Refrigerant Data Summary

This article summarizes key physical, safety, and environmental data for common refrigerants and leading candidates. It includes the latest environmental data from international scientific assessments of stratospheric ozone depletion and global climate change.

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Manufacturers have commercialized more than 50 new refrigerants (including blends) in the last decade, and they are examining additional candidates. Users should expect a number of new introductions as the phaseout approaches for R-22, which now is the most widely used refrigerant. A similar flurry of service fluids occurred with the phaseout of R-12 and R-502; R-12 was the most widely used refrigerant until a few years ago.

This article provides two tables that summarize selected physical, safety, and environmental data for the old and current refrigerants and for leading replacement candidates. The data in the two tables are the same, but are presented in different manners.

Table 1 is sorted by standard refrigerant designations. Table 2 contains the same information sorted by the normal boiling points of the refrigerants. Table 1 lends itself to finding information on a specific refrigerant. The sort order for Table 2 rearranges the refrigerants in coarse proximity of candidacy for similar applications, to facilitate comparisons.

The data in these tables were taken from the ARTI Refrigerant Database, an information system on alternative refrigerants, associated lubricants, and their use in air conditioning and refrigeration.[1] The database consolidates and facilitates access to property, compatibility, safety, environmental, application, and other data.[2] It also provides an extensive bibliographic reference system.

REFRIGERANT DATA TABLES

The parameter descriptions that follow are in the same sequence as presented in the tables, going from the left to the right columns.

Identifiers. The number shown is the standard designation based on those assigned by or recommended for addition to ANSI/ASHRAE Standard 34-1997, *Designation and Safety Classification of Refrigerants*, and pending addenda thereto.[3] These familiar designations are used almost universally, usually preceded by "R-", "R", the word "Refrigerant", composition-designating prefixes (e.g. "CFC-", "HCFC-", "HFC-", or "HC-"), or manufacturer trade names.

The chemical formula indicates the molecular makeup of the single-compound refrigerants, namely those consisting of only one chemical substance. The blend composition is shown for refrigerant blends, namely those consisting of two or more chemicals that are mixed to obtain desired characteristics. The composition consists of two parts. The first identifies the components, in order of increasing normal

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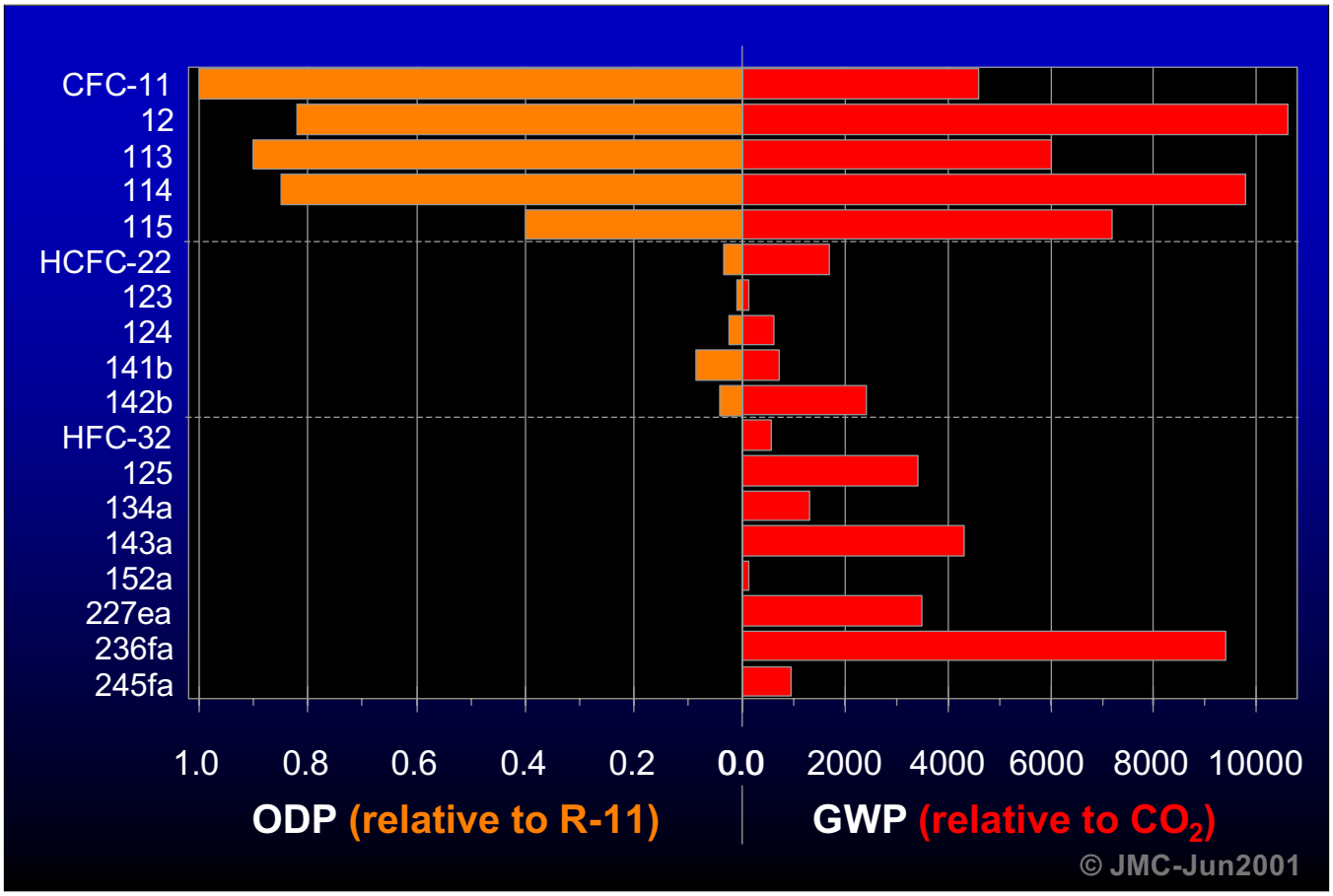

