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REFRIGERACION S.A.
Desde 1946

Freon™ 134a

Refrigerant (R-134a)

Properties, Uses, Storage, and Handling

Chemours™

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Introduction

Background

Freon™ 134a was introduced by Chemours as a replacement for chlorofluorocarbons (CFCs) in many applications. CFCs, which were developed over 60 years ago, have many unique properties. They are low in toxicity, nonflammable, noncorrosive and compatible with other materials. In addition, they offer the thermodynamic and physical properties that make them ideal for a variety of uses. CFCs are used as refrigerants; as blowing agents in the manufacture of insulation, packaging and cushioning foams; as cleaning agents for metal and electronic components; and in many other applications.

However, the stability of these compounds, coupled with their chlorine content, has linked them to depletion of the earth's protective ozone layer. As a result, Chemours has phased out production of CFCs and introduced environmentally acceptable alternatives, such as hydrofluorocarbon (HFC) 134a.

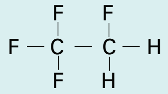
Freon™ 134a—An Environmentally Acceptable Alternative

Freon™ 134a does not contain chlorine; therefore, it has an ozone depletion potential (ODP) of zero. Listed below are all generic and Chemours trade names:

- Hydrofluorocarbon-134a
- Freon™ 134a
- HFA-134a
- Freon™ 134a
- Freon™ 134a (Auto)
- Formacel™ Z-4 (foam blowing agent market)
- HFC-134a (aerosol market)

The chemical properties of Freon™ 134a are listed below.

Freon™ 134a Chemical Information

Chemical Name	1,1,1,2-tetrafluoroethane
Molecular Formula	CH_2FCF_3
CAS Registry Number	811-97-2
Molecular Weight	102.0
Chemical Structure	 $\begin{array}{ccccccc} & & F & & F & & \\ F & - & C & - & C & - & H \\ & & F & & H & & \end{array}$

Uses

Freon™ 134a can be used in many applications that currently use dichlorodifluoromethane (CFC-12). These include refrigeration, polymer foam blowing, and aerosol products. However, equipment design changes are sometimes required to optimize the performance of Freon™ 134a in these applications.

The thermodynamic and physical properties of Freon™ 134a, coupled with its low toxicity, make it a very efficient and safe replacement refrigerant for CFC-12 in many segments of the refrigeration industry, most notably in automotive air conditioning, appliances, small stationary equipment, medium-temperature supermarket cases, and industrial and commercial chillers. **Table 1** provides a comparison of the theoretical performance of CFC-12 and Freon™ 134a at medium-temperature conditions.

Figure 1. Infrared Spectrum of Freon™ 134a Vapor at 400 mmHg Pressure (53.3 kPa) in a 10-cm Cell

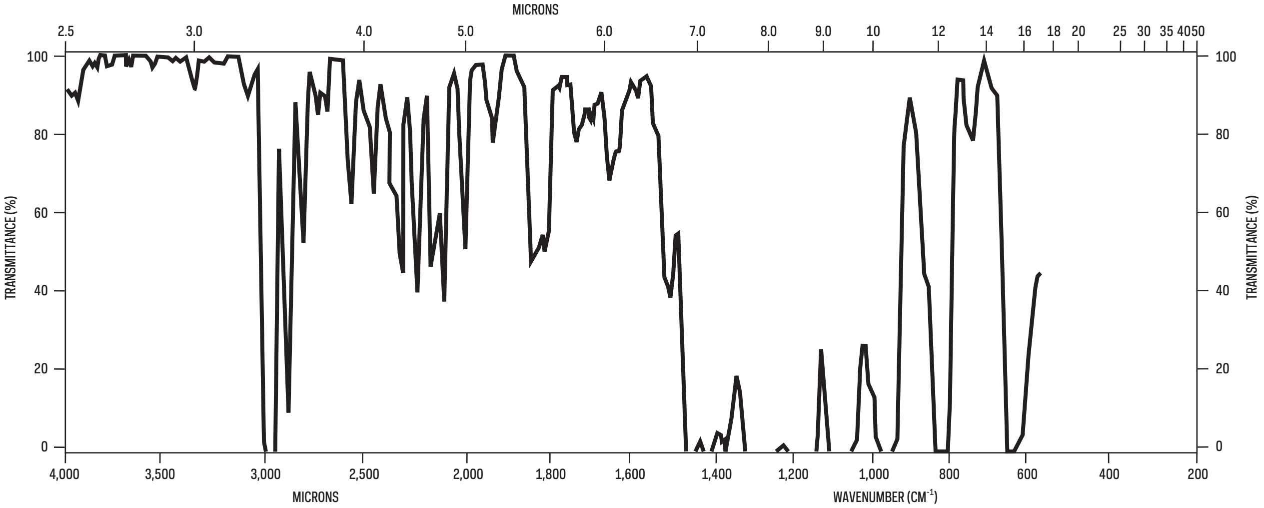


Table 1. Theoretical Cycle Comparison of CFC-12 and Freon™ 134a*

	CFC-12	Freon™ 134a
Capacity (as % CFC-12)	100	99.7
Coefficient of Performance (COP)	3.55	3.43
Compressor		
Exit Temperature, °C (°F)	86.8 (188.2)	83.1 (181.5)
Exit Pressure, kPa (psia)	1349 (195.6)	1473 (213.7)
Compression Ratio	4.1	4.7

*Temperatures were as follows: Condenser, 54.4 °C (130.0 °F); Evaporator, 1.7 °C (35.0 °F); Compressor Suction, 26.7 °C (80.0 °F); Expansion Device, 51.7 °C (125.0 °F).

Freon™ 134a can be used to replace CFC-11, CFC-12, and HCFC-142b in many thermoplastic foam applications. Freon™ 134a can be used as a replacement for CFC-12 and HCFC-141b in thermoset foams. HFC-134a features properties that are advantageous for high value-in-use products and meets the requirements of safety/environmental issues. Freon™ 134a is nonflammable, has negligible photochemical reactivity, and low vapor thermal conductivity.

Freon™ 134a is also being developed for use in pharmaceutical inhalers because of its low toxicity and nonflammability. Other aerosol applications may use Freon™ 134a where these properties are critical. See Chemours technical bulletin for additional information on aerosol applications of HFC-134a.

Physical Properties

Physical properties of Freon™ 134a are given in **Table 2** and **Figures 2** through **8**. Additional physical property data may be found in other Chemours publications. Technical bulletin "Transport Properties of Freon™ Refrigerants" contains viscosity, thermal conductivity, and heat capacity data for saturated liquid and vapor, in addition to heat capacity data and heat capacity ratios for both saturated and superheated vapors. Thermodynamic tables in English and SI units are available in technical bulletins, "Thermodynamic Properties of HFC-134a". Liquid and vapor densities are included in the thermodynamic tables.

Chemical/Thermal Stability

Thermal Decomposition

Freon™ 134a vapors will decompose when exposed to high temperatures from flames or electric resistance heaters. Decomposition may produce toxic and irritating compounds, such as hydrogen fluoride. The pungent odors released will irritate the nose and throat and generally force people to evacuate the area. Therefore, it is important to prevent decomposition by avoiding exposure to high temperatures.

Stability with Metals and Refrigeration Lubricants

Stability tests for refrigerants with metals are typically performed in the presence of refrigeration oils. The results of sealed tube stability tests are available for CFC-12/mineral oil combinations, which have shown long-term stability in contact with copper, steel, and aluminum in actual refrigeration systems. Polyalkylene glycol (PAG) and polyol ester (POE) lubricants are used with Freon™ 134a. Sealed tube tests were run to determine the relative long-term stability of Freon™ 134a/metals in the presence of these lubricants.

The method followed was generally the same as ASHRAE 97 with several minor modifications. A 3-mL volume of refrigerant/lubricant solution was heated in the presence of copper, steel, and aluminum strips in an oven for 14 days at 175 °C (347 °F). Both the neat lubricant and a mixture of lubricant and refrigerant (50/50 volume ratio) were tested. Visual ratings were obtained on both the liquid solutions and the metal coupons after the designated exposure time. The visual ratings ranged from 0 to 5, with 0 being the best.

After the visual ratings were obtained, sample tubes were opened and the lubricant and refrigerant (if present) were analyzed. The lubricant was typically checked for halide content and viscosity, while the refrigerant was examined for the presence of decomposition products. **Table 3** summarizes typical data for both Freon™ 134a and CFC-12. Visual ratings are listed for the neat lubricant, the lubricant/refrigerant solution, and the three metals that were present in the lubricant/refrigerant solutions. Viscosity was determined on the unused lubricant, the tested neat lubricant, and the lubricant tested in the presence of refrigerant. A percent change was calculated for the two tested lubricants. The decomposition products listed are HFC-143a (the predominant decomposition product for Freon™ 134a) and fluoride ion. Both species are typically measured in the low parts per million (ppm) range.

As the CFC-12/mineral oil combinations have been proven in actual service, these tests indicate that Freon™ 134a/PAG and Freon™ 134a/POE solutions have acceptable chemical stability. In several other tests, results have confirmed that the Freon™ 134a molecule is as chemically stable as CFC-12.

