



FORANE[®] 22

Forane[®] 22 refrigerant (R-22), an HCFC, has properties providing for a broad range of applications, including residential air conditioning, refrigeration, and other cooling applications. R-22 is going through a mandatory phase-out, according to the schedule set by the Montreal Protocol. End-users should consult their local wholesaler or refrigerant manufacturer for more information on the R-22 phase-out.

Application	R-22 is used in a variety of applications, including residential and commercial air conditioning, refrigeration, chillers, room air conditioning, transport refrigeration, and other comfort cooling and refrigeration applications.
Properties & Performance	R-22 has properties making it a useful refrigerant in many air conditioning and refrigeration applications. R-22 is a single component, non-flammable, non-toxic refrigerant with an A1 ASHRAE safety rating.
Lubrication	R-22 works with mineral oil, alkylbenzene oil, or POE oil. End-users should check with the equipment manufacturers guidelines for specific oil selection directions.
Charging	Charging with R-22 can be done either as a vapor or a liquid. End-users should check with their equipment manufacturers guidelines for specific charging instructions.

PROPERTIES	R-22
Average Molecular Weight (g/mol)	86.5
Normal Boiling Point (°F)	-41.3
Critical Temperature (°F)	204.8
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.055
Global Warming Potential (GWP)	1,810

R-22 TRANSITION

Montreal Protocol HCFC Phase-out

Ongoing R-22 Reduction



R-22 is the most widely used HCFC refrigerant for HVACR applications, such as residential air conditioning, refrigeration, and other cooling applications. Although R-22 has been a good solution for many different applications, it is classified as an HCFC and is subject to phase-out according to the Montreal Protocol international treaty and the Clean Air Act in the United States.

In the USA, the Clean Air Act has met the requirements of the Montreal Protocol by limiting consumption of HCFC, including R-22, through a series of phase downs through 2030. Each step reduces R-22 consumption by reducing or eliminating R-22 in different market segments.

As part of this phase down, R-22 will not be permitted for use in new OEM HVACR equipment in 2010, reducing the R-22 demands into this sector and helping to meet the 75% reduction in ozone depleting substances.

In 2015, R-22 will have another step change reduction of 90% of the overall allowable consumption for servicing R-22 systems in the United States.

These step-downs will continue through 2030, when R-22 will be completely phased out in the United States.

In the USA, these regulations may change in the future. Please visit www.forane-us.com.

R-22 users should be aware of the need to transition to other, more sustainable refrigerants meeting the application's requirements. Current HFC refrigerants listed in this Tech Digest meet these needs and are not under any phase-out restrictions.

DEFINITIONS

Bubble Point (Saturated Liquid Temperature)	The temperature (for a given pressure) at which the liquid of a refrigerant blend (any 400 or 500 series refrigerant) begins to evaporate or boil. This is similar to the saturated liquid temperature of a single component refrigerant.
Dew Point (Saturated Vapor Temperature)	The temperature (for a given pressure) at which the vapor of a given refrigerant blend (any 400 or 500 series refrigerant) begins to condense or liquefy. This is similar to the saturated vapor temperature of a single component refrigerant.
Fractionation	The change in composition of a refrigerant blend (any 400 or 500 series refrigerant) when it changes phase from liquid to vapor (evaporation) or from vapor to liquid (condensation). This behavior in blends explains the permanent changes to refrigerant composition from leaks, causing the blend to deviate outside the tolerances of the designed composition.
Glide	The difference in temperature between the evaporator outlet and inlet due to fractionation of the blend. Theoretically, this can be calculated by finding the difference between the dew and bubble temperatures at constant pressure. Actual measurements may differ slightly depending on the state of the liquid refrigerant at either end of the evaporator (or condenser). Pressure losses through the evaporator may also affect glide.
Normal Boiling Point (NBP)	The temperature at which a given refrigerant begins to boil while at atmospheric pressure (14.7 psia).
Abbreviations	AB – alkylbenzene GWP – global warming potential MO – mineral oil ODP – ozone depletion potential OEM – original equipment manufacturer POE – polyolester PAG – polyalkylene glycol

OTHER TOPICS

Refrigerant Lubricants

The phase-out of ozone depleting refrigerants has impacted air-conditioning and refrigeration equipment design in many ways. One of the most significant changes to these systems is the transition of the compressor lubricants. Use of an appropriate lubricant is important when servicing, installing, or retrofitting a system. The following information may be helpful as general background information on refrigerant lubricants; however, always follow OEM recommendations for proper lubricant selection.

