Copeland®

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HFC-134A REFRIGERANT GUIDELINES

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.

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 1
Refrigerant Properties

Property	HFC-134a	CFC-12
Boiling Point, Degrees F	-15.7	-21.6
Critical Temperature, Degrees F	214	233
Critical Pressure, psia	595.0	598.0
psig	(580)	(583)
Latent Heat Of Vaporization (Btu/lb) At -15 Degrees F	88.22	68.20
Saturated Vapor Density (lb/ft^3) At 5 Degrees 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

Table 2
Comparison Of Saturated Pressures For CFC-12 and HFC-134a

Temperature Degrees F	Saturation Pressures, psig & (in. HG vac.) CFC-12	HFC-134a
-40	(11.0)	(19.7)
-30	(5.4)	(9.8)
-20	.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 compares the pressure/enthalpy diagrams for the two refrigerants

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

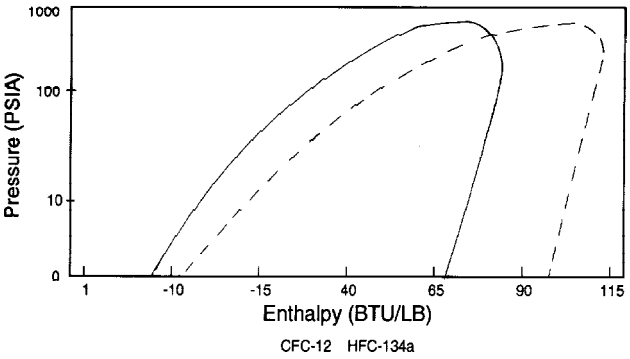


Table 3 shows selected thermodynamic properties for each refrigerant.

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 pentaerythritol ester oil (POE) MOBIL EAL ARCTIC 22 CC. Other lubricants are being evaluated. Refer to Application Engineering Bulletin 17-1248 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.

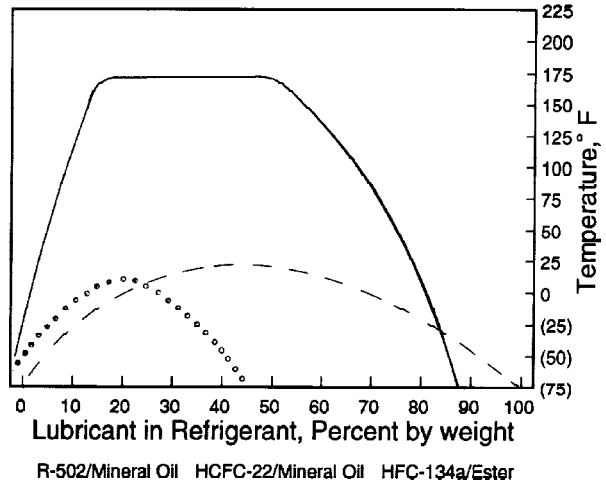
Figure 2 shows the miscibility profiles for various refrigerant/lubricant combinations. Since the area outside the curves represents the fully miscible region, it can be seen that the HFC-134a/polyol ester combination is comparatively very miscible, therefore, expected to return quite well to the compressor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

Table 3
Selected Theoretical Thermodynamic Properties Of HFC-134a And CFC-12

	-40/130°F		-40/90°F		-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	181.0	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^3)	.203	.140	.203	.140	.297	.211	.806	.631
Specific Capacity (BTU/lb)	48.3	59.24	58.5	74.35	53.4	66.87	50.1	62.10
Capacity (BTU/ft^3)	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	187	151	141

(Return Gas 65°F; Subcooling 0°F. Isentropic Efficiency = 1.0)

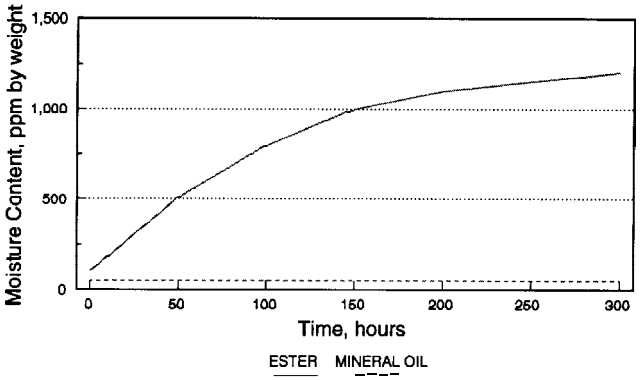
Figure 2
Miscibility Profile



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 recently 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:

R-134A Estimated Moisture Concentration (PPM)

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

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 now 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. Copeland has tested and approved the Ridgid "System Safe" dye and found it to be compatible with compressor materials in systems using mineral oil and HCFC-22. Testing has not been conducted by Copeland with HFC-134a and POE, however, the suppliers of these dyes claim to have appropriate materials for the new refrigerants. If you intend on using this technique in a Copeland system, please consult Application Engineering for the status regarding approval of the dyes.

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.

MODEL AVAILABILITY

For a complete list of models approved for use with HFC-134a consult the following Marketing Bulletins:

Hermetic Compressors 1.302
Discus Compressors 1.202