Table 2. Physical Properties of Freon™ 134a

Physical Property	Unit	Freon™ 134a
Chemical Name	—	Ethane, 1,1,1,2-Tetrafluoro
Chemical Formula	—	CH_2FCF_3
Molecular Weight	g/mol	102.03
Boiling Point at 1 atm (101.3 kPa or 1.013 bar)	°C °F	−26.1 −14.9
Freezing Point	°C °F	−103.3 213.9
Critical Temperature	°C °F	101.1 213.9
Critical Pressure	kPa psia	4060 588.9
Critical Volume	m^3/kg ft^3/lb	1.94 x 10^{-3} 0.031
Critical Density	kg/m^3 lb/ft^3	515.3 32.17
Density (Liquid) at 25 °C (77 °F)	kg/m^3 lb/ft^3	1,206 75.28
Density (Saturated Vapor) at Boiling Point	kg/m^3 lb/ft^3	5.25 0.328
Heat Capacity (Liquid) at 25 °C (77 °F)	kJ/kg·K Btu/lb·(°F)	1.44 0.339
Heat Capacity (Vapor at Constant Pressure) at 25 °C (77 °F) (1 atm) (101.3 kPa or 1.013 bar)	kJ/kg·K Btu/lb·(°F)	0.852 0.204
Vapor Pressure at 25 °C (77° F)	kPa bar psia	666.1 6.661 96.61
Heat of Vaporization at Normal Boiling Point	kJ/kg Btu/lb	217.2 93.4
Thermal Conductivity at 25 °C (77 °F) Liquid Vapor at 1 atm (101.3 kPa or 1.013 bar)	W/m·K Btu/hr·ft·(°F) W/m·K Btu/hr·ft·(°F)	0.0824 0.0478 0.0145 0.00836
Viscosity at 25 °C (77 °F) Liquid Vapor at 1 atm (101.3 kPa or 1.013 bar)	MPa·S (cP) MPa·S (cP)	0.202 0.012
Solubility of Freon™ 134a in Water at 25 °C (77 °F) and 1 atm (101.3 kPa or 1.013 bar)	wt%	0.15
Solubility of Water in Freon™ 134a at 25 °C (77 °F)	wt%	0.11
Flammability Limits in Air at 1 atm (101.3 kPa or 1.013 bar)	vol %	None
Auto-Ignition Temperature	°C °F	770 1,418
Ozone Depletion Potential (ODP)	—	0
Halocarbon Global Warming Potential (HGWP) (For CFC-11, HGWP = 1)	—	0.28
Global Warming Potential (GWP) (100 yr ITH) (GWP For CO_2, GWP = 1)	—	1,200
TSCA Inventory Status	—	Reported/Included
Toxicity AEL* (8- and 12-hr TWA)	ppm (v/v)	1,000

*Acceptable exposure limit (AEL) is an airborne inhalation exposure limit established by Chemours that specifies time-weighted average (TWA) concentrations to which nearly all workers may be repeatedly exposed without adverse effects.

Note: kPa is absolute pressure.

Table 3. Stability of Freon™ 134a with Metals and Lubricating Oils

Oil	Mineral Oil	Mineral Oil	UCON RO-W-6602*	Mobil EAL Arctic 32**	Castrol Icematic SW 100**
Oil Viscosity, cSt at 40 °C (104 °F)	30.7	125	134	29.4	108.8
Refrigerant	R-12	R-12	Freon™ 134a	Freon™ 134a	Freon™ 134a
Ratings					
Neat Oil	—	—	0	0	0
Oil/Refrigerant	4	4	0	0	0
Copper	2	2	0	0	0
Iron	3	3	0	0	0
Aluminum	2	2	0	0	0
Viscosity Change					
% Change Neat	ND	ND	<1	−3.1	4.3
% Change with Refrigerant	ND	ND	−12.7	−36.2	−27.1
Decomposition Analysis					
HFC-143a, ppm	ND	ND	<7	<3	<0.3
Fluoride, ppm	ND	420	<0.7	—	<7

*Polyalkylene glycol lubricant.
**Polyol ester lubricant.
ND = Not determined.

Stability Ratings: 0 to 5
0 = Best
3 = Failed
5 = Coked

Figure 2. Solubility of Water in Freon™ 134a

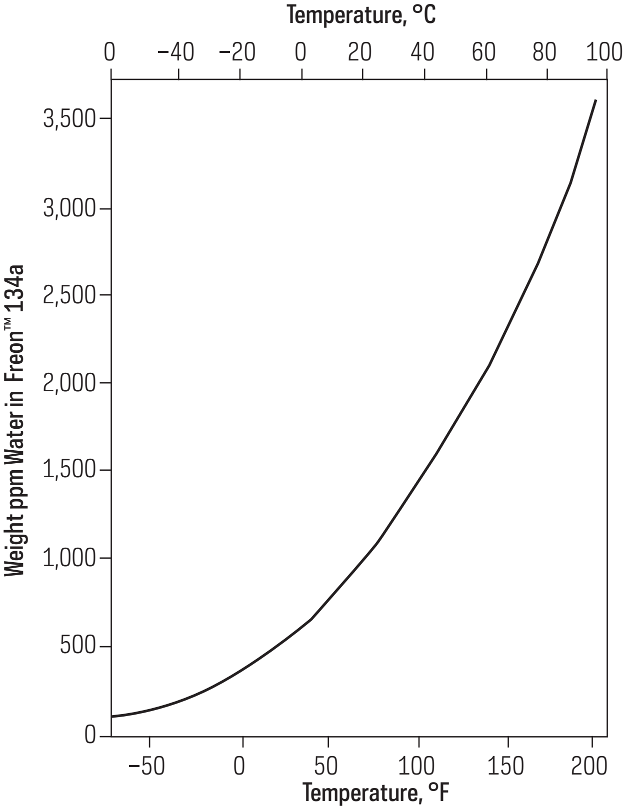


Figure 3. Pressure vs. Temperature (SI Units)

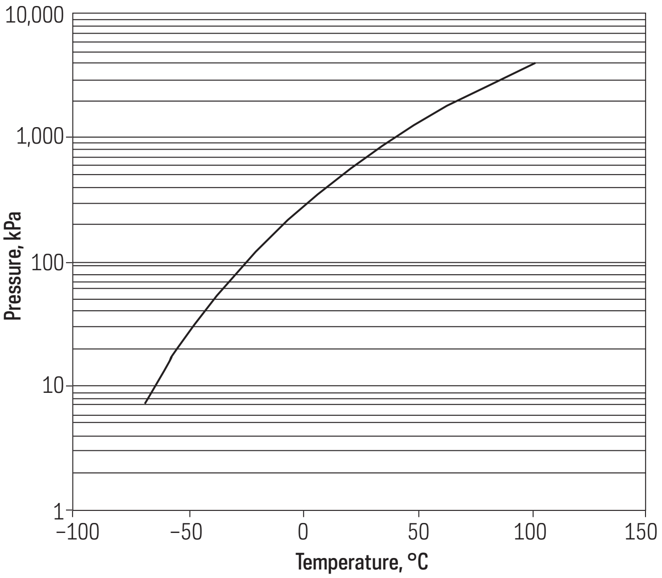


Figure 4. Pressure vs. Temperature (English Units)

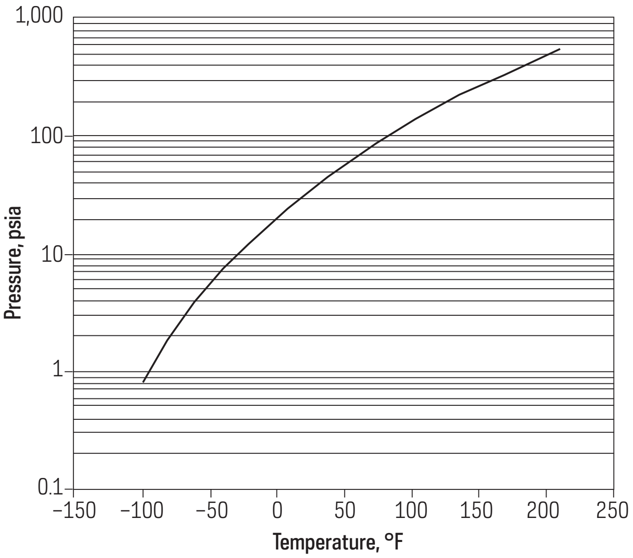


Figure 5. Vapor Thermal Conductivity of Freon™ 134a at Atmospheric Pressure (SI Units)