Mineral Oil: Mineral oil has been the lubricant of choice for systems utilizing many of the CFC and HCFC refrigerants. Both the CFCs and HCFCs tend to have adequate miscibility with mineral oil, helping to ensure acceptable oil return under normal operating conditions. Sometimes a synthetic lubricant (i.e. AB or POE) is required under certain conditions, such as reduced miscibility with CFC retrofit blends or high discharge temperatures with products like R-22.

Alkylbenzene: Alkylbenzene is a synthetic refrigerant compressor lubricant used in new refrigeration systems and for retrofits from CFCs to HCFCs. Typically, Alkylbenzene has better miscibility with HCFCs than mineral oil, resulting in more reliable oil return. For retrofits of older CFC equipment, a partial oil change from mineral oil to alkylbenzene may be acceptable.

Polyolester: HFC refrigerants serve as the replacements for the ozone-depleting CFCs and HCFCs. However, both mineral oil and alkylbenzene have poor miscibility with HFCs, making oil return with these products unreliable in many systems. POEs are synthetic oils commonly used in new HFC systems and for retrofitting older CFC and HCFC equipment to HFC refrigerants. Special care must be taken when using POE oils due to their quick absorption of moisture when left exposed to the atmosphere (hygroscopic).

Polyalkylene Glycol: In addition to POE oils, polyalkylene glycol (PAG) lubricants are used with R-134a in automotive air-conditioning applications. Like POEs, PAGs are hygroscopic synthetic oils and must be treated with care to minimize exposure to moisture. While both POEs and PAGs are used with R-134a in automotive systems, the two oil types are not interchangeable and should not be mixed.

Material Compatibility

Whenever retrofitting an air-conditioning or refrigeration system, compatibility of system materials is always a concern. Items such as elastomers, hoses, and filter-driers respond differently to different refrigerants and oils. For these reasons, before performing any refrigerant retrofit, Arkema recommends contacting the OEM for specific recommendations. Arkema's Technical Service hotline can also be reached at (800) 738-7695.

Leak Detection

Leak checking should be a routine practice whenever performing maintenance on or servicing an air-conditioning or refrigeration system. As elastomers and other sealing components may react differently to new refrigerants and oils, leak checking should always be performed after any refrigerant retrofit.

Certain older style leak detectors have difficulty detecting newer refrigerants. It is important to verify whether or not your leak detector is rated for the type of refrigerant (CFC, HCFC, or HFC) you will be working with. Also, some refrigerant dyes are only compatible with specific refrigerant oils. Always check with the manufacturer before using a leak dye in an air-conditioning or refrigeration system.

