Freon™ 407C and 410A

Refrigerants (R-407C and R-410A)

Properties, Uses, Storage, and Handling

Chemours™

Introduction

Background

Chlorodifluoromethane (R-22 or HCFC-22) has been used as a refrigerant in various refrigeration, industrial cooling, air conditioning, and heating applications for over six decades. The low ozone depletion potential (ODP) of R-22 compared to CFC-11 (chlorofluorocarbon 11) and CFC-12, as well as its excellent refrigerant properties have helped facilitate the transition away from chlorofluorocarbons (CFCs). However, R-22 will be phased out in the first quarter of the 21st century. In preparation for this phaseout, Chemours offers Freon™ 407C and Freon™ 410A, environmentally acceptable alternatives to R-22.

Freon™ 407C and Freon™ 410A Refrigerant Descriptions

Freon™ 407C is a non-ozone depleting blend of three hydrofluorocarbon (HFC) refrigerants. It exhibits performance characteristics similar to R-22. Freon™ 410A is a non-ozone depleting blend of two HFC refrigerants. It exhibits higher pressures and refrigeration capacity than R-22.

The compositions of Freon™ 407C and Freon™ 410A are as follows:

	HFC-32	HFC-125	HFC-134a
Freon™ 407C (R-407C), wt%	23	25	52
Freon™ 410A (R-410A), wt%	50	50	—

Because Freon™ 407C and Freon™ 410A are mixtures of HFCs, they have zero ODP.

Table 1 lists the chemical names and formulae of the components that make up Freon™ 407C and Freon™ 410A.

Table 1. Components of Freon™ 407C: HFC-32/HFC-125/HFC-134a and Freon™ 410A: HFC-32/HFC-125

Component	Chemical Name	Formula	CAS Number	Molecular Weight
HFC-32	Difluoromethane	CF_2H_2	75-10-5	52.0
HFC-125	Pentafluoroethane	CF_3CHF_2	354-33-6	120.0
HFC-134a	1,1,1,2-Tetrafluoroethane	CF_3CH_2F	811-97-2	102.0

Uses

Freon™ 407C refrigerant performs similarly to HCFC-22 under evaporator temperatures ranging from –7 to 10 °C (20 to 50 °F). It is designed for use in new equipment and as a service refrigerant for existing HCFC-22 air conditioning, heat pump, and medium-temperature refrigeration equipment.

Freon™ 410A is intended for use in new air conditioning applications that have traditionally been serviced by HCFC-22. Many other applications are also possible, such as medium- and low-temperature refrigeration. Due to the significantly higher pressures that Freon™ 410A exhibits compared to HCFC-22, a typical compressor designed for HCFC-22 cannot be used with Freon™ 410A.

Table 2 shows theoretical performance of Freon™ 407C, Freon™ 410A, and HCFC-22. Freon™ 407C exhibits similar performance to HCFC-22, while Freon™ 410A gives significantly higher pressure and refrigeration capacity.

Physical Properties

General physical properties for Freon™ 407C and Freon™ 410A are shown in **Table 3**. The pressure-enthalpy diagrams for Freon™ 407C are shown in **Figures 1** and **2**.

Additional physical property data may be found in other Chemours publications. Thermodynamic properties booklets are also available for Freon™ 407C and Freon™ 410A in both English and metric units. Piping guidelines are also available for Freon™ 410A.

Table 2. Theoretical Cycle Performance

	HCFC-22	Freon™ 407C (R-407C)	Freon™ 410A (R-410A)
Refrigeration Capacity (HCFC-22 = 1.0)	1.00	1.02	1.45
Coefficient of Performance (HCFC-22 = 1.0)	1.00	0.97	0.93
Compression Ratio	2.66	2.82	2.63
Compressor Discharge Temperature, °C	76.7	71.2	74.1
Compressor Discharge Pressure, kPa	1661	1787	2622
Temperature Glide, K	0	4.62	0.08

Conditions: 43.3 °C (110 °F) condenser/7.2 °C (45 °F) evaporator/2.8 °C (5 °F) of subcooling/8.3 °C (15 °F) of superheat