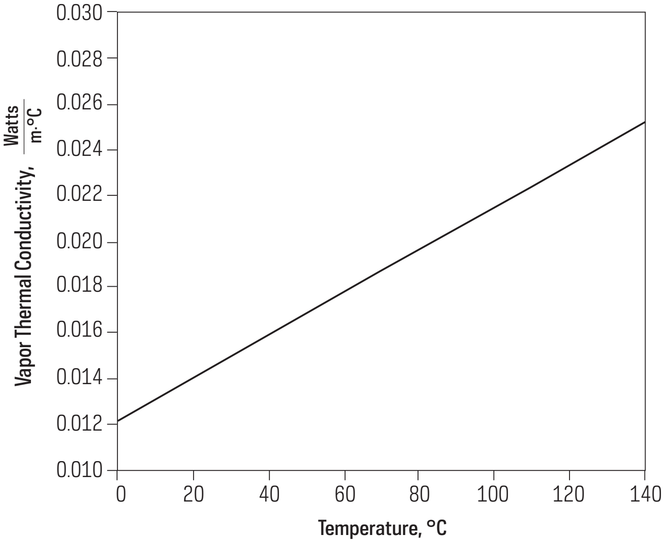
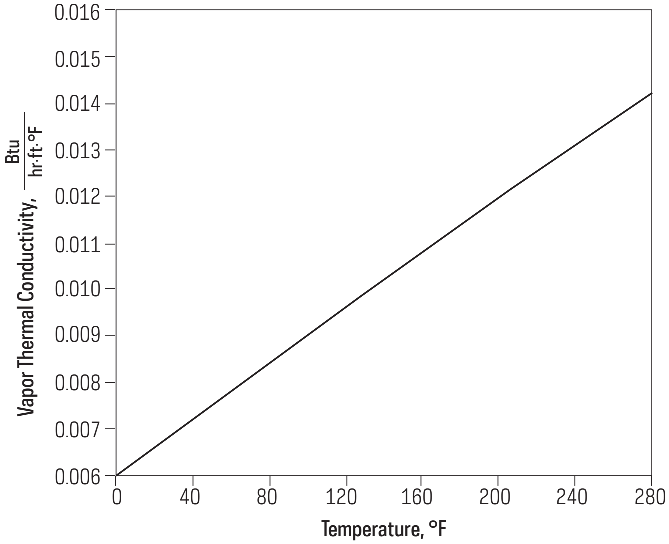


Figure 6. Vapor Thermal Conductivity of Freon™ 134a at Atmospheric Pressure (English Units)



Stability with Foam Chemicals

As with other alternative blowing agents, the stability of Freon™ 134a in foam chemicals (B-side systems) is being studied. The first tests evaluated Freon™ 134a stability in a sucrose-amine polyether polyol with either an amine catalyst, a potassium catalyst, a tin catalyst, or an amine catalyst neutralized with an organic acid. The initial tests, which included analysis of the volatile components, showed no degradation of Freon™ 134a in any of the systems, even at elevated temperatures. The results are summarized in Table 4.

Table 4. Stability of Freon™ 134a with Foam Chemicals

Catalyst	Degradation, %
Amine	<0.001
Potassium	<0.001
Tin	<0.001
Neutralized Amine	<0.001
Test Conditions Six weeks at 60 °C (140 °F) 25% (wt) Freon™ 134a Two parts catalyst per 100 parts polyol by weight One part water per 100 parts polyol by weight Type 1010 steel test coupon	

Compatibility Concerns If Freon™ 134a and CFC-12 Are Mixed

Freon™ 134a and CFC-12 are chemically compatible with each other; this means that they do NOT react with each other to form other compounds. However, when the two materials are mixed together, they form what is known as an azeotrope. An azeotrope is a mixture of two components that acts like a single compound, but has physical and chemical properties different from either of the two components. An example of this is Freon™ 502, which is an azeotrope of HCFC-22 and CFC-115. When Freon™ 134a and CFC-12 are mixed in certain concentrations, they form a high-pressure (low boiling) azeotrope. This means that the vapor pressure of the azeotrope is higher than that of either of the two components by themselves. At 752 kPa absolute (109 psia) the azeotrope contains 46 wt% Freon™ 134a. In general, compressor discharge pressures will be undesirably high if refrigeration equipment is operated with a mixture of Freon™ 134a and CFC-12.

Another characteristic of an azeotrope is that it is very difficult to separate the components once they are mixed together. Therefore, a mixture of Freon™ 134a and CFC-12 cannot be separated in an on-site recycle machine or in the typical facilities of an off-site reclaimer. Mixtures of Freon™ 134a and CFC-12 will usually have to be disposed of by incineration.

Materials Compatibility

Because Freon™ 134a is used in many applications, it is important to review materials of construction for compatibility when designing new equipment, retrofitting existing equipment, or preparing storage and handling facilities.

Plastics

Customary industry screening tests, in which 23 typical plastic materials were exposed to liquid Freon™ 134a in sealed glass tubes at room temperature, are summarized in **Table 5**. Observations of weight gain and physical change were used to separate materials meriting further laboratory and/or field testing from materials that appeared unacceptable. Users of this bulletin should confirm compatibility in their own system designs.

Table 5. Plastics Compatibility of Freon™ 134a

Chemical Type	Trade Name
Plastic materials meriting further testing:	
ABS	Kralastic (Uniroyal Chem.)
Acetal	Delrin™
Epoxy	Teflon™
Fluorocarbons	
PTFE	Teflon™
ETFE	Tefzel™
PVDF	
Ionomer	Surlyn™
Polyamide	
6/6 Nylon	Zytel™
Polyarylate	Arylon™
Polycarbonate	Tuffak (Rohm & Haas Co.)
Polyester	
PBT	Valox (General Electric)
PET	Rynite™
Polyetherimide	Ultem (General Electric)
Polyethylene-HD	Alathon
Polyphenylene Oxide	Noryl (General Electric)
Polyphenylene Sulfide	Ryton (Phillips Chem. Co.)
Polypropylene	
Polystyrene	Styron (Dow Chem. Co.)
Polysulfone	Polysulfone
Polyvinyl Chloride	
PVC	
CPVC	
Plastic materials exhibiting unacceptable change:	
Acrylic	Lucite®
Cellulosic	Ethocel (Dow Chem. Co.)

Test Conditions: Plastic specimens exposed to liquid Freon™ 134a (no lubricant) in sealed glass tubes for two weeks at room temperature.

Because the performance of plastic materials is affected by polymer variations, compounding agents, fillers, and molding processes, verifying compatibility using actual fabricated parts under end-use conditions is advised.

Elastomers

Compatibility results for Freon™ 134a and CFC-12 are compared for 11 typical elastomers in **Tables 6** through **17**. It should be recognized, however, that effects on specific elastomers depend on the nature of the polymer, the compounding formulation used, and the curing or vulcanizing conditions. Actual samples should be tested under end-use conditions before specifying elastomers for critical components.

Recommendations, based on the detailed data in **Tables 7** through **17**, are given in **Table 6**. Data on temporary elastomer swell and hardness changes were used as the prime determinants of compatibility. The subsequent final data were used as a guide to indicate if the seals in a refrigeration system should be replaced after equipment teardown.

Most polymeric materials used in refrigeration equipment are exposed to a mixture of refrigerant and refrigeration oil.

Chemours has measured the compatibility of Mylar® polyester film with Freon™ 134a/polyol ester lubricant systems compared to CFC-12/mineral oil systems. Slot liners, wedges, and interphase insulation of Mylar® are widely used in hermetic compressor motors for CFC-12 service. Studies indicate that the life of Mylar® in systems using Freon™ 134a will be comparable to film life in CFC-12 systems. In cases where polyester film fails in hermetic systems, the cause is usually traced to unwanted moisture. Too much moisture causes polyester film to hydrolyze and embrittle. Results indicate that the POE lubricants used with Freon™ 134a tend to pull water from Mylar®. This promotes a drier film, which should result in a longer motor insulation life. Because polyester motor insulation is buried beneath windings and can be difficult to dry, this water extraction capability of POE lubricants should be a valuable performance asset. Further information is available from Chemours.

Additional materials compatibility data are being developed by equipment manufacturers.

Figure 7. Pressure-Enthalpy Diagram for Freon™ 134a (SI Units)

