning and domestic refrigeration applications, it has also been found to be acceptable in medium and high temperature commercial applications. Generally speaking, HFC-134a is considered an adequate refrigerant to replace CFC-12 where the evaporation processes occur at temperatures -10°F or higher.

At low evaporator temperatures where high compression ratios are encountered, compressors using HFC- 134a exhibit lower volumetric efficiency than CFC-12. Capacity losses as great as 30-40% can result, rendering HFC-134a inappropriate as a CFC-12 replacement for low temperature applications.

Due to the differences in volumetric capacity, HFC-134a should not be used in a compressor originally intended for use with HCFC-22.

Refrigerant Description

HFC-134a is considered non-toxic (Acceptable Exposure Limit or AEL=1000 ppm) and non-flammable.

Table 1 Refrigerant Properties

Property	HFC-134a	CFC-12
Boiling Point	-15.7	-21.6
Critical Point	214	233
Critical, Pressure, psia psig	595	598
Latent Heat of Vaporization (BTU/lb) at -15F	88.22	68.20
Saturated Vapor Density (lb/ft3) at 5° F	0.527	0.686
Ozone Depletion Potential	0	1.00
Global Warming Potential	0.285	3.050
Toxicity (TLV ppm)	1,000	1,000
Flammability	No	No

Caution: HFC-134a refrigerant is non-flammable and non-explosive. However, mixing HFC-134a with flammable gasses or liquids can result in a flammable solution; therefore, HFC-134a should never be mixed with any flammable gas or liquid.

The physical properties of HFC-134a in comparison to CFC-12 are presented in Table 1.

Table 2 presents the saturation pressures of both refrigerants at various temperatures.

Table 2 Comparison of Saturated Pressures for CFC-12 and HFC-134a

Temp °F	Saturation Pressures psig & (in. HG vac)	
	CFC-12	HFC-134a
-40	(11.0)	(19.7)
-30	(5.4)	(9.8)
-20	0.6	(3.8)
-10	4.4	1.8
0	9.2	6.3
10	14.6	11.6
20	21.0	18.0
30	28.4	25.6
40	37.0	34.5
50	46.7	44.9
60	57.7	56.9
70	70.2	70.7
80	84.2	86.4
90	99.8	104.2
100	117.2	124.3
110	136.4	146.8
120	159.7	171.9
130	181.0	199.8
140	206.6	230.5
150	234.6	264.4

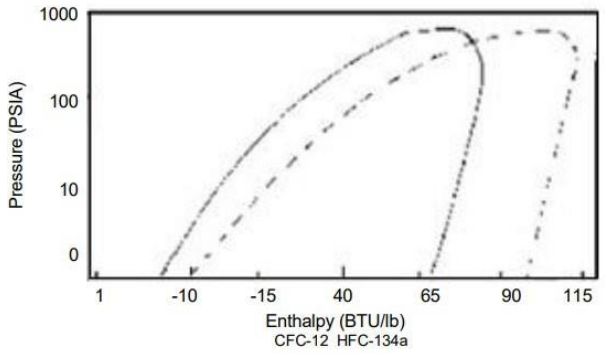


Figure 1 Comparison of HFC-134a and CFC-12 Pressure - Enthalpy Diagram

Figure 1 compares the pressure/enthalpy diagrams for the two refrigerants

Table 3 shows selected thermodynamic properties for each refrigerant.

Lubricants

Conventional mineral oils are not suitable as lubricants with HFC-134a due to insufficient lubricity and miscibility. After screening numerous synthetic lubricants, Copeland has selected a modified polyol ester oil (POE) MOBIL EAL ARCTIC 22 CC. Other lubricants are being evaluated. Refer to Copeland Accepted Refrigerants/Lubricants Form 93-11 for a list of all approved lubricants.

Material Compatibility

As of the date of this publication, the compatibility of the lubricant/refrigerant and materials commonly used in compressors has been validated. Additional testing is being conducted to determine the compatibility of various polymers, enamels, insulating films, gaskets, etc. Testing has uncovered a material incompatibility with the Viton seals used in our Moduload unloading device. Although other materials are available that are compatible, the unloading characteristics are not acceptable with HFC-134a. Therefore, moduload will not be released for HFC-134a.