FIGURE 1. Ozone depletion potential (ODP) contrasted to global warming potential (GWP) for key single-compound refrigerants. CFCs generally have high ODP and GWP. HCFCs generally have much lower ODP and GWP. HFCs offer near-zero ODP, but some have comparatively high GWPs.

boiling points and separated by slashes. The second part, which is enclosed in parentheses, indicates the mass fractions (as percentages) of those components in the same order. The tables also indicate the common names by which some refrigerants are frequently identified.

Physical properties. The molecular mass is a calculated value based on the atomic weights recognized by International Union of Pure and Applied Chemists (IUPAC).[4] It indicates the mass in grams of a mole of the refrigerant or, for blends, the mass-weighted average of a mole of the mixture.

The normal boiling point (NBP) is the temperature at which liquid refrigerant boils at standard atmospheric pressure, namely 101.325 kPa (14.6959 psia). The NBP and most dimensional units in the tables are shown in both metric (SI) and inch-pound (IP) units of measure. The bubble point temperature — at which a bubble first appears, hence the temperature at which boiling begins — is shown as the NBP for blends. Unlike single-compound refrigerants that boil at a single temperature for a given pressure, the dissimilar volatilities of components cause mixture boiling to span a range between the bubble point and dewpoint temperatures. The dewpoint is so named because it is the condition at which condensation begins when the blend is cooled.

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The critical temperature (T_c) is the temperature at the critical point of the refrigerant, namely where the properties of the liquid and vapor phases are identical. Unless actually determined, the T_c values shown for blends are the mass weighted averages of the component T_c's, sometimes referred to as the pseudo-critical temperature.

The critical pressure (P_c) is the pressure at the critical point.

The NBP and critical properties suggest the application range for which an individual refrigerant might be suitable. Those with extremely low NBP lend themselves to ultra-low temperature refrigeration, for example in cryogenic applications. Those with high NBPs generally are limited to high-temperature applications, such as chillers and industrial heat pumps. Both capacity and efficiency decline when

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condensing temperatures approach the T_c in a typical vapor-compression (reverse Rankine) cycle, the one most commonly used. The P_c will exceed the operating pressure except in transcritical cycles, which are uncommon except for R-744 (carbon dioxide). It is useful to compare relative operating pressures since practical cycles usually are designed to condense at 70% to 90% of the T_c (on an absolute basis) and, therefore, at corresponding fractions of the P_c.[5]

Safety data. The first value is the occupational exposure limit, namely the Threshold Limit Value - Time Weighted Average (TLV-TWA) or a consistent measure. It is an indication of chronic (long-term, repeat exposure) toxicity of the refrigerant. Two consistent toxicity indices are the Workplace Environmental Exposure level (WEEL) guide and the permissible exposure limit (PEL). Some countries and manufacturers refer to them as the acceptable exposure limit (AEL), industrial exposure limit (IEL), or occupational exposure limit (OEL). These measures indicate adopted limits for workplace exposures for trained personnel for typical workdays and work weeks.

Blends were assigned dual classification such as A1/A2 in the past. That practice changed to the assignment of a single safety group reflecting the worst case of fractionation for specified leak and refill scenarios.

The lower flammability limit (LFL) is the lowest concentration at which the refrigerant burns in air under prescribed test conditions. It is an indication of flammability.

The heat of combustion (HOC) is an indicator of how much energy the refrigerant releases when it burns in air, assuming complete reaction to the most stable products in their vapor state. Negative values indicate endothermic reactions (those that require heat to proceed) while positive values indicate exothermic reactions (those that liberate heat).

The ASHRAE Standard 34 safety group is an assigned classification that is based on the TLV-TWA (or consistent measure), LFL, and HOC. It comprises a letter (A or B) that indicates relative toxicity followed by a number (1, 2, or 3) that indicates relative flammability. These classifications are widely used in mechanical and fire construction codes, to determine requirements to promote safe use. Most of these code provisions are based on ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration." Some of the classifications shown are followed by the lower case letter "r," which signifies that SSPC 34 has recommended *revision* or *addition* of the classification shown, but final approval and/or publication is still pending. Similarly, a "d" indicates pending *deletion*.

Blends were assigned dual classifications such as A1/A2 in the past, to indicate the safety groups both as formulated and for the worst case of fractionation. That practice changed to assignment of a single safety group reflecting the worst case of fractionation for specified leak and refill scenarios.