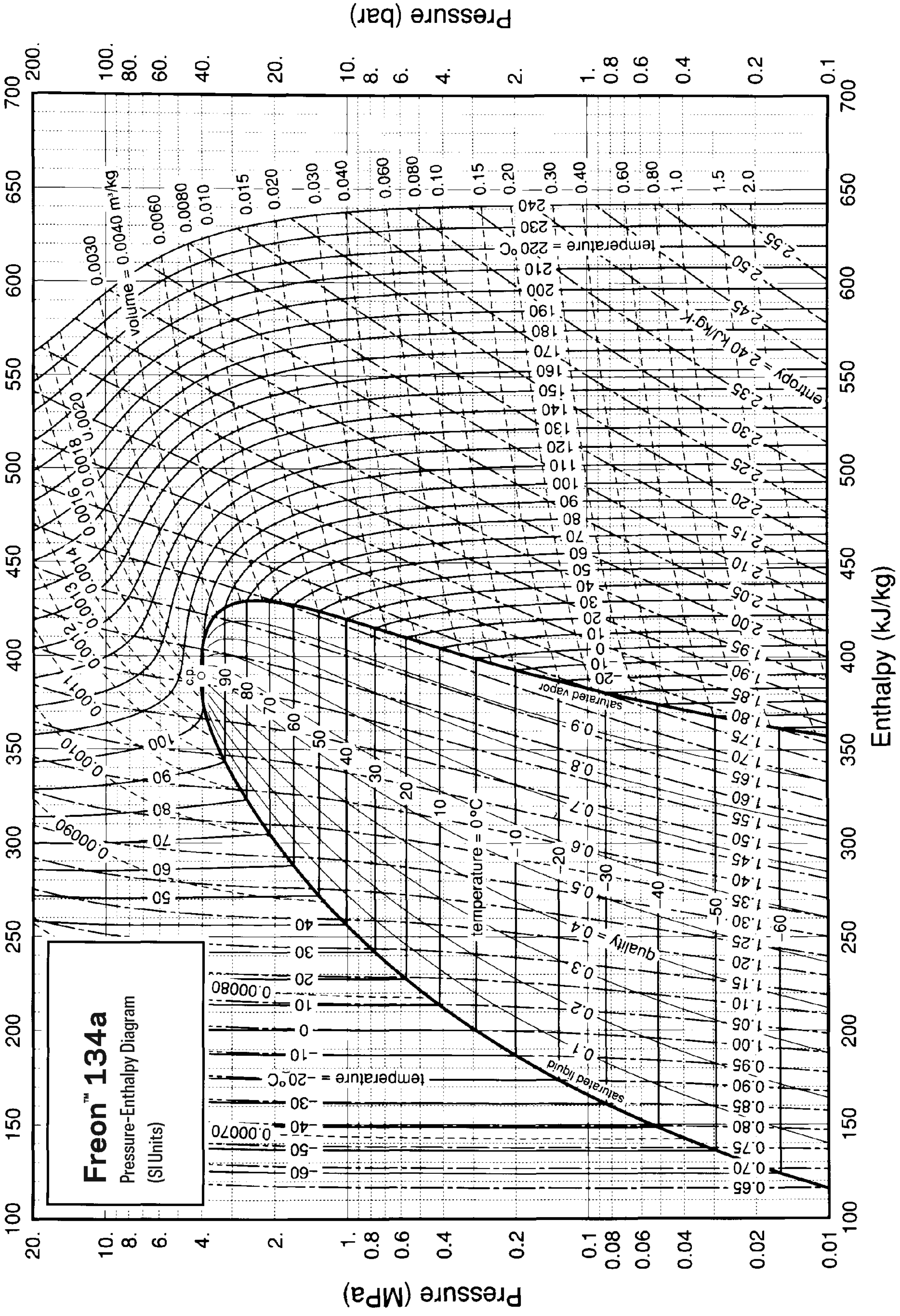
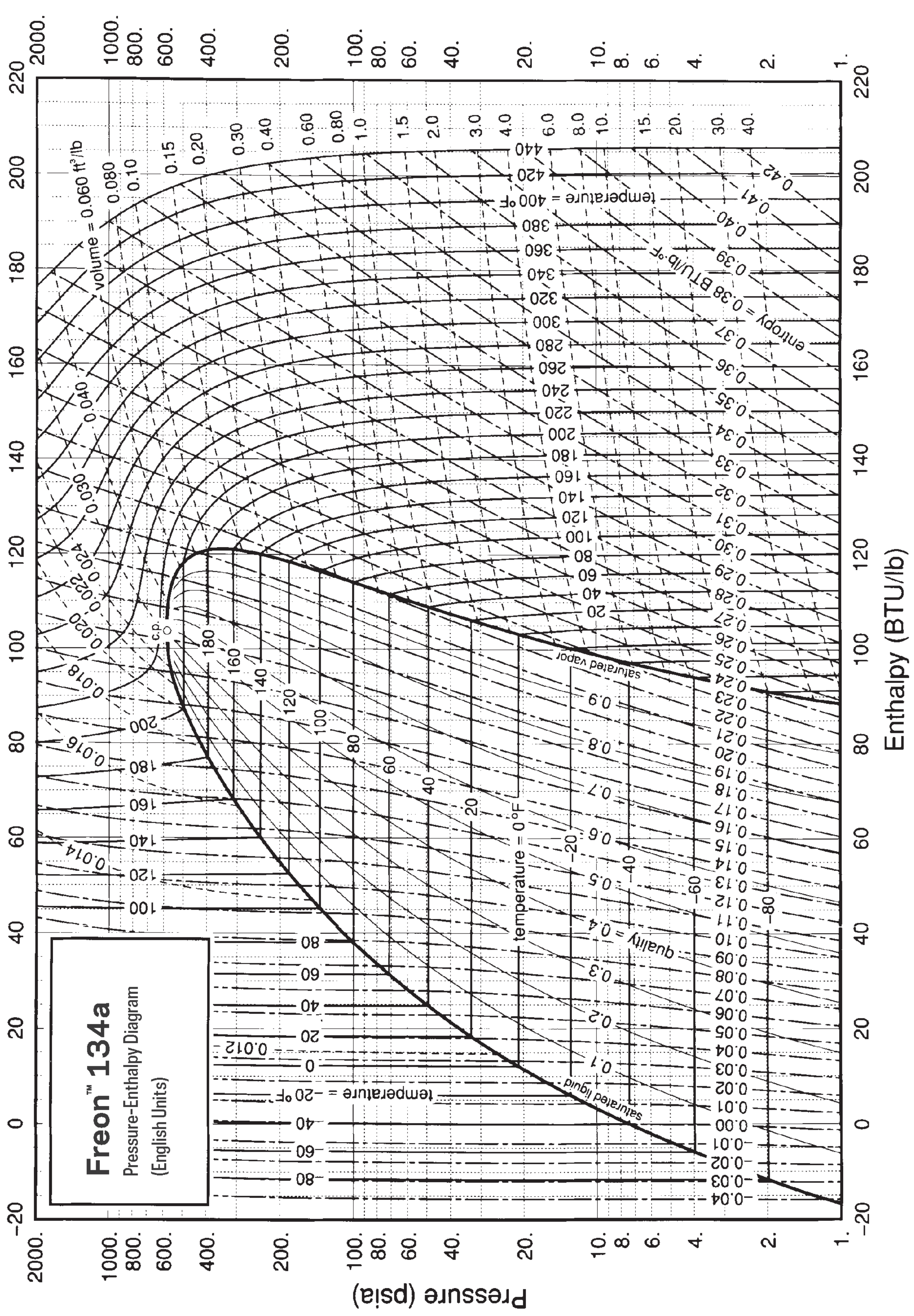


Figure 8. Pressure-Enthalpy Diagram for Freon™ 134a (English Units)



Hose Permeation

Elastomeric hoses are used in mobile air conditioning systems and for transferring Freon™ 134a in other applications. The permeation rates of Freon™ 134a and CFC-12 through several automotive A/C hoses were measured as a guide to hose selection.

The studies were run at 80 °C (176 °F) with an initial 80 vol % liquid loading of Freon™ 134a in 76-cm (30-in) lengths of 15.9-mm (5/8-in) inside diameter automotive air conditioning hose. Hose construction and permeation rates are summarized in **Table 18**. Based on these tests, hoses lined with nylon, as well as those made of Hypalon® 48, appear to be suitable for use with Freon™ 134a. Note, however, that these rate measurements provide a comparison of the various hoses at a single temperature and should not be used as an indication of actual permeation losses from an operating system.

Desiccants

Driers filled with desiccant are typically used in refrigeration systems and bulk storage facilities. A common molecular sieve desiccant used with CFC-12, 4A-XH-5, is not compatible with Freon™ 134a. However, manufacturers have developed other molecular sieve desiccants that perform well with Freon™ 134a. XH-7 and XH-9 or MS 592 and MS 594 desiccants may be used in loose filled driers. Compacted bead dryers, in which the desiccant is compacted by mechanical pressure, may use XH-6 in addition to the desiccants listed above.

In molded core driers, the molecular sieve is dispersed within a solid core. Several manufacturers offer molded core driers that are compatible with Freon™ 134a. Consult the drier manufacturer for recommendations.

Refrigeration Lubricants

Most compressors require a lubricant to protect internal moving parts. The compressor manufacturer usually recommends the type of lubricant and viscosity that should be used to ensure proper operation and equipment durability. Recommendations are based on several criteria, such as lubricity, compatibility with materials of construction, thermal stability, and refrigerant/oil miscibility. To ensure efficient operation and long equipment life, it is important to follow the manufacturer's recommendations.

Current lubricants used with CFC-12 are fully miscible over the range of expected operating conditions, easing the problem of getting the lubricant to flow back to the compressor. Refrigeration systems using CFC-12 take advantage of this full miscibility when considering lubricant return. Refrigerants such as Freon™ 134a, with little or no chlorine, may exhibit less solubility with many existing mineral oil or alkylbenzene lubricants.

The search for lubricants for use with Freon™ 134a started with commercially available products. **Table 19** shows solubilities of various refrigerant/lubricant combinations. Current naphthenic, paraffinic, and alkylbenzene lubricants have very poor solubility with Freon™ 134a. PAGs with low viscosity show good solubility; but, as viscosity increases, they become less soluble. Polyol ester lubricants, of which there are many types, generally show good solubility with Freon™ 134a. When compared with PAGs, ester lubricants are more compatible with hermetic motor components and are less sensitive to mineral oil and CFC-12 remaining in a refrigeration system.