Table 3. General Property Information: Freon™ 407C, Freon™ 410A, and HCFC-22

Property	Unit	Freon™ 407C (R-407C)	Freon™ 410A (R-410A)	HCFC-22
Molecular Weight	g/mol	86.20	72.58	86.47
Vapor Pressure at 25 °C (77 °F)	kPa abs psia	1174.1 170.29	1652.9 239.73	1043.1 151.40
Boiling Point (1 atm)	°C °F	−43.56 −46.40	−51.53 −60.76	−40.80 −41.40
Critical Temperature	°C °F	86.74 188.13	72.13 161.83	96.24 205.24
Critical Pressure	kPa abs psia	4619.10 669.95	4926.1 714.5	4980.71 722.39
Critical Density	kg/m^3 lb/ft^3	527.30 32.92	488.90 30.52	524.21 32.73
Density (Liquid) at 25 °C (77 °F)	kg/m^3 lb/ft^3	1134.0 70.80	1062.4 66.32	1194.68 74.53
Density (Saturated Vapor) at 25 °C (77 °F)	kg/m^3 lb/ft^3	41.98 2.62	65.92 4.12	44.21 2.76
Specific Heat, Liquid at 25 °C (77 °F)	kJ/kg·K Btu/lb·(°F)	1.54 0.367	1.84 0.440	1.24 0.296
Specific Heat, Liquid at 25 °C (77 °F) (1 atm)	kJ/kg·K Btu/lb·(°F)	0.830 0.198	0.832 0.199	0.685 0.157
Vapor Pressure of Saturated Liquid at 25 °C (77 °F) , kPa (psig)	kPa abs psia	1173.4 170.3	1652.9 239.73	1043.1 151.4
Heat of Vaporization at Boiling Point	kJ/kg Btu/lb	245.1 105.4	276.2 118.8	233.5 100.4
Thermal Conductivity at 25 °C (77 °F) Liquid Vapor (1 atm)	 W/m·K Btu/hr·ft·(°F) W/m·K Btu/hr·ft·(°F)	 0.0819 0.0455 0.01314 0.00758	 0.0886 0.0511 0.01339 0.00772	 0.0849 0.0458 0.01074 0.00621
Viscosity at 25 °C (77 °F) Liquid Vapor (1 atm)	 Pa·s Pa·s	 1.60×10^{-4} 1.23×10^{-5}	 1.20×10^{-4} 1.27×10^{-5}	 1.59×10^{-4} 1.30×10^{-5}
Flammability Limits in Air (1 atm)	vol%	None	None	None
Ozone Depletion Potential (ODP)	(CFC-11, ODP = 1)	0	0	0.05
Halocarbon Global Warming Potential (HGWP)	(CFC-11, ODP = 1)	0.38	0.46	0.34
Global Warming Potential (GWP)	CO_2, GWP = 1 (100 yr ITH)	1600	1890	1700
TSCA Inventory Status	Included	Yes	Yes	Yes
Workplace Environmental Exposure Level (WEEL)*	ppm (v/v) 8- and 12-hr TWA	1000	1000	1000

*Established by Occupational Alliance for Risk Science (OARS)

Figure 1.. Pressure-Enthalpy Diagram for Freon™ 407C (ENG Units)