Environmental data. The atmospheric lifetime (τ_{atm}) is an indication of the average persistence of refrigerant released into the atmosphere until it decomposes, reacts with other chemicals, or is otherwise removed. While τ_{atm} factors into additional environmental parameters, it also is significant in its own right. It suggests atmospheric perseverance and therefore the potential for accumulation of released refrigerants (and other chemicals). Long atmospheric lifetime implies the potential for slow recovery from environmental problems, both those already known and additional concerns that may be identified in the future.

The values shown for the refrigerant lives are composite atmospheric lifetimes. The lifetimes also can be shown separately for the tropospheric (lower atmosphere, where we live), stratospheric (the next layer, where global depletion of ozone is a concern), and higher layers since the atmospheric chemistry changes between layers.

The ozone depletion potential (ODP) is a normalized indicator, based on a value of 1.000 for R-11, of the ability of refrigerants (and other chemicals) to destroy stratospheric ozone molecules. The data shown are the values adopted by international scientific assessment. The ODPs shown for blends are mass-weighted averages.

The ODPs in the tables are modeled ODP values, the most indicative of environmental impacts. There are several other ODP indices, including semi-empirical, time-dependent, and regulatory variations.

Semi-empirical ODPs are calculated values that incorporate adjustments for observed atmospheric measurements. This approach is conceptually more accurate, but it is difficult to measure precisely the data needed for representative adjustments.

Time-dependent ODPs use chemicals other than R-11 as the reference. Normalizing values to short-lived compounds emphasizes near-term impacts, but discounts long-term effects. Time-dependent ODPs are not often cited, particularly since the release of ozone-depleting substances already has peaked and recovery of the stratospheric ozone layer is underway.

Regulatory ODPs generally are old data used to set phaseout steps, determine compliance with the Montreal Protocol, and allocate production quotas in national regulations. Because of the political and competitive complexities in changing consumption targets and production allocations, these values commonly are left unchanged even when newer scientific findings improve the quantification precision. The ODP values listed in the annexes to the Montreal Protocol, for example, have not been updated since 1987 for chlorofluorocarbons (CFCs) and 1992 for hydrochlorofluorocarbons (HCFCs). A note in the protocol indicates that the values "are estimates based on existing knowledge and will be reviewed and revised periodically," but that has not happened yet.[6]

The global warming potential (GWP) is a similar indicator of the potency to warm the planet by action as a greenhouse gas. The values shown are relative to carbon dioxide (CO_2) for an integration period of 100 years. The GWPs shown for blends are mass-weighted averages.

GWP values can be calculated for any desired integration period, commonly referred to as the integration time horizon (ITH). Short ITH periods emphasize immediate effects but overlook later impacts, while long ITH periods incorporate the later effects. The most common GWP values, including those cited herein, are for an ITH of 100 years.

A variant of GWPs includes an offset for cooling (more correctly negative radiative forcing) resulting from ozone destruction related

to the released refrigerant (or other chemical), since ozone is itself a potent greenhouse gas. Once again, the idea behind these net GWPs is conceptually more accurate, but they are not frequently cited since the offset is difficult to quantify with current understanding.

Both the ODP and GWP are calculated from the τ_{atm}, measured chemical properties, and other atmospheric data. The τ_{atm}, ODP, and GWP all should be as low as possible in an ideal refrigerant, but those goals must be assessed along with criteria for performance, safety, and both chemical and thermal stability in use.[5]

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NEW ENVIRONMENTAL DATA

The values for τ_{atm}, ODP, and GWP change as understanding of atmospheric science expands and the chemical kinetics involved become better understood. They also change when newer measurements are made for both specific and reference chemicals and as modeling of atmospheric chemistry improves. These factors have driven periodic reviews and consensus assessments by the scientific community.

The τ_{atm}, ODP, and GWP values shown in Tables 1 and 2 reflect data from the latest international scientific assessments of ozone depletion and climate change, published in February 1999 and June 2001 respectively.[7,8] The tables include additional data from selected scientific publications for refrigerants not addressed in these assessments. The data indicated for blends are calculated values based on data for the components and the nominal compositions.

One reason why readers may see diverging values for environmental data, beyond differences associated with parameter choices and whether the data are current, has to do with accuracy. Some manufacturers and authors round the data, and errors propagate when rounded values are used for blend calculations. Also, some sources mislabel halocarbon or absolute GWP (HGWP and AGWP, respectively) values as GWPs; References 7 and 8 provide further information on these indices.

ACKNOWLEDGMENTS

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TABLE 1. Summary physical, safety, and environmental data for refrigerants (sorted by ASHRAE 34 designation)