Forane® Refrigerant Pressure Temperature Chart

PRESSURE (PSIG)																		
Sat. Temp (°F)	R-22	R-407C Liquid Pressure	R-407C Vapor Pressure	R-410A Liquid Pressure	R-427A Liquid Pressure	R-427A Vapor Pressure	R-407A Liquid Pressure	R-407A Vapor Pressure	R-123	R-12	R-134a	R-409A Liquid Pressure	R-409A Vapor Pressure	R-401A Liquid Pressure	R-401A Vapor Pressure	R-401B Liquid Pressure	R-401B Vapor Pressure	Sat. Temp (°C)
-50	6.2	2.9	11.4	5.3	3.8	11.9	0.8	9.0	29.2	15.4	18.7	12.4	17.2	13.5	17.9	12.2	16.8	-45.6
-45	2.7	0.4	8.5	8.0	0.1	9.0	1.7	5.7	29.0	13.3	16.9	9.7	15.2	11.1	16.0	9.6	14.7	-42.8
-40	0.5	2.5	5.2	11.0	1.9	5.9	3.9	2.0	28.9	11.0	14.8	6.8	13.1	8.4	13.8	6.7	12.4	-40.0
-35	2.6	4.8	1.5	14.2	4.1	2.4	6.4	1.0	28.7	8.4	12.5	3.5	10.7	5.3	11.4	3.4	9.7	-37.2
-30	4.9	7.3	1.3	17.8	6.6	0.8	9.2	3.3	28.4	5.5	9.8	0.0	8.1	2.0	8.7	0.1	6.8	-34.4
-25	7.4	10.1	3.6	21.8	9.3	2.9	12.2	5.8	28.1	2.3	6.9	2.0	5.1	0.8	5.6	2.0	3.5	-31.7
-20	10.1	13.1	6.1	26.1	12.2	5.3	15.6	8.5	27.8	0.6	3.7	4.1	1.9	2.9	2.2	4.1	0.1	-28.9
-15	13.2	16.5	8.8	30.8	15.4	7.9	19.2	11.5	27.4	2.4	0.1	6.5	0.8	5.1	0.7	6.5	2.0	-26.1
-10	16.5	20.1	11.9	35.9	18.9	10.8	23.2	14.9	27.0	4.5	1.9	9.0	2.8	7.5	2.8	9.1	4.2	-23.3
-5	20.0	24.0	15.2	41.5	22.8	14.0	27.5	18.5	26.5	6.7	4.1	11.8	4.9	10.1	5.0	11.9	6.6	-20.6
0	23.9	28.3	18.9	47.5	26.9	17.5	32.2	22.5	25.9	9.1	6.5	14.8	7.2	13.0	7.4	14.9	9.2	-17.8
5	28.2	33.0	22.9	54.1	31.4	21.2	37.3	26.9	25.3	11.8	9.1	18.1	9.7	16.1	10.1	18.2	12.1	-15.0
10	32.8	38.0	27.3	61.2	36.3	25.4	42.8	31.6	24.6	14.6	11.9	21.7	12.5	19.5	13.0	21.8	15.2	-12.2
15	37.7	43.5	32.0	68.8	41.5	29.9	48.7	36.7	23.7	17.7	15.0	25.5	15.4	23.1	16.2	25.7	18.6	-9.4
20	43.0	49.3	37.2	77.1	47.2	34.7	55.1	42.3	22.8	21.0	18.4	29.6	18.7	27.1	19.6	29.9	22.3	-6.7
25	48.7	55.7	42.7	86.0	53.3	40.0	62.0	48.3	21.8	24.6	22.1	34.0	22.2	31.4	23.4	34.4	26.3	-3.9
30	54.9	62.5	48.7	95.5	59.8	45.7	69.3	54.8	20.7	28.4	26.0	38.7	26.0	36.0	27.4	39.3	30.6	-1.1
35	61.5	69.8	55.2	105.7	66.8	51.9	77.2	61.8	19.5	32.5	30.3	43.8	30.1	40.9	31.8	44.5	35.2	1.7
40	68.5	77.6	62.1	116.6	74.3	58.7	85.6	69.4	18.1	36.9	35.0	49.2	34.5	46.2	36.5	50.1	40.2	4.4
45	76.0	86.0	69.5	128.3	82.3	65.6	94.6	77.4	16.6	41.6	40.0	54.9	39.2	51.8	41.6	56.0	45.6	7.2