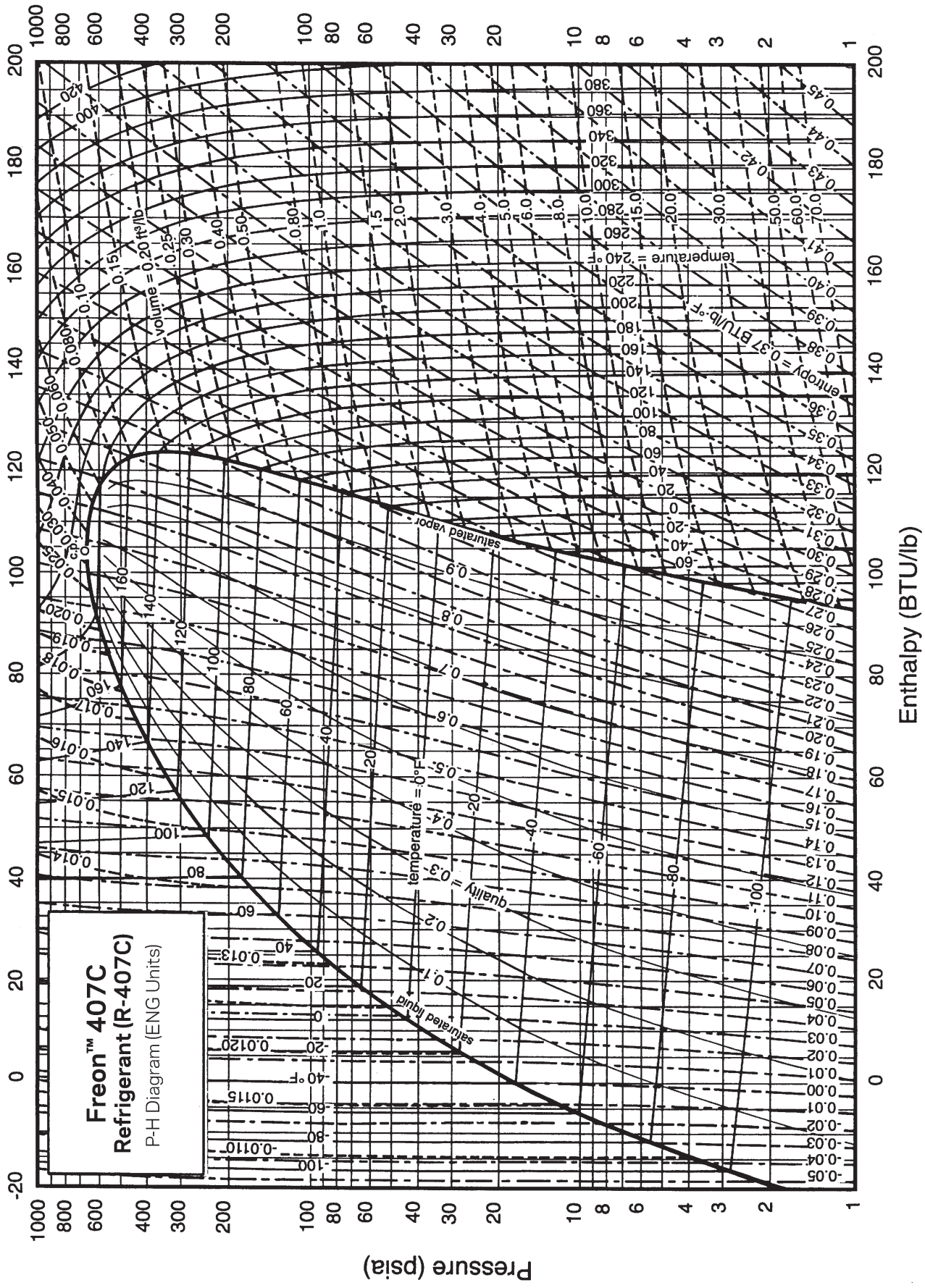

Table 5. Compatibility of Freon™ 407C Refrigerant with Selected Elastomers

Material	R-22			Freon™ 407C (R-407C)			Freon™ 407C/Polyol Ester		
	Rating	Linear Swell, %	Hardness Change, Units	Rating	Linear Swell, %	Hardness Change, Units	Rating	Linear Swell, %	Hardness Change, Units
Alcryn	0	–3	0	0	1	4	0	0	–10
Buna S	2a	1	–21	0	1	–10	1	6	–38
Butyl Rubber	0	0	–7	0	–1	0	0	–1	–8
Chlorosulfonated Polyethylene	1	0	–7	0	0	0	1	6	–12
EPDM	0	–1	–8	0	0	–6	0	–1	0
Ethylene Acrylic	2b	19	–12	0	8	–7	2	16	–12
Hytrel	0	9	–2	0	2	0	0	3	0
Kalrez	1	11	—	1	5	–16	1	6	–23
Natural Rubber	1	11	–9	0	–1	–3	0	5	–10
NBR	2b	—	–21	0	0	–1	0	5	–8
Neoprene	2a	15	–20	0	1	–1	0	1	–10
Polysulfide	1	2	–13	0	0	1	0	0	5
Polyurethane	2	21	–17	0	4	–6	1c	7	–30
Santoprene	0	1	–1	0	0	1	0	–1	–3
Silicone	1	11	–3	0	2	–10	1	6	–13
Viton™ A	1	21	–4	2	14	–12	2	23	–15
Viton™ B	2	18	–17	2	15	–28	2	18	–32