refrigerant		physical data							safety data					environmental data		
			NBP		Tc		Pc				HOC			atmos-pheric		
number	chemical formula or blend composition - common name	molec-ular mass	(°C)	(°F)	(°C)	(°F)	(MPa)	(psia)	TLV-TWA (PPM)	LFL (%)	MJ/kg	Btu/lb	Std 34 safety group	life (yr)	ODP	GWP 100 yr
11	CCl3F	137.37	23.7	74.7	198.0	388.4	4.41	640	C1000	none	0.9	387	A1	45	1.000	4600
12B1	CBrClF2 - halon 1211	165.36	-4.0	24.8	154.0	309.2	4.10	595		none				11	5.100	1300
12	CCl2F2	120.91	-29.8	-21.6	112.0	233.6	4.14	600	1000	none	-0.8	-344	A1	100	0.820	10600
13B1	CBrF3 - halon 1301	148.91	-57.7	-71.9	67.1	152.8	3.96	574	1000	none			A1	65	12.000	6900
13	CClF3	104.46	-81.3	-114.3	28.9	84.0	3.88	563	1000	none	-3.0	-1290	A1	640	1.000	14000
13I1	CF3I	195.91	-21.8	-7.2	123.3	253.9	3.95	573		none				<0.1	0.000	1
14	CF4 - carbon tetrafluoride	88.00	-128.1	-198.6	-45.6	-50.1	3.75	544		none			A1	50000	0.000	5700
21	CHCl2F	102.92	8.9	48.0	178.3	352.9	5.18	751	10	none			B1	2.0	0.010	210
22	CHClF2	86.47	-40.8	-41.4	96.2	205.2	4.99	724	1000	none	2.2	946	A1	11.9	0.034	1700
23	CHF3 - fluoroform	70.01	-82.1	-115.8	25.9	78.6	4.84	702	1000	none	-12.5	-5374	A1	260	0.000	12000
30	CH2Cl2 - methylene chloride	84.93	40.2	104.4	237.0	458.6	6.08	882	50	13.0			B2	0.46	0.000	10
31	CH2ClF	68.48	-9.1	15.6					0.1						0.010	
32	CH2F2 - methylene fluoride	52.02	-51.7	-61.1	78.2	172.8	5.80	841	1000	12.7	9.4	4041	A2	5.0	0.000	550
40	CH3Cl - methyl chloride	50.49	-24.2	-11.6	143.1	289.6	6.67	967	50	8.0			B2	1.3	0.020	16
41	CH3F - methyl fluoride	34.03	-78.1	-108.6	44.1	111.4	5.90	856						2.6	0.000	97
50	CH4 - methane	16.04	-161.5	-258.7	-82.6	-116.7	4.60	667	1000	4.8			A3	12.0	0.000	23
113	CCl2FCClF2	187.37	47.6	117.7	214.1	417.4	3.39	492	1000	none	0.1	43	A1	85	0.900	6000
114	CClF2CClF2	170.92	3.6	38.5	145.7	294.3	3.26	473	1000	none	-3.1	-1333	A1	300	0.850	9800
115	CClF2CF3	154.47	-38.9	-38.0	80.0	176.0	3.12	453	1000	none	-2.1	-903	A1	1700	0.400	7200
116	CF3CF3 - perfluoroethane	138.01	-78.2	-108.8	19.9	67.8	3.04	441	1000	none			A1	10000	0.000	11900
123	CHCl2CF3	152.93	27.8	82.0	183.8	362.8	3.66	531	50	none	2.1	903	B1	1.4	0.012	120
124	CHClFCF3	136.48	-12.0	10.4	122.3	252.1	3.62	525	1000	none	0.9	387	A1	6.1	0.026	620
125	CHF2CF3	120.02	-48.1	-54.6	66.2	151.2	3.63	526	1000	none	-1.5	-645	A1	29	0.000	3400
E125	CHF2-O-CF3	136.02	-42.0	-43.6	81.3	178.3	3.35	486						150	0.000	14900
134a	CH2FCF3	102.03	-26.1	-15.0	101.1	214.0	4.06	589	1000	none	4.2	1806	A1	13.8	0.000	1300
E134	CHF2-O-CHF2	118.03	6.2	43.2	160.8	321.4	4.23	614		none				26.2	0.000	6100
141b	CH3CCl2F	116.95	32.0	89.6	204.2	399.6	4.25	616	500	5.8	8.6	3697		9.3	0.086	700
142b	CH3CClF2	100.49	-9.0	15.8	137.2	279.0	4.12	598	1000	6.0	9.8	4213	A2	19	0.043	2400
143a	CH3CF3	84.04	-47.2	-53.0	72.9	163.2	3.78	548	1000	7.0	10.3	4428	A2	52	0.000	4300
E143a	CH3-O-CF3	100.04	-24.1	-11.4	104.9	220.8	3.63	526		flam				4.4	0.000	750
152a	CH3CHF2	66.05	-24.0	-11.2	113.3	235.9	4.52	656	1000	3.7	17.4	7481	A2	1.4	0.000	120
160	CH3CH2Cl - ethyl chloride	64.51	13.1	55.6	187.3	369.1	5.27	764	100	3.6	20.6	8856		<1	0.000	
161	CH3CH2F - ethyl fluoride	48.06	-37.1	-34.8	102.2	216.0	4.70	682		3.8				0.3	0.000	12
170	CH3CH3 - ethane	30.07	-88.9	-128.0	32.2	90.0	4.87	706	1000	2.9			A3		0.000	~20
E170	CH3-O-CH3 - dimethyl ether	46.07	-24.8	-12.6	128.8	263.8	5.32	772	1000	3.3				0.015	0.000	1
218	CF3CF2CF3 - perfluoropropane	188.02	-36.6	-33.9	71.9	161.4	2.68	389	1000	none			A1	2600	0.000	8600
227ea	CF3CHFCF3	170.03	-15.6	3.9	102.8	217.0	2.98	432	1000	none	3.3	1419		33	0.000	3500
236fa	CF3CH2CF3	152.04	-1.4	29.5	124.9	256.8	3.20	464	1000	none			A1	220	0.000	9400