Although Freon™ 134a and CFC-12 are chemically compatible with each other, such is not the case with CFC-12 and PAG lubricants. Specifically, the chlorine contained in CFC-12 or other chlorinated compounds can react with the PAG and cause lubricant degradation. Lubricant degradation can result in poor lubrication and premature failure. In addition, sludge will be formed, which can plug orifice tubes and other small openings.

Table 6. Elastomer Compatibility of Freon™ 134a

	Ratings					
	CFC-12			Freon™ 134a		
	25 °C (77 °F)	80 °C (176 °F)	141 °C (285 °F)	25 °C (77 °F)	80 °C (176 °F)	141 °C (285 °F)
Adiprene L	1	5		2	5	1
Buna N	1*	0*	2*	1	0*	1
Buna S	3	4		3	2	0
Butyl Rubber	2	4		0	3	0
Hypalon 48	1	0	0	1*	0	0
Natural Rubber	4	5		0	2	0
Neoprene W	0*	1*		0	2	0
Nordel Elastomer	2*	2*		1	1	0
Silicone	5	5		2	2	2
Thiokol FA	1	1		1*	0	0
Viton™ A	5	5		5	5	2

*Recommend elastomer replacement after equipment teardown.

Codes: 0 = No change
1 = Acceptable change
2 = Borderline change
3 = Slightly unacceptable change
4 = Moderately unacceptable change
5 = Severely unacceptable change

Table 7. Compatibility of Refrigerants with Adiprene L

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	1.8	5.5	2.1	5.0
Final	0.3	0.1	—[a]	−0.5
Weight Change, %				
Temporary	8.5	20	5.2	20
Final	1.2	0.3	—[a]	−0.5
Shore A Hardness				
Original	60	61	60	63
Temporary, D SH	−2	−4	—[a]	−28
Final, D SH	0	1	—	−19
Elasticity Rating				
Temporary	0	0	5[a]	4[b]
Final	0	0	5[a]	5[c]
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	1[d]
Final	0	0	5[a]	2[d]

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] Sample disintegrated
[b] More elastic
[c] Broke when stretched
[d] Sticky

Table 8. Compatibility of Refrigerants with Buna N

	CFC-12			Freon™ 134a		
	25 °C (77 °F)	80 °C (176 °F)	141 °C (285 °F)	25 °C (77 °F)	80 °C (176 °F)	141 °C (285 °F)
Length Change, % (±0.5)						
Temporary	2	1	2	2	2	3
Final	0	−1	0	0	0	0
Weight Change, % (±0.5)						
Temporary	7	6	8	8	8	8
Final	0	−1	2	0	0	0
Shore A Hardness						
Original	77	76	72	77	74	75
Temporary, D SH	−6	−1	9	−5	−1	−3
Final, D SH	7	9	14	5	7	4
Elasticity Rating						
Temporary	0	1	1[a]	0	1	1
Final	0	0	0	0	0	0
Visual Rating						
Liquid	0	0	0	0	0	0
Polymer						
Temporary	0	1	1[b]	0	0	0
Final	0	1	1[b]	0	0	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F), 80 °C (176 °F), and 141 °C (285 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] More elastic

[b] Surface dulled

Table 9. Compatibility of Refrigerants with Buna S

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	−0.1	1.1	0.7	0.8
Final	−2.5	<0.1	−2.6	0.3
Weight Change, %				
Temporary	2.8	1.9	2.9	2.5
Final	−6.2	−0.1	−6.2	−0.1
Shore A Hardness				
Original	85	84	83	81
Temporary, D SH	−12	−12	−16	−9
Final, D SH	8	−2	−9	−2
Elasticity Rating				
Temporary	0	0	0	1[a]
Final	3[b]	1[b]	3[b]	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	0
Final	0	0	0	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] More elastic

[b] Less elastic

Table 10. Compatibility of Refrigerants with Butyl Rubber

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	6.3	0.2	7.6	1.3
Final	−1.2	0	−0.8	0.4
Weight Change, %				
Temporary	34	2.0	36	3.7
Final	−2.6	−0.1	−1.2	0.6
Shore A Hardness				
Original	54	54	57	58
Temporary, D SH	−8	−1	−14	−4
Final, D SH	−1	−2	−10	−3
Elasticity Rating				
Temporary	1[a]	1[a]	3[a]	0
Final	0	0	3[b]	0
Visual Rating				
Liquid	0	0	3[b]	0
Polymer				
Temporary	0	0	3[c]	4c
Final	0	0	1[d]	2[d]

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] More elastic

[b] White solids in liquid

[c] White deposit on elastomer

[d] White film on elastomer

Table 11. Compatibility of Refrigerants with Hypalon 48

	CFC-12			Freon™ 134a		
	25 °C (77 °F)	80 °C (176 °F)	141 °C (285 °F)	25 °C (77 °F)	80 °C (176 °F)	141 °C (285 °F)
Length Change, % (±0.5)						
Temporary	1	0	1	0	0	1
Final		0	0	0	0	0
Weight Change, % (±0.5)						
Temporary	7	5	9	0	1	2
Final	2	1	4	0	0	1
Shore A Hardness						
Original	79	81	81	76	82	82
Temporary, D SH	−4	0	0	3	1	1
Final, D SH	4	2	2	8	1	4
Elasticity Rating						
Temporary	0	0	0	0	0	0
Final	0	0	0	0	0	0
Visual Rating						
Liquid	0	0	0	0	0	0
Polymer						
Temporary	0	1	1*	0	0	0
Final	0	1	1*	0	0	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F), 80 °C (176 °F), and 141 °C (285 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

*Surface dulled

Table 12. Compatibility of Refrigerants with Natural Rubber

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	14	1.3	14	2.0
Final	−1.1	−0.3	−0.8	0.4
Weight Change, %				
Temporary	51	4.5	55	5.8
Final	−2.6	−0.5	−2.6	−0.6
Shore A Hardness				
Original	55	56	56	57
Temporary, D SH	−9	−1	−17	−8
Final, D SH	−5	−4	−8	−4
Elasticity Rating				
Temporary	0	0	1*	1*
Final	0	0	2*	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	0
Final	0	0	0	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

*More elastic

Table 13. Compatibility of Refrigerants with Neoprene W

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	0.2	0.7	0.9	1.4
Final	−7.6	−0.5	−7.3	−0.3
Weight Change, %				
Temporary	6.6	2.3	6.8	2.9
Final	−12	−0.6	−13	−1.8
Shore A Hardness				
Original	73	73	73	72
Temporary, D SH	−1	0	−5	−7
Final, D SH	−10	0	5	−5
Elasticity Rating				
Temporary	2[a]	0	1[b]	0
Final	2[a]	0	2[b]	0
Visual Rating				
Liquid	1[c]	0	1[d]	0
Polymer				
Temporary	0	0	1[e]	0
Final	0	0	0	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] Less elastic [b] More elastic [c] Clear, yellow [d] Hazy [e] White film

Table 14. Compatibility of Refrigerants with Nordel Elastomer

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	–0.6	0.5	–0.4	0.7
Final	–8.2	–0.2	–8.4	0.4
Weight Change, %				
Temporary	5.5	2.8	6.1	4.4
Final	–22	<0.1	–22	–0.2
Shore A Hardness				
Original	66	66	65	63
Temporary, D SH	–4	–3	0	–6
Final, D SH	19	–4	20	0
Elasticity Rating				
Temporary	2[a]	0	2b	1[b]
Final	2[a]	0	2[b]	0
Visual Rating				
Liquid	0	0	0	1[d]
Polymer				
Temporary	0	0	0	0
Final	0	0	1[c]	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] Less elastic
[b] More elastic
[c] White film
[d] Hazy

Table 15. Compatibility of Refrigerants with Silicone

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	41	6.1	44	5.5
Final	–0.1	0.1	–0.2	–0.2
Weight Change, %				
Temporary	173	20	187	20.3
Final	0.7	–0.1	–0.7	–0.3
Shore A Hardness				
Original	60	61	60	58
Temporary, D SH	–13	–8	–15	–6
Final, D SH	–7	–4	–7	–2
Elasticity Rating				
Temporary	0	1[a]	1[a]	0
Final	0	0	0	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	5[b]	0	4b	0
Final	0	0	0	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] Less elastic
[b] Swollen

Table 16. Compatibility of Refrigerants with Thiokol FA

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	1.3	0.8	1.4	−0.2
Final	−0.5	−0.2	−0.5	−0.9
Weight Change, %				
Temporary	1.9	1.0	3.7	1.9
Final	−0.2	−0.1	−0.8	−0.8
Shore A Hardness				
Original	70	69	74	74
Temporary, D SH	−6	−4	−6	0
Final, D SH	−5	−6	−1	0
Elasticity Rating				
Temporary	1[b]	1[b]	0	1[b]
Final	0	0	1[a]	2[a]
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	0
Final	0	0	0	0

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] Less elastic [b] More elastic

Table 17. Compatibility of Refrigerants with Viton™ A

	25 °C (77 °F)		80 °C (176 °F)	
	CFC-12	Freon™ 134a	CFC-12	Freon™ 134a
Length Change, %				
Temporary	5.5	13	4.9	12
Final	0.7	−0.1	1.2	0.3
Weight Change, %				
Temporary	19	48	20	49
Final	1.8	0.7	2.5	1.2
Shore A Hardness				
Original	74	74	73	73
Temporary, D SH	−19	−30	−23	−31
Final, D SH	−7	−8	−10	−6
Elasticity Rating				
Temporary	2[b]	2[b]	3[a]	3[a]
Final	0	0	0	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	1[c]	0	0
Final	0	1[d]	0	5[e]

Test Conditions: 27 days immersion of the polymer at 25 °C (77 °F) and 80 °C (176 °F) in liquid (temporary) plus two weeks drying in air at about 25 °C (77 °F) (final).