Rating

0 = Both % linear swell and hardness change are less than 10

1 = Either swell OR hardness change greater than 10

2 = Both swell AND hardness change greater than 10

Comments

a = Sample popped due to rapid degassing

b = Sample distorted

c = Significant loss of tensile properties

Table 6. Compatibility of Freon™ 410A Refrigerant with Selected Elastomers

Material	R-22			Freon™ 410A (R-410A)			Freon™ 410A/Polyol Ester		
	Rating	Linear Swell, %	Hardness Change, Units	Rating	Linear Swell, %	Hardness Change, Units	Rating	Linear Swell, %	Hardness Change, Units
Alcryn	0	–3	0	0	0	–3	0	5	–6
Buna S	2a	1	–21	1	0	–14	2	32	–42
Butyl Rubber	0	0	–7	0	0	0	0	2	–6
Chlorosulfonated Polyethylene	1	0	–7	0	2	–4	0	4	–8
EPDM	0	–1	–8	0	1	–3	0	0	1
Ethylene Acrylic	2b	19	–12	0	7	–7	1	17	–9
Hytrel	0	9	–2	0	3	–1	0	6	–1
Kalrez	1	11	—	1	5	–16	1	4	–13
Natural Rubber	1	11	–9	0	2	–4	2	11	–12
NBR	2b	—	–21	0	5	–10	1	8	–30
Neoprene	2a	15	–20	0	0	2	0	3	–8
Polysulfide	1	2	–13	0	0	–3	0	2	–1
Polyurethane	2	21	–17	0	6	–5	2d	—	—
Santoprene	0	1	–1	0	–1	–3	0	1	–1
Silicone	1	11	–3	0	4	–4	1	9	–12
Viton™ A	1	21	–4	2	12	–15	2	15	–12
Viton™ B	2	18	–17	2	14	–18	2	19	–32

Rating

0 = Both % linear swell and hardness change are less than 10

1 = Either swell OR hardness change greater than 10

2 = Both swell AND hardness change greater than 10

Comments

a = Sample popped due to rapid degassing

b = Sample distorted

c = Significant loss of tensile properties

Table 7. Compatibility of Freon™ 407C Refrigerant with Selected Plastics

Plastic	R-22		Freon™ 407C (R-407C)		Freon™ 407C/Polyol Ester	
	Rating	Weight Change, %	Rating	Weight Change, %	Rating	Weight Change, %
High-Density Polyethylene	1	3	0	1	1	2
Polypropylene	1	9	0	1	1	5
Polystyrene	2c	—	1	4	2c	28
Polyvinyl Chloride	1	2	0	0	0	3
Fluoropolymers						
PTFE	1	4	1	2	1	2
ETFE	1	8	1	4	1	4
PVDF	1	3	1	2	1	7
ABS	2c	—	1	2	2c	14
Epoxy	0	0	0	0	0	1
Acetal	1	8	0	1	1	2
Modified Polyphenylene Oxide	2b	33	1	2	1	3
Polycarbonate	2b	32	1	2	1	4
Poly(butylene terephthalate)	0	1	0	0	0	1
Nylon	0	1	0	0	1b	0
Polyetherimide	1	8	0	1	0	1
Polyimide	0	0	0	1	0	0
Polyphenylene Sulfide	1	5	1	2	1	3
Polysulfone	2	13	0	1	0	1

Rating

0 = Best by visual inspection and weight change

1 = Borderline by visual inspection and weight change

2 = Worst by visual inspection and weight change

Comments

a = No change

b = Surface change

c = Destroyed or dissolved