245fa	CHF2CH2CF3	134.05	15.1	59.2	154.1	309.4	4.43	643	300	none	6.1	2623	B1 r	7.2	0.000	950
E245cb1	CH3-O-CF2-CF3	150.05	5.9	42.6	133.7	272.7	2.89	419		flam				4.7	0.000	160
C270	-CH2-CH2-CH2- - cyclopropane	42.08	-33.5	-28.3	125.2	257.4	5.58	809		2.4	49.7	21367			0.000	
290	CH3CH2CH3 ó propane	44.10	-42.2	-44.0	96.7	206.1	4.25	616	2500	2.1	50.3	21625	A3		0.000	~20
C318	-CF2-CF2-CF2-CF2-	200.03	-6.0	21.2	115.2	239.4	2.78	403	1000	none			A1 r	3200	0.000	10000
E347mmy1	CF3-CF(OCH3)-CF3	200.05	29.4	84.9	160.8	321.4	2.55	370						3.4	0.000	330
400 >>	R-12/114 (50.0/50.0) - R-400(50/50)	141.63	-20.8	-5.4	128.9	264.0	3.92	569		none			A1		0.835	10000
400 >>	R-12/114 (60.0/40.0) - R-400(60/40)	136.94	-23.2	-9.8	125.4	257.7	3.99	579		none			A1		0.832	10000
401A	R-22/152a/124 (53.0/13.0/34.0) - MP39	94.44	-34.4	-29.9	105.3	221.5	4.61	669	1000	none			A1		0.027	1100
401B	R-22/152a/124 (61.0/11.0/28.0) - MP66	92.84	-35.7	-32.3	103.5	218.3	4.68	679	1000	none	-2.7	-1161	A1		0.028	1200
401C	R-22/152a/124 (33.0/15.0/52.0) - MP52	101.03	-30.5	-22.9	109.9	229.8	4.40	638		none			A1		0.025	900
402A	R-125/290/22 (60.0/2.0/38.0) - HP80	101.55	-49.2	-56.6	76.0	168.8	4.23	614	1000	none	-1.4	-602	A1		0.013	2700
402B	R-125/290/22 (38.0/2.0/60.0) - HP81	94.71	-47.2	-53.0	83.0	181.4	4.53	657	1000	none	-1.6	-688	A1		0.020	2300
403A	R-290/22/218 (5.0/75.0/20.0) - 69-S	91.99	-44.0	-47.2	91.2	196.2	4.69	680	1000	none			A1		0.026	3000
403B	R-290/22/218 (5.0/56.0/39.0) - 69-L	103.26	-43.8	-46.8	88.7	191.7	4.40	638	1000	none			A1		0.019	4300
404A	R-125/143a/134a (44.0/52.0/4.0) - HP62 and FX-70	97.60	-46.6	-51.9	72.1	161.8	3.74	542	none	none	-6.6	-2837	A1		0.000	3800
405A	R-22/152a/142b/C318 (45.0/7.0/5.5/42.5) - G2015	111.91	-32.9	-27.2	106.0	222.8	4.29	622	1000	none			d		0.018	5200
406A	R-22/600a/142b (55.0/4.0/41.0) - GHG	89.86	-32.7	-26.9	116.5	241.7	4.88	708		none			A2		0.036	1900
407A	R-32/125/134a (20.0/40.0/40.0) - Klea 60	90.11	-45.2	-49.4	81.9	179.4	4.49	651	none	none	-3.6	-1548	A1		0.000	2000
407B	R-32/125/134a (10.0/70.0/20.0) - Klea 61	102.94	-46.8	-52.2	74.4	165.9	4.08	592	none	none	-1.8	-774	A1		0.000	2700
407C	R-32/125/134a (23.0/25.0/52.0) - Klea 66; Suva 9000	86.20	-43.8	-46.8	87.3	189.1	4.63	672	none	none	-4.9	-2107	A1		0.000	1700
407D	R-32/125/134a (15.0/15.0/70.0)	90.96	-39.4	-38.9	91.6	196.9	4.48	650	none	none	-4.3	-1849	A1		0.000	1500
407E	R-32/125/134a (25.0/15.0/60.0)	83.78	-42.8	-45.0	88.8	191.8	4.73	686	none	none	-4.8	-2064	A1		0.000	1400
408A	R-125/143a/22 (7.0/46.0/47.0) - FX-10	87.01	-45.5	-49.9	83.3	181.9	4.42	641	1000	none	5.7	2451	A1		0.016	3000
409A	R-22/124/142b (60.0/25.0/15.0) - FX-56	97.43	-35.4	-31.7	106.9	224.4	4.69	680	1000	none	3.0	1290	A1		0.039	1500
409B	R-22/124/142b (65.0/25.0/10.0) - FX-57	96.67	-36.5	-33.7	104.4	219.9	4.71	683		none			A1		0.033	1500
410A	R-32/125 (50.0/50.0) - Suva 9100; AZ-20	72.58	-51.6	-60.9	72.5	162.5	4.95	718	none	none	-4.4	-1892	A1		0.000	2000
410B	R-32/125 (45.0/55.0)	75.57	-51.5	-60.7	71.0	159.8	4.78	693		none			A1		0.000	2100
411A	R-1270/22/152a (1.5/87.5/11.0)	82.36	-39.7	-39.5	99.1	210.4	4.95	718	1000	none			A2		0.030	1500
411B	R-1270/22/152a (3.0/94.0/3.0)	83.07	-41.6	-42.9	96.0	204.8	4.95	718	1000	none	6.5	2794	A2		0.032	1600
----	R-1270/22/152a (3.0/95.5/1.5) - G2018C; proposed as R-411C	83.44	-41.8	-43.2	95.5	203.9	4.95	718		none			A1 r		0.032	1600
412A	R-22/218/142b (70.0/5.0/25.0) - Arcton TP5R	92.17	-36.4	-33.5	107.5	225.5	4.88	708	1000	none			A2		0.035	2200
413A	R-218/134a/600a (9.0/88.0/3.0) - ISCEON 49	103.95	-29.3	-20.7	101.4	214.5	4.24	615		wff			A2		0.000	1900
414A	R-22/124/600a/142b (51.0/28.5/4.0/16.5) - GHG-X4	96.93	-34.0	-29.2	110.7	231.3	4.70	682	1000		3.6	1548	A1		0.032	1400