50	84.0	94.9	77.5	140.8	90.8	73.3	104.2	86.1	15.0	46.7	45.4	61.0	44.3	57.9	47.0	62.4	51.4	10.0
55	92.5	104.5	86.0	154.1	99.9	81.5	114.4	95.3	13.1	52.0	51.1	67.6	49.8	64.3	52.8	69.2	57.5	12.8
60	101.6	114.6	95.1	168.2	109.6	90.3	125.2	105.2	11.2	57.7	57.3	74.5	55.6	71.2	59.0	76.5	64.1	15.6
65	111.2	125.4	104.8	183.2	119.9	99.6	136.7	115.7	9.0	63.7	63.9	81.8	61.9	78.5	65.7	84.2	71.2	18.3
70	121.4	136.9	115.2	199.2	130.8	109.6	148.8	127.0	6.6	70.2	71.0	89.5	68.6	86.3	72.8	92.3	78.7	21.1
75	143.6	149.1	126.2	216.1	142.4	120.3	161.7	138.9	4.0	76.9	78.6	97.7	75.8	94.5	80.3	101.0	86.7	23.9
80	143.6	162.1	137.8	234.0	154.6	131.6	175.3	151.6	1.2	84.1	86.6	106.4	83.4	103.2	88.4	110.2	95.2	26.7
85	155.7	175.8	150.2	253.0	167.6	143.7	189.7	165.1	0.9	91.7	95.1	115.5	91.5	112.4	96.9	119.8	104.2	29.4
90	168.4	190.2	163.4	273.0	181.2	156.4	204.8	179.3	2.5	99.7	104.2	125.2	100.2	122.2	106.0	130.1	113.8	32.2
95	181.8	205.5	177.4	294.1	195.6	170.0	220.8	194.4	4.2	108.2	113.8	135.3	109.4	132.5	115.6	140.9	123.9	35.0
100	195.9	221.6	192.1	316.4	210.8	184.4	237.6	210.4	6.1	117.1	124.1	146.0	119.2	143.3	125.7	152.3	134.7	37.8
105	210.7	238.5	207.8	339.9	226.8	199.6	255.3	227.4	8.1	126.5	134.9	157.2	129.6	154.8	136.5	164.3	146.0	40.6
110	226.3	256.4	224.4	364.6	243.6	215.7	273.9	245.2	10.3	136.4	146.3	169.0	140.6	166.8	147.8	176.9	158.0	43.3
115	242.7	275.1	241.9	390.5	261.2	232.7	293.5	264.1	12.6	146.7	158.4	181.4	152.3	179.4	159.8	190.1	170.6	46.1
120	259.9	294.7	260.5	417.7	279.7	250.6	314.0	284.0	15.1	157.6	171.1	194.4	164.7	192.7	172.4	204.0	183.9	48.9
125	277.9	315.2	280.1	446.3	299.1	269.5	335.4	305.0	17.7	169.0	184.5	208.0	177.8	206.6	185.7	218.6	197.9	51.7
130	296.8	336.7	300.9	476.3	319.4	289.5	357.9	327.1	20.6	180.9	198.7	222.3	191.6	221.2	199.7	233.9	212.6	54.4
135	316.5	359.2	322.9	507.6	340.7	310.5	381.5	350.5	23.6	193.5	213.6	237.2	206.3	236.5	214.5	250.0	228.1	57.2
140	337.2	382.6	346.2	540.5	362.9	332.6	406.2	375.1	26.8	206.5	229.3	252.9	221.8	252.5	229.9	266.7	244.3	60.0
145	358.8	407.0	370.8	574.8	386.1	355.9	431.9	401.0	30.2	220.2	245.7	269.3	238.2	269.3	246.2	284.3	261.4	62.8
150	381.5	432.4	396.9	610.6	410.3	380.4	458.9	428.3	33.8	234.5	263.0	286.4	255.5	286.8	263.2	302.6	279.3	65.6