[a] Less elastic [b] More elastic [c] Very slightly tacky [d] Oily sheen [e] Puffed mounds—5% of surface

Table 18. Freon™ 134a Permeation Through Elastomeric Hoses

	Permeation Rate, g/cm·yr (lb/ft·yr)			
	Nylon	Hypalon 48	Nitrile #1	Nitrile #2
Temporary	5.5	13	4.9	12
CFC-12	4.5 (0.3)	14.9 (1.0)	22.3 (1.5)	28.3 (1.9)
Freon™ 134a	3.0 (0.2)	3.0 (0.2)	26.8 (1.8)	40.2 (2.7)
Hose Construction				
Inner Liner	Nylon	Hypalon 48	Nitrile (NBR)	
Second Layer	—	Rayon	Rayon	
Reinforcement	Nylon	2 Braids	2 Braids	
Outer Cover	Chlorobutyl	EPDM	EPDM	

Table 19. Solubilities of Freon™ 134a in Lubricants Temperature Range: –50 to 93 °C (–58 to 199 °F)

Oil Type	30%	60%	90%
500 SUS Naphthenic	2 phase	2 phase	2 phase
500 SUS Paraffinic	2 phase	2 phase	2 phase
125 SUS Dialkylbenzene	2 phase	2 phase	2 phase
300 SUS Alkylbenzene	2 phase	2 phase	2 phase
165 SUS PAG	–50 to >93*	–50 to >93	–50 to 73
525 SUS PAG	–50 to >93	–40 to 35	–23 to –7
100 SUS Ester	–40 to >93	–35 to >93	–35 to >93
150 SUS Ester	–50 to >93	–50 to >93	–50 to >93
300 SUS Ester	–50 to >93	–50 to >93	–50 to >93
500 SUS Ester	–40 to >93	–35 to >93	–35 to >93

* One phase in this temperature range, °C.

Safety

Users must have and understand the applicable Freon™ 134a Safety Data Sheet (SDS).

Inhalation Toxicity

Freon™ 134a poses no acute or chronic hazard when handled in accordance with Chemours recommendations and exposures are maintained below recommended exposure limits, such as the Chemours acceptable exposure limit (AEL) of 1,000 ppm, 8- or 12-hour time-weighted average (TWA).

An AEL is an airborne inhalation exposure limit established by Chemours that specifies time-weighted average concentrations to which nearly all workers may be repeatedly exposed without adverse effects. The AEL for Freon™ 134a has the same value as the threshold limit values (TLVs) established for CFC-12 and HCFC-22. TLVs are established by the American Conference of Governmental and Industrial Hygienists (ACGIH).

However, inhaling high concentrations of Freon™ 134a vapor may cause temporary nervous system depression with anesthetic effects, such as dizziness, headache, confusion, incoordination, and loss of consciousness. Higher exposures to the vapors may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation. Similar effects are observed in overexposure to CFC-12. Intentional misuse or deliberate inhalation of Freon™ 134a may cause death without warning. This practice is extremely dangerous.

A person experiencing any of the initial symptoms should be moved to fresh air and kept calm. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Cardiac Sensitization

If vapors are inhaled at a concentration of 75,000 ppm, which is well above the AEL, the heart may become sensitized to adrenaline, leading to cardiac irregularities and, possibly, cardiac arrest. Similar effects are observed with many other halocarbons and hydrocarbons. The likelihood of these cardiac problems increases if under physical or emotional stress.

Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, should be considered only as a last resort in life-threatening emergencies.

Skin and Eye Contact

At room temperature, Freon™ 134a vapors have little or no effect on the skin or eyes. However, in liquid form, Freon™ 134a can freeze skin or eyes on contact, causing frostbite. If contact with liquid does occur, soak the exposed areas in lukewarm water, not cold or hot. In all cases, seek medical attention immediately.

Always wear protective clothing when there is a risk of exposure to liquid Freon™ 134a. Where splashing is possible, always wear eye protection and a face shield.

Spills or Leaks

If a large release of vapor occurs, such as from a large spill or leak, the vapors may concentrate near the floor or low spots and displace the oxygen available for breathing, causing suffocation.

Evacuate everyone until the area has been ventilated. Use blowers or fans to circulate the air at floor level. Do not reenter the affected area, unless you are equipped with a self-contained breathing apparatus or an area monitor indicates that the concentration of Freon™ 134a vapors in the area is below the AEL.

Always use self-contained breathing apparatus or an air-line mask when entering tanks or other areas where vapors might exist. Use the buddy system and a lifeline. Refer to the SDS for Freon™ 134a for more information.

Freon™ 134a vapors have a slightly sweet odor that can be difficult to detect. Therefore, frequent leak checks and the installation of permanent area monitors are necessary in enclosed spaces. Refer to American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standards 15-94 and 34 for refrigeration machinery rooms.

To ensure safety when working with Freon™ 134a in enclosed areas:

1. Route relief and purge vent piping (if present) outdoors, away from air intakes.
2. Make certain the area is well ventilated, using auxiliary ventilation, if necessary, to move vapors.
3. Make sure the area is clear of vapors prior to beginning work.
4. Install air monitoring equipment to detect leaks. (Monitors are discussed in the next section, Monitors and Leak Detection.)

Combustibility of Freon™ 134a

Freon™ 134a is not flammable in air at temperatures up to 100 °C (212 °F) at atmospheric pressure. However, mixtures of Freon™ 134a with high concentrations of air at elevated pressure and/or temperature can become combustible in the presence of an ignition source. Freon™ 134a can also become combustible in an oxygen-enriched environment (oxygen concentrations greater than that in air). Whether a mixture containing Freon™ 134a and air, or Freon™ 134a in an oxygen-enriched atmosphere, become combustible depends on the inter-relationship of 1) the temperature, 2) the pressure, and 3) the proportion of oxygen in the mixture.

In general, Freon™ 134a should not be allowed to exist with air above atmospheric pressure or at high temperatures or in an oxygen-enriched environment. **For example, Freon™ 134a should NOT be mixed with air under pressure for leak testing or other purposes.**

Refrigerants should not be exposed to open flames or electrical heating elements. High temperatures and flames can cause the refrigerants to decompose, releasing toxic and irritating fumes. In addition, a torch flame can become dramatically larger or change color if used in high concentrations of many refrigerants, including R-500 or R-22, as well as many alternative refrigerants. This flame enhancement can cause surprise or even injury. Always recover refrigerants, evacuate equipment, and ventilate work areas properly before using any open flames.

Test results and calculations have shown:

- At ambient temperature, all concentrations of Freon™ 134a in air are nonflammable at pressures below 205 kPa absolute (15 psig).

- Combustible mixtures of air and Freon™ 134a will not form when liquid Freon™ 134a is pumped into a closed vessel if the initial air pressure in the vessel is limited to 1 atm absolute and the final pressure is limited to 2,170 kPa absolute (300 psig). If the initial air pressure is greater than 1 atm, combustible mixtures may form as the tank is filled.

Based on the above information, the following operating practices are recommended.

- Do Not Mix With Air for Leak Testing
  - Equipment should never be leak tested with a pressurized mixture of Freon™ 134a and air. Pressurized mixtures of dry nitrogen and Freon™ 134a can be used for leak testing.
- Bulk Delivery and Storage
  - Tanks normally be evacuated at the start of filling and never be filled while under positive air pressure.
  - Tank pressure should never be allowed to exceed the tank manufacturer's maximum allowable working pressure when filling with Freon™ 134a. Relief devices on either the tanks or the Freon™ 134a supply system should be present and in good operating condition.
  - Tank pressures should be monitored routinely.
  - Air lines should never be connected to storage tanks.
- Filling and Charging Operations
  - Before evacuating cylinders or refrigeration equipment, any remaining refrigerant should be removed by a recovery system.
  - Vacuum pump discharge lines should be free of restrictions that could increase discharge pressures and result in the formation of combustible mixtures.
  - Cylinders or refrigeration equipment should be evacuated at the start of filling and never be filled while under positive air pressure.
  - Filled cylinders should periodically be analyzed for air (nonabsorbable gas [NAG]).
- Refrigerant Recovery Systems

  Efficient recovery of refrigerant from equipment or containers requires evacuation at the end of the recovery cycle. Suction lines to a recovery compressor should be periodically checked for leaks to prevent compressing air into the recovery cylinder during evacuation. In addition, the recovery cylinder pressure should be monitored, and evacuation stopped in the event of a rapid pressure rise—indicating the presence of air. The recovery cylinder contents should then be analyzed for NAG, and the recovery system leak checked if air is present. Do not continue to evacuate a refrigeration system that has a major leak.