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Refrigerant Data Summary

TABLE 1 continued. Summary physical, safety, and environmental data for refrigerants (sorted by ASHRAE 34 designation)

refrigerant number	chemical formula or blend composition - common name	molecular mass	physical data: NBP (°C)	NBP (°F)	Tc (°C)	Tc (°F)	Pc (MPa)	Pc (psia)	safety data: TLV-TWA (PPM)	LFL (%)	HOC MJ/kg	HOC Btu/lb	Std 34 safety group	environmental data: atmospheric life (yr)	ODP	GWP 100yr
414B	R-22/124/600a/142b (50.0/39.0/1.5/9.5) - HOT SHOT	101.59	-34.4	-29.9	108.0	226.4	4.59	666		none			A1 r		0.031	1300
416A	R-134a/124/600 (59.0/39.5/1.5) - FR-12	111.92	-23.4	-10.1	108.2	226.8	4.02	583			7.8	3353	A1 r		0.010	1000
417A	R-125/134a/600 (46.6/50.0/3.4) - Isceon 59; NU-22	106.75	-38.0	-36.4	89.9	193.8	4.10	595		none			A1 r		0.000	2200
----	R-22/124/600 (50.0/47.0/3.0) - DI-36	102.64	-34.8	-30.6	102.6	216.7	4.56	661	900	none					0.029	1100
----	R-22/142b (40.0/60.0)	94.37	-27.9	-18.2	123.1	253.6	4.72	685		wff					0.039	2100
----	R-22/142b (60.0/40.0)	91.58	-33.4	-28.1	114.8	238.6	4.90	711		wff					0.038	2000
----	R-22/152a (52.0/48.0) - THR01	75.30	-32.2	-26.0	108.0	226.4	4.82	699	1000	12.4	9.7	4170			0.018	940
----	R-22/152a (60.0/40.0)	76.95	-33.6	-28.5	106.7	224.1	4.86	705	1000	none	16.2	6965			0.020	1100
----	R-22/152a (82.0/18.0)	81.91	-37.6	-35.7	101.9	215.4	4.96	719		5.6	2.7	1161			0.028	1400
----	R-23/125/143a (20.0/36.0/44.0) - ES20	90.16	-64.8	-84.6	67.3	153.1	4.03	585							0.000	5500
----	R-23/22/152a (5.0/65.0/30.0) - NARM-12	78.29	-44.8	-48.6	100.8	213.4	4.95	718							0.022	1700
----	R-23/22/152a (5.0/80.0/15.0) - NARM-22	81.72	-47.0	-52.6	97.2	207.0	5.04	731	1000	none					0.027	2000
----	R-23/22/152a (5.0/90.0/5.0) - NARM-502	84.18	-48.4	-55.1	94.4	201.9	5.10	740	1000	none					0.031	2100
----	R-23/32/134a (4.5/21.5/74.0) - FX-220	83.14	-42.2	-44.0	89.0	192.2	4.90	711		none					0.000	1600
----	R-32/125/134a/600 (10.0/42.0/45.0/3.0)	96.64	-42.2	-44.0	87.2	189.0	4.40	638							0.000	2100
----	R-32/125/143a (10.0/45.0/45.0) - FX-40	90.69	-48.4	-55.1	72.0	161.6	4.05	587		none					0.000	3500
----	R-32/125/143a/134a (2.0/41.0/50.0/7.0) - FX-48B	95.82	-46.8	-52.2	72.9	163.2	3.81	553		none					0.000	3600
----	R-32/125/143a/134a (10.0/33.0/36.0/21.0) - HX4	90.80	-49.4	-56.9	77.5	171.5	4.01	582		none					0.000	3000
----	R-32/134a (25.0/75.0)	82.26	-40.3	-40.5	93.7	200.7	4.83	701	compo	wff					0.000	1100
----	R-32/134a (30.0/70.0)	79.19	-41.8	-43.2	92.4	198.3	4.94	716	compo	wff					0.000	1100
----	R-125/22 (70.0/30.0) - FX-20	107.51	-47.4	-53.3	73.7	164.7	4.04	586		none					0.010	2900
----	R-125/134a/152a (35.0/40.0/25.0) - GHG-X8	94.15	-35.0	-31.0	95.5	203.9	4.14	600	1000	wff					0.000	1700
----	R-125/143a/290/22 (42.0/6.0/2.0/50.0) - DI-44	95.70	-47.7	-53.9	81.0	177.8	4.45	645	1000	none					0.017	2500
----	R-125/152a/227ea (40.0/5.0/55.0) - GHG-X7	136.53	-38.6	-37.5	87.2	189.0	3.58	519	1000	none					0.000	3300
----	R-134a/142b (80.0/20.0)	101.71	-24.1	-11.4	107.5	225.5	4.12	598							0.010	1500
----	R-134a/142b (80.6/19.4) - RB276	101.73	-24.2	-11.6	107.3	225.1	4.12	598		none					0.008	1500
----	R-161/13I1 (80.0/20.0)	56.60													0.000	9.8
----	R-161/218/1311 (65.4/18.2/16.4)	64.88													0.000	1600
----	R-170/290 (6.0/94.0) - ER22/502	42.90	-50.0	-58.0	91.2	196.2	4.29	622		1.9					0.000	~20