Red Numerals (in bold and italics) - Inches Hg. Below 1 ATM

PRESSURE (PSIG)

Sat. Temp (°F)	R-502	R-408A Liquid Pressure	R-402A Liquid Pressure	R-402B Liquid Pressure	R-404A Liquid Pressure	R-507A	Sat. Temp (°C)
-50	<i>0.2</i>	<i>1.6</i>	2.5	1.1	0.6	1.1	-45.6
-45	1.9	1.1	4.9	3.2	2.7	3.3	-42.8
-40	4.1	3.3	7.4	5.6	5.0	5.7	-40.0
-35	6.5	5.6	10.3	8.2	7.6	8.3	-37.2
-30	9.2	8.2	13.4	11.1	10.4	11.2	-34.4
-25	12.1	11.0	16.7	14.2	13.4	14.3	-31.7
-20	15.3	14.1	20.4	17.6	16.8	17.8	-28.9
-15	18.8	17.5	24.5	21.4	20.5	21.6	-26.1
-10	22.6	21.2	28.8	25.4	24.5	25.7	-23.3
-5	26.7	25.2	33.6	29.8	28.8	30.1	-20.6
0	31.1	29.5	38.7	34.6	33.5	34.9	-17.8
5	35.9	34.2	44.2	39.8	38.6	40.2	-15.0
10	41.0	39.3	50.1	45.3	44.0	45.8	-12.2
15	46.5	44.8	56.5	51.3	49.9	51.8	-9.4
20	52.5	50.7	63.4	57.6	56.2	58.3	-6.7
25	58.8	57.0	70.7	64.5	63.0	65.3	-3.9
30	65.6	63.7	78.5	71.8	70.3	72.8	-1.1
35	72.8	71.0	86.9	79.6	78.1	80.8	1.7
40	80.5	78.7	95.8	88.0	86.4	89.3	4.4
45	88.7	87.0	105.3	96.9	95.2	98.4	7.2
50	97.4	95.8	115.4	106.3	104.7	108.1	10.0
55	106.6	105.1	126.1	116.3	114.7	118.5	12.8
60	116.4	115.1	137.4	127.0	125.3	129.4	15.6
65	126.7	125.6	149.4	138.2	136.6	141.1	18.3
70	137.6	136.8	162.1	150.1	148.6	153.4	21.1
75	149.1	148.7	175.5	162.7	161.2	166.4	23.9
80	161.2	161.2	189.7	176.0	174.6	180.2	26.7
85	174.0	174.4	204.6	189.9	188.8	194.8	29.4
90	187.4	188.4	220.2	204.7	203.7	210.1	32.2
95	201.4	203.1	236.8	220.2	219.4	226.3	35.0
100	216.2	218.7	254.2	236.5	235.9	243.4	37.8
105	231.7	235.4	272.4	253.6	253.4	261.3	40.6
110	247.9	252.1	291.6	271.6	271.7	280.2	43.3
115	264.9	270.2	311.7	290.5	290.9	300.0	46.1
120	282.7	289.1	332.8	310.3	311.1	320.8	48.9
125	301.4	308.9	354.9	331.0	332.3	342.6	51.7
130	320.8	329.7	378.1	352.7	354.5	365.5	54.4
135	341.2	351.5	402.4	375.4	377.8	389.4	57.2
140	362.6	374.3	427.8	399.2	402.2	414.5	60.0
145	385.0	398.1	454.4	424.0	427.7	440.7	62.8
150	408.4	423.0	482.3	450.0	454.4	468.1	65.6

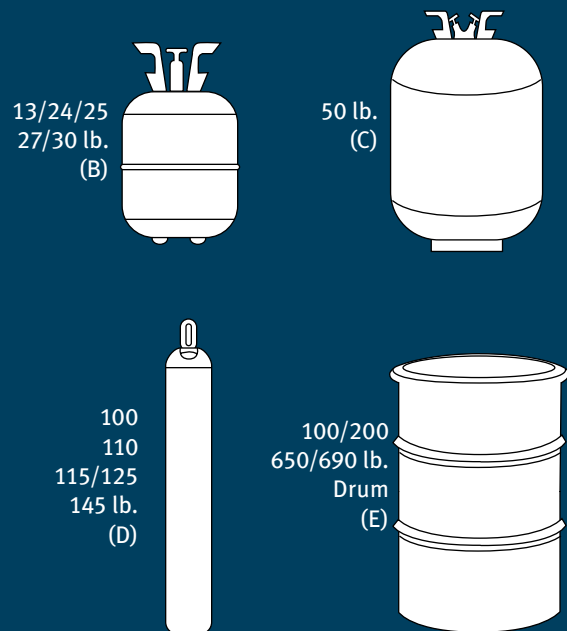
Red Numerals (in bold and italics) - Inches Hg. Below 1 ATM