Combustibility with Chlorine

Experimental data have also been reported that indicate combustibility of Freon™ 134a in the presence of chlorine.

Monitors and Leak Detection

Service personnel have used leak detection equipment for years when servicing equipment. Leak detectors exist not only for pinpointing specific leaks, but also for monitoring an entire room on a continual basis. There are several reasons for leak pinpointing or area monitoring, including: conservation of HFCs, protection of valuable equipment, reduction of fugitive emissions, and protection of employees. ASHRAE Standard 15-94 requires area monitors in refrigeration machinery rooms as defined in the standard.

Leak detectors can be placed into two broad categories: leak pinpointers and area monitors. Before purchasing a monitor or pinpointer, several instrumental criteria should be considered, including sensitivity, detection limits, and selectivity.

Types of Detectors

Using selectivity as a criterion, leak detectors can be placed into one of three categories: nonselective, halogen-selective, or compound-specific. In general, as the specificity of the monitor increases, so does the complexity and cost. Another method used to find leaks is to add fluorescent dyes to the system.

A detailed discussion of leak detection is given in Chemours technical bulletin, "Leak Detection Guidance for Freon™ Refrigerants."

Nonselective Detectors

Nonselective detectors are those that will detect any type of emission or vapor present, regardless of its chemical composition. These detectors are typically quite simple to use, very rugged, inexpensive, and almost always portable. However, their inability to be calibrated, long-term drift, and lack of selectivity and sensitivity limit their use for area monitoring.

Some nonselective detectors designed for use with CFC-12 may have a much lower sensitivity when used with Freon™ 134a. However, newly designed detectors with good Freon™ 134a sensitivity are now available. Be sure to consult with the manufacturer before selecting or using a nonselective detector with Freon™ 134a.

Halogen-Selective Detectors

Halogen-selective detectors use a specialized sensor that allows the monitor to detect compounds containing fluorine, chlorine, bromine, and iodine without interference from other species. The major advantage of such a detector is a reduction in the number of nuisance alarms—false alarms caused by the presence of some compound in the area other than the target compound.

These detectors are typically easy to use, feature higher sensitivity than nonselective detectors (detection limits are typically <5 ppm when used as an area monitor and <1.4g/yr [<0.05 oz/yr] when used as a leak pinpointer), and very durable. In addition, due to the partial specificity of the detector, these instruments can be calibrated easily.

Compound-Specific Detectors

The most complex detectors, which are also the most expensive, are compound-specific detectors. These units are typically capable of detecting the presence of a single compound without interference from other compounds.

Fluorescent Dyes

Fluorescent dyes have been used in refrigeration systems for several years. These dyes, invisible under ordinary lighting, but visible under ultraviolet (UV) light, are used to pinpoint leaks in systems. The dyes are typically placed into the refrigeration lubricant when the system is serviced. Leaks are detected by using a UV light to search for dye that has escaped from the system.

Recent innovations in dye technology have allowed fluorescent dyes to be used with Freon™ 134a. However, before adding dyes to a system, the compatibility of the specific dye with the lubricant and refrigerant should be tested.

Storage and Handling

Shipping Containers in the United States

Freon™ 134a is a liquefied compressed gas. According to the U.S. Department of Transportation (DOT), a nonflammable compressed gas is defined as a nonflammable material having an absolute pressure greater than 40 psi at 21 °C (70 °F) and/or an absolute pressure greater than 104 psi at 54 °C (130 °F). The appropriate DOT designations are as follows:

Proper Shipping Name	Liquefied Gas, N.O.S. (Tetrafluoroethane)
Hazard Class	2.2
UN Number	3159

A list of the different types of containers that can be used to ship Freon™ 134a in the United States, along with their water capacities, dimensions, DOT specifications, and net weights of Freon™ 134a, are provided in **Table 20**. All pressure relief devices used on the containers must be in compliance with the corresponding Compressed Gas Association (CGA) standards for compressed gas cylinders, cargo, and portable tanks.

The 30-lb and 123-lb cylinders designed for refrigerant applications are a light blue color with labels that bear the name of the product in light blue. The color designation is "Light Blue (Sky)," PMS 2975.

The 30-lb single-use cylinder, known as a Dispos-A-Can (DAC), fits into a box that measures 10 in x 10 in x 17 in. When used to ship Freon™ 134a for the stationary refrigeration market, these 30-lb cylinders have the same outlet fittings as cylinders of CFC-12. However, when used for Freon™ 134a (Auto) for the automotive industry, these cylinders have a CGA-167 valve outlet. This fitting was specified by the Society of Automotive Engineers (SAE) to avoid mixing CFC-12 and Freon™ 134a when servicing mobile air conditioning systems.

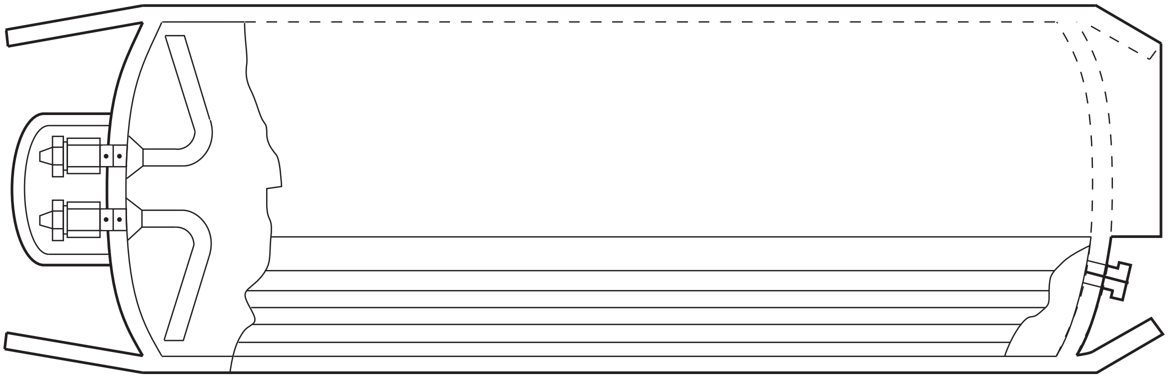
The 123-lb cylinders are equipped with a nonrefillable liquid vapor CGA-660 valve. With this two-way valve, Freon™ 134a can be removed from the cylinder as either a vapor or as a liquid without inverting the cylinder. The vapor handwheel is located on the top. The liquid wheel is on the side of the valve and attached to a dip tube extending to the bottom of the cylinder. Each is clearly identified as vapor or liquid.

The 4,400-gal cylinder is known as an ISO tank. The dimensions referenced in **Table 20** represent the frame in which the container is shipped. The tank itself has the same length of 20 ft and an outside diameter of approximately 86 in. ISO tanks are used for export shipments of Freon™ 134a from the United States.

Table 20. Specifications of Shipping Containers for Freon™ 134a

Water Capacity	Dimensions	DOT Specification	Net Weight (lb) Freon™ 134a
30-lb Dispos-A-Can	10 in x 10 in x 17 in (box)	39	30
123 lb	55 in H x 10 in OD	4BA300	125
1,682 lb	82 in L x 30 in OD	110A500W	1,750
5,000 gal	Tank Truck	MC-330 or -331	40,000
4,400 gal ISO	8 ft x 8.5 ft x 20 ft (frame)	51	30,865
170,000 lb	Tank Rail Car	114A340W	—

Figure 9. One-Ton Returnable Container



The general construction of a one-ton returnable container is shown in **Figure 9**. Notice that one end of the container is fitted with two valves. When the container is turned so that the valves are lined up vertically, the top valve will discharge vapor and the bottom valve will discharge liquid. The valves are protected by a dome cover.

Ton containers are equipped with two fusible plugs in each end. The fusible metal in the plugs is designed to start melting at 69 °C (157 °F) and completely melt at 74 °C (165 °F). Containers should never be heated to temperatures higher than 52 °C (125 °F). One spring-loaded pressure relief valve is also located in each end of the ton container.

Bulk Storage Systems

Chemours sells storage systems, at cost, to its Freon™ 134a customers. The systems are prefabricated, tested, and ready to install on site. The units are designed to optimize economy, efficiency, and safety in the storage and dispensing of Freon™ 134a. The delivered systems include all components, such as storage tanks, pumps, piping, valves, motors, and gauges, as an integrated unit. All systems are equipped with the Chemours Fluorochemical Emission Elimination Delivery (FEED) system to prevent emissions during deliveries and with dual pumps to provide an installed spare. The units are skid-mounted and require only placement on a concrete pad and connection to electrical and process systems.

A typical bulk storage system is shown in **Figure 10.**

Your Chemours sales representative can arrange for guidance on site selection, purchase, installation, start-up, and maintenance.