----	R-218/134a/600 (32.7/62.8/4.5)	115.36	-31.4	-24.5	99.8	211.6	4.15	602							0.000	3600
----	R-290/600a (50.0/50.0)	50.15	-32.8	-27.0	114.8	238.6	4.04	586		2.0	49.8	21410			0.000	~20
----	R-600a/600 (50.0/50.0) - isobutane/butane	58.12	-6.5	20.3	143.6	290.5	3.73	541		1.6					0.000	~20
500	R-12/152a (73.8/26.2)	99.30	-33.6	-28.5	102.1	215.8	4.17	605	1000	none			A1		0.605	7900
501	R-22/12 (75.0/25.0)	93.10	-40.5	-40.9	96.2	205.2	4.76	690		none			A1		0.231	3900
502	R-22/115 (48.8/51.2)	111.63	-45.3	-49.5	80.7	177.3	4.02	583	1000	none			A1		0.221	4500
503	R-23/13 (40.1/59.9)	87.25	-87.5	-125.5	18.4	65.1	4.27	619	1000	none					0.599	13000
504	R-32/115 (48.2/51.8)	79.25	-57.7	-71.9	62.1	143.8	4.44	644		none					0.207	4000
505	R-12/31 (78.0/22.0)	103.48	-30.0	-22.0	117.8	244.0	4.73	686		none					0.642	
506	R-31/114 (55.1/44.9)	93.69	-12.3	9.9	142.2	288.0	5.16	748		none					0.387	
507A	R-125/143a (50.0/50.0) - AZ-50	98.86	-47.1	-52.8	70.9	159.6	3.79	550	none	none	-5.5	-2365	A1		0.000	3900
508A	R-23/116 (39.0/61.0) - Klea 5R3	100.10	-87.4	-125.3	11.0	51.8	3.70	537	1000	none			A1		0.000	12000
508B	R-23/116 (46.0/54.0) - Suva 95	95.39	-87.4	-125.3	14.0	57.2	3.93	570	1000	none			A1		0.000	12000
509A	R-22/218 (44.0/56.0) - Arcton TP5R2	123.96	-40.4	-40.7	87.2	189.0	4.03	585	1000	none			A1		0.015	5600
----	R-134a/600a (80.0/20.0) - Electrolux RC	88.64	-29.5	-21.1	111.3	232.3	4.81	698		3.9					0.000	1000
----	R-218/152a (83.5/16.5)	144.11	-34.8	-30.6	86.8	188.2	3.38	490							0.000	7200
----	R-32/600 (90.0/10.0)	52.58	-51.2	-60.2	84.8	184.6	6.15	892	R-32	flam					0.000	500
----	R-32/600 (95.0/5.0)	52.30	-51.4	-60.5	81.4	178.5	5.99	869	R-32	flam					0.000	520
----	R-32/600a (90.0/10.0)	52.58	-53.1	-63.6	83.2	181.8	6.30	914	R-32	flam					0.000	500
----	R-32/600a (95.0/5.0)	52.30	-52.7	-62.9	80.7	177.3	6.07	880	R-32	flam					0.000	520
600	CH3-CH2-CH2-CH3 - butane	58.12	-0.5	31.1	152.0	305.6	3.80	551	800	1.5	49.5	21281	A3		0.000	~20
600a	CH(CH3)2-CH3 - isobutane	58.12	-11.7	10.9	134.7	274.5	3.64	528	800	1.7	49.4	21238	A3		0.000	~20
601	CH3-CH2-CH2-CH2-CH3 - pentane	72.15	36.0	96.8	196.6	385.9	3.37	489	600	1.4				<<1	0.000	11
601a	(CH3)2CH-CH2-CH3 - isopentane	72.15	27.8	82.0	187.8	370.0	3.39	492	600	1.0					0.000	
610	CH3-CH2-O-CH2-CH3 - ethyl ether	74.12	34.6	94.3	214.0	417.2	6.00	870	400	1.9					0.000	
611	HCOOCH3 - methyl formate	60.05	31.8	89.2	214.0	417.2	5.99	869	100	4.5			B2		0.000	
630	CH3(NH2) - methylamine	31.06	-6.7	19.9	156.9	314.4	7.46	1082	5	4.9					0.000	
631	CH3-CH2(NH2) - ethylamine	45.08	16.6	61.9	183.0	361.4	5.62	815	5	3.5					0.000	
704	He - helium	4.00	-268.9	-452.0	-267.9	-450.2	0.23	33		none			A1		0.000	
717	NH3 - ammonia	17.03	-33.3	-27.9	132.3	270.1	11.34	1645	25	15.0	22.5	9673	B2		0.000	<1
718	H2O - water	18.02	100.0	212.0	373.9	705.0	22.06	3200		none			A1		0.000	<1
729	air	28.97	-194.4	-317.9	-140.7	-221.3	3.77	547		none					0.000	0
744	CO2 - carbon dioxide	44.01	-78.4	-109.1	31.1	88.0	7.38	1070	5000	none			A1	>50	0.000	1
764	SO2 - sulfur dioxide	64.06	-10.0	14.0	157.5	315.5	7.88	1143	2	none			B1		0.000	
1130	CHCl=CHCl - dielene	96.94	47.8	118.0	243.3	469.9	5.48	795	200	5.6						
1150	CH2=CH2 - ethylene	28.05	-109.4	-164.9	9.2	48.6	5.04	731	1000	2.3			A3		0.000	
1270	CH3CH=CH2 - propylene	42.08	-47.7	-53.9	92.4	198.3	4.67	677	660	2.0			A3		0.000	~20