Forane® Refrigerant Cylinder Identification

Type	Color Code	Sizes (Net lbs.)	
R-12	CFC	White	30 (B), 50 (C), 145 (D), 2000
R-502	CFC	Lavender	30 (B), 125 (D)
R-22	HCFC	Light Green	30 (B), 50 (C), 125 (D), 1000, 1750
R-123	HCFC	Light Blue Grey	100 (E), 200 (E)
R-401A	HCFC	Pinkish Red	30 (B), 125 (D)
R-401B	HCFC	Mustard	30 (B), 125 (D)
R-402A	HCFC	Sand	27 (B), 110 (D)
R-402B	HCFC	Olive	13 (B)
R-408A	HCFC	Medium Purple	24 (B), 100 (D), 1300
R-409A	HCFC	Tan	30 (B), 125 (D), 1800
R-134a	HFC	Light Blue	30 (B), 125 (D), 1000, 1750
R-404A	HFC	Orange	24 (B), 100 (D), 1300 tons
R-407A	HFC	Lime Green	25 (B), 115 (D)
R-407C	HFC	Brown	25 (B), 115 (D), 1000, 1600
R-427A	HFC	Green	25 (B) 110 (D)
R-410A	HFC	Rose	25 (B), 100 (D), 850, 1350
R-507A	HFC	Teal	25 (B), 100 (D), 800, 1400

Container Types

Size not to scale



Forane® Refrigerant Basic Property Data Chart

Properties	R-410A	R-427A	R-407A	R-407C	R-134a	R-404A	R-507A	R-22	R-408A	R-409A	R-123
Average Molecular Weight (g/mol)	72.6	90.4	90.1	86.2	102.0	97.6	98.8	86.5	87.0	97.4	152.9
Normal Boiling Point (NBP) (°F)	-61.9	-44.8	-49.0	-46.1	-14.9	-51.5	-52.8	-41.3	-47.9	-30.1	82.1
Latent Heat of Vaporization at NBP (BTU/lb)	116.7	102.0	101.3	107.4	92.8	86.0	84.3	100.5	97.6	94.6	73.7
Critical Temp (°F)	162.0	185.6	180.1	187.2	214.1	161.6	159.8	204.8	182.6	224.2	362.7
Critical Pressure (psia)	717.9	637.1	654.9	670.1	590.3	539.5	539.5	722.3	629.5	667.2	532.9
Density of Saturated Vapor @ NBP (lb/ft ³)	0.26	0.30	0.30	0.29	0.33	0.34	0.34	0.29	0.30	0.31	0.40
Density of Saturated Liquid at 77°F (lb/ft ³)	66.3	71.9	71.5	71.1	75.3	65.2	65.0	74.5	66.3	75.9	91.3
Specific Heat of Saturated Vapor at NBP (BTU/lb °R)	0.17	0.18	0.18	0.17	0.19	0.18	0.18	0.14	0.16	0.15	0.16
Specific Heat of Saturated Liquid at 77°F (BTU/lb °R)	0.44	0.38	0.36	0.38	0.34	0.39	0.39	0.30	0.37	0.30	0.23
Ozone Depletion Potential (ODP) (CFC-11 = 1.0)	0	0	0	0	0	0	0	0.055	0.026	0.05	0.02
ASHRAE Safety Group Classification	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	B1
Occupational Exposure Limits (8 hr time/wt. Avg.) (ppm)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	50
Global Warming Potential (GWP)	2,100	2,130	2,100	1,800	1,430	3,900	4,000	1,810	2,650	1,290	77

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Arkema Inc.
 2000 Market Street
 Philadelphia, PA 19103-3222
 Tel.: 215-419-7000
 www.arkema-inc.com