Converting Bulk Storage Tanks from CFC-12 to Freon™ 134a

Before switching from CFC-12 to Freon™ 134a, the existing storage equipment must be checked to verify that it is adequate. Storage tanks built to the specifications of the American Society of Mechanical Engineers (ASME) Pressure Vessel Code are required to have a metal nameplate indicating each tank's maximum allowable working pressure (MAWP). This rating must be 1,377 kPa absolute (185 psig) or higher for Freon™ 134a service. In most cases, existing storage tanks that have been properly designed to contain CFC-12 will have an adequate pressure rating for Freon™ 134a. The set pressure of the relief devices on the top of tanks must also be verified and changed, if necessary.

We recommend that storage tanks be **completely** emptied of all CFC-12 liquid and vapor before introducing Freon™ 134a. In general, converting a storage tank from CFC-12 to Freon™ 134a requires:

1. Removing CFC-12 from the storage tank, lines, and equipment.
2. Evacuating the storage tank to 25 in of mercury vacuum (16.7 kPa absolute pressure), and purging with compressed dry nitrogen gas.
3. Making necessary repairs to the tank after initial evacuation and purging.
4. Repeating step 2 until CFC-12 and moisture analyses are within acceptable limits.
5. Refilling system with Freon™ 134a.

The above is a simplified outline of what is actually a lengthy procedure. Your Chemours sales representative can assist in obtaining the equipment, instrumentation, and technical assistance to safely and effectively make the conversion.

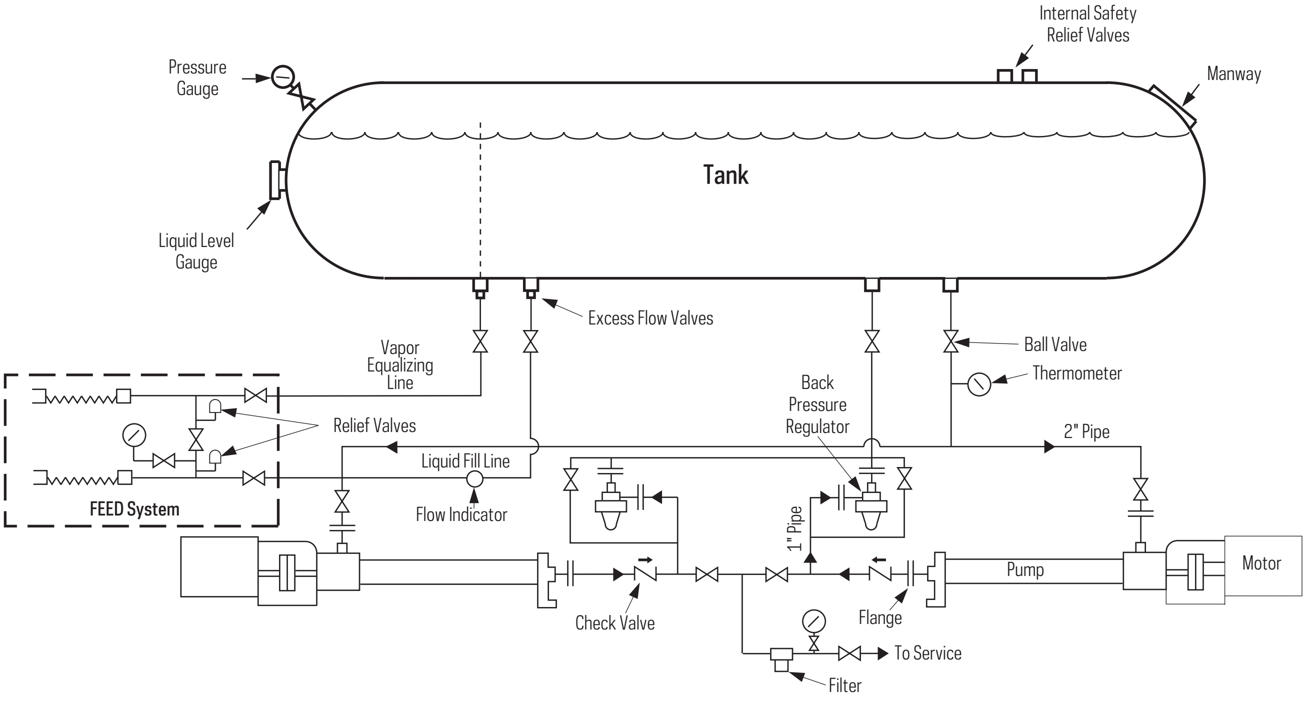
Material Compatibility Concerns

Most metal components suitable for use with CFC-12 are also compatible with Freon™ 134a, including standard types of carbon steel, aluminum, and copper. Some elastomeric or nonmetallic components suitable for CFC-12 may not be adequate. Therefore, all elastomeric or nonmetallic components throughout the system must be identified and their compatibility with Freon™ 134a verified (see the Materials Compatibility section). For complete reliability, any component that cannot be properly identified should be replaced.

In a fluorocarbon storage system, elastomers are most commonly found in:

- Packing and seats of manual valves
- Pressure-relief device seats
- Flange and manway gaskets
- Mechanical pump seals
- Wet-end pump gaskets and O-rings
- Filter O-rings
- Sight-flow indicator gaskets
- Back-pressure regulator diaphragms and O-rings

Figure 10. Typical Bulk Storage System



Handling Precautions for Freon™ 134a Shipping Containers

The following rules for handling Freon™ 134a containers are strongly recommended:

- Use personal protective equipment, such as side shield glasses, gloves, and safety shoes, when handling Freon™ 134a containers.
- Avoid skin contact with liquid Freon™ 134a, because it may cause frostbite.
- Never heat a container to a temperature higher than 52 °C (125 °F).
- Never apply direct flame or live steam to a container or valve.
- Never refill disposable cylinders with anything. The shipment of refilled disposable cylinders is prohibited by DOT regulations.
- Never refill returnable cylinders without Chemours consent. DOT regulations forbid transportation of returnable cylinders refilled without Chemours authorization.
- Never use a lifting magnet or sling (rope or chain) when handling containers. A crane may be used when a safe cradle or platform is used to hold the container.
- Never use containers as rollers, supports, or for any purpose other than to carry Freon™ 134a.
- Protect containers from any object that will result in a cut or other abrasion in the surface of the metal.
- Never tamper with the safety devices in the valves or containers.
- Never attempt to repair or alter containers or valves.
- Never force connections that do not fit. Make sure the threads on the regulators or other auxiliary equipment are the same as those on the container valve outlets.
- Keep valves tightly closed and valve caps and hoods in place when the containers are not in use.
- Store containers under a roof to protect them from weather extremes.
- Use a vapor recovery system to collect Freon™ 134a vapors from lines after unloading.

Recovery, Reclamation, Recycle, and Disposal

Responsible use of Freon™ 134a requires that the product be recovered for reuse or disposal whenever possible. Chemours purchases used refrigerants for reclamation through its distributor networks in the United States, Canada, and Europe. In the United States, used Freon™ 134a is accepted as part of this program. Recovery and reuse of Freon™ 134a makes sense from an environmental and economic standpoint. In addition, the U.S. Clean Air Act prohibits known venting of CFC, HCFC, and HFC refrigerants during the maintenance, servicing, or disposal of refrigeration equipment.

Recovery

Recovery refers to the removal of Freon™ 134a from equipment and collection in an appropriate external container. As defined by the Air Conditioning and Refrigeration Institute (ARI), a U.S. organization, recovery does not involve processing or analytical testing. Freon™ 134a may be recovered from refrigeration equipment using permanent on-site equipment or one of the portable recovery devices now on the market. The portable devices contain a small compressor and an air-cooled condenser, and may be used for vapor or liquid recovery. At the end of the recovery cycle, the system is evacuated to remove vapors. In the United States, the Environmental Protection Agency (EPA) sets standards for recovery equipment. Before purchasing a specific recovery unit, check with the manufacturer to be sure that it contains elastomeric seals and a compressor oil compatible with Freon™ 134a.

Reclamation

Reclamation refers to the reprocessing of used Freon™ 134a to new product specifications. Quality of reclaimed product is verified by chemical analysis. In the United States, Freon™ 134a is included in Chemours refrigerant reclamation program. Contact Chemours or one of its authorized distributors for further information.

Reclamation offers advantages over on-site refrigerant recycling procedures, because these systems cannot guarantee complete removal of contaminants. Putting refrigerants that do not meet new product specifications back into expensive equipment may cause damage.

Recycle

Refrigerant recycle refers to the reduction of used refrigerant contaminants using devices that reduce oil, water, acidity, and particulates. Recycle is usually a field or shop procedure with no analytical testing of refrigerant. Freon™ 134a may be recycled using one of the devices now on the market. In the United States, the EPA sets standards for these devices. Recycle is becoming the accepted practice in the United States mobile air conditioning service industry. Consult with the manufacturer before specifying a recycle device for Freon™ 134a.

Disposal

Disposal refers to the destruction of used Freon™ 134a. Disposal may be necessary when Freon™ 134a has become badly contaminated with other products and no longer meets the acceptance specifications of Chemours or other reclaimers. Although Chemours does not presently accept severely contaminated refrigerants for disposal, licensed waste disposal firms are available. Be sure to check the qualifications of any firm before sending them used Freon™ 134a.