Miscibility and Solubility

These properties determine how easily the lubricant mixes with the liquid and vapor phases of the refrigerant. From a system designers' viewpoint, the more miscible the combination, the easier it is for the oil to return to the compressor. Oil logging in heat exchangers results in loss of capacity and can lead to eventual compressor failure due to lack of adequate lubrication if not corrected.

Table 3 Selected Theoretical Thermodynamic Properties of HFC-134a and CFC-12

	-40 / 130 F		-40 / 90F		-25 / 110 F		20 / 120 F	
	CFC-12	HFC-134a	CFC-12	HFC-134a	CFC-12	HFC-134a	CFC-12	HFC-134a
Suction Pressure psig (in of Hg)	(11.0)	(14.7)	(11.0)	(14.7)	(2.2)	6.9	21.0	18.0
Discharge Pressure psig	181	199.8	99.8	104.2	136.4	146.8	157.7	171.9
Pressure Ratio	21.01	27.63	12.28	15.43	11.14	13.82	4.83	5.53
Suction Gas Density (lb/ft)	.203	.140	.203	.140	.297	.211	0.806	.631
Specific Gas Density (BTU/lb)	48.3	59.24	58.5	74.35	53.4	66.87	50.1	62.10
Capacity (BTU/lb)	9.82	8.30	11.88	10.42	15.88	14.12	40.41	39.22
EER (BTU / watt-hr)	5.48	5.30	8.26	8.22	7.98	7.84	12.53	12.20
Discharge Temperature F	286	259	210	189	207	207	151	141

Figure 2 shows the miscibility profiles for various refrigerant/lubricant combinations. Since the area outside the curves represents the fully miscible region, it can be seen that the HFC-134a/polyol ester combination is comparatively very miscible, therefore, expected to return quite well to the compressor with ordinary system design practices.

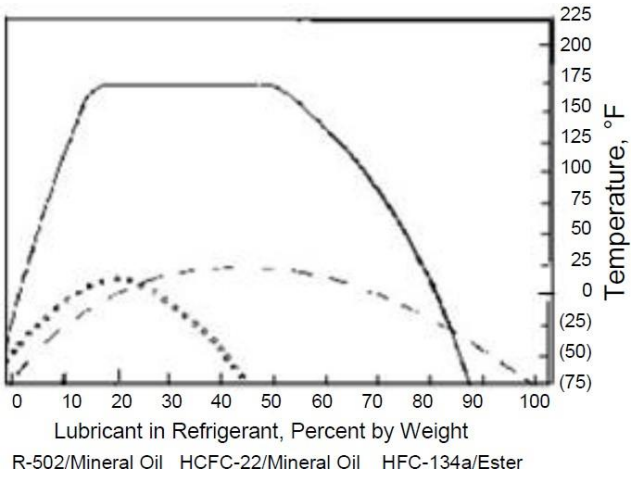


Figure 2 Miscibility Profile

Hygroscopicity

Ester lubricants have the characteristic of quickly absorbing moisture from the ambient surroundings. This is shown graphically in Figure 3 where it can be seen that such lubricants absorb moisture faster and in greater quantity than conventional mineral oils. Since moisture levels greater than 100 ppm will result in system corrosion and ultimate failure, it is imperative that compressors, components, containers, and the entire system be kept sealed as much as possible. Lubricants will be packaged in specially designed, sealed containers. After opening, all the lubricant in a container should be used at once since it will readily absorb moisture if left exposed to the ambient. Any unused lubricant should be properly disposed of. Similarly, work on systems and compressors must be carried out with the open time as short as possible. Leaving the system or compressor open during breaks or overnight MUST BE AVOIDED!

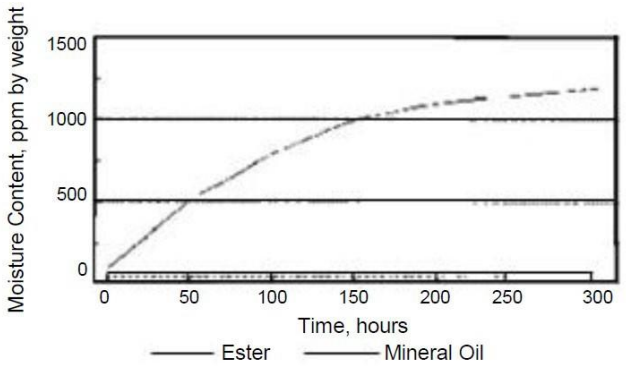


Figure 3 Hygroscopicity
68° F and 50% Relative Humidity

Color

As received, the POE lubricant will be clear or straw colored. After use, it may acquire a darker color. This does not indicate a problem as the darker color merely reflects the activity of the lubricant's protective additive.

Piping and Accessory Items

It is generally accepted that pipe sizing with CFC-12 is also appropriate for HFC-134a. ASHRAE has published pipe sizing/pressure drop tables that are available through their organization.

The valve and/or capillary tube suppliers should be contacted to assure the suitability of their components with HFC-134a. In particular, the seats and gland materials must be verified to be proper. In addition, parts coated with mineral oil during their manufacturing must be cleaned prior to use.

Liquid line filter dryers and suction filters should also be specified for HFC-134a. The proper molecular sieve is:

- XH-9 For loose fill type dryers
- XH-6 or 7 For solid or packed beaded dryers

Existing liquid line sight glasses with moisture indicators will give an indication of moisture levels when used with HFC-134a. Component suppliers have extimated the moisture concentration as follows:

Liqui Temp F	Very Dry	Dry to Caution	Caution to Wet	Very Wet
75	7	25	74	124
100	12	44	134	222

R-134A Estimated Moisture Concentration (PPM)

Due to the smaller molecule size, HFC-134a will leak through hoses previously used in many systems. The suppliers should be contacted to obtain suitable materials.

Maximum System Charges

During Copeland's testing of HFC-134a and POE it was found that this refrigerant/lubricant exhibits a greater tendency to introduce oil into the cylinder during flooded start conditions. If allowed to continue, this condition will cause mechanical failure of the compressor. There are two suggested methods for preventing this occurrence:

- Limit the system charge (as in capillary tube systems) to less than 1 lb.

OR

- Take steps to assure the compressor is always warmer than the evaporator during start- up. On start-up, if the system has been in storage or shipping in an ambient colder than room temperature, it is advisable to leave the system in the warm ambient for several hours before connecting power. This will allow the compressor time to warm up and any refrigerant in the crankcase to evaporate.

Crankcase heaters are required on any systems with charges over 1 lb. if used in outdoor applications.

Copeland Application Engineering should be consulted to assure this potential problem is properly evaluated.

Evacuation and Leak Detection

Due to the smaller molecule size of HFC-134a, it will tend to leak more readily than CFC-12. Consequently, it is of the utmost importance that proper system evacuation and leak detection procedures be employed.

Copeland recommends a minimum evacuation to 500 microns on medium or high temp systems and 250 microns on low temp systems. In addition, a vacuum decay test is strongly recommended to assure there is not a large pressure differential between the system and vacuum pump. Good evacuation processes include frequent vacuum pump oil changes and large diameter, short, hose connections to both high and low sides of the system preferably using bronze braided hose.

Leak detection can be carried out in the conventional manner. If HCFC or CFC tracer gas is used, care must be taken to completely remove all traces of the gas prior to introducing HFC-134a.

Electronic leak detectors are available that will sense HFC's. This is considered preferable since it removes the possibility of chlorine remaining in the system. There is a view that even small quantities of chlorine may act as a catalyst encouraging copper plating and/or corrosion and should therefore be avoided.

CAUTION: HFC-134a has been shown to be combustible at pressures as low as 5.5 psig (at 350°F) when mixed with air at concentrations more than 60% air by volume. At lower temperature, higher pressures are required to support combustion. Therefore, air should never be mixed with HFC-134a for leak detection.

Within the last several years manufacturers have developed fluorescent dye leak detection systems for use with refrigerants. These dyes mix with the lubricant and when exposed to an ultraviolet light "fluoresce" thereby clearly indicating the location of leaks.

Some manufacturers are successfully using helium mass spectrometers as a leak detection means. This technique offers a high degree of accuracy and is well suited to high volume production leak detection.

Retrofit

To change an existing CFC-12 system to HFC-134a, refer to Copeland Form 93-04, Refrigerant Changeover Guidelines CFC-12 to HFC- 134a.

POE must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE, including without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).

Revision Tracking R1

The document format has been updated to the new Copeland format

All occurrences of "Emerson" have been removed

A note regarding A3 and R290 venting has been updated