NBP = normal boiling point; Tc = critical temperature; Pc = critical pressure; TLV = ACGIH Threshold Limit Value or consistent chronic occupational exposure limit, such as AIHA Workplace Environmental Exposure Level (WEEL) or OSHA Permissible Exposure Limit (PEL), as Time-Weighted Average (TWA) unless value is preceded by C for Ceiling; LFL = lower flammability limit (% volume in air), "wff" signifies that the worst case of fractionation may become flammable; HOC = heat of combustion; ODP = ozone depletion potential (modeled); GWP = global warming potential (for 100 yr integration)

Suffixes to safety classifications indicate recommended changes that are not final yet ("d" for deletion and "r" for revision or addition) or classifications assigned as provisional ("p").

Data sources are identified in the Refrigerant Database; verify the data and associated limitations in those sources before use.

Refrigerant Data Summary

TABLE 2. Summary physical, safety, and environmental data for refrigerants (sorted by normal boiling point)

refrigerant		physical data							safety data					environmental data†		
			NBP		Tc		Pc			HOC				atmos-pheric		
number	chemical formula or blend composition - common name	molec-ular mass	(°C)	(°F)	(°C)	(°F)	(MPa)	(psia)	TLV-TWA (PPM)	LFL (%)	MJ/kg	Btu/lb	Std 34 safety group	life (yr)	ODP	GWP 100 yr
704	He - helium	4.00	-268.9	-452.0	-267.9	-450.2	0.23	33		none			A1		0.000	
729	air	28.97	-194.4	-317.9	-140.7	-221.3	3.77	547		none					0.000	0
50	CH4 - methane	16.04	-161.5	-258.7	-82.6	-116.7	4.60	667	1000	4.8			A3	12.0	0.000	23
14	CF4 - carbon tetrafluoride	88.00	-128.1	-198.6	-45.6	-50.1	3.75	544		none			A1	50000	0.000	5700
1150	CH2=CH2 - ethylene	28.05	-109.4	-164.9	9.2	48.6	5.04	731	1000	2.3			A3		0.000	
170	CH3CH3 - ethane	30.07	-88.9	-128.0	32.2	90.0	4.87	706	1000	2.9			A3		0.000	~20
503	R-23/13 (40.1/59.9)	87.25	-87.5	-125.5	18.4	65.1	4.27	619	1000	none					0.599	13000
508A	R-23/116 (39.0/61.0) - Klea 5R3	100.10	-87.4	-125.3	11.0	51.8	3.70	537	1000	none			A1		0.000	12000
508B	R-23/116 (46.0/54.0) - Suva 95	95.39	-87.4	-125.3	14.0	57.2	3.93	570	1000	none			A1		0.000	12000
23	CHF3 - fluoroform	70.01	-82.1	-115.8	25.9	78.6	4.84	702	1000	none	-12.5	-5374	A1	260	0.000	12000
13	CClF3	104.46	-81.3	-114.3	28.9	84.0	3.88	563	1000	none	-3.0	-1290	A1	640	1.000	14000
744	CO2 - carbon dioxide	44.01	-78.4	-109.1	31.1	88.0	7.38	1070	5000	none			A1	>50	0.000	1
116	CF3CF3 - perfluoroethane	138.01	-78.2	-108.8	19.9	67.8	3.04	441	1000	none			A1	10000	0.000	11900
41	CH3F - methyl fluoride	34.03	-78.1	-108.6	44.1	111.4	5.90	856						2.6	0.000	97
----	R-23/125/143a (20.0/36.0/44.0) - ES20	90.16	-64.8	-84.6	67.3	153.1	4.03	585							0.000	5500
13B1	CBrF3 - halon 1301	148.91	-57.7	-71.9	67.1	152.8	3.96	574	1000	none			A1	65	12.000	6900
504	R-32/115 (48.2/51.8)	79.25	-57.7	-71.9	62.1	143.8	4.44	644		none					0.207	4000
----	R-32/600a (90.0/10.0)	52.58	-53.1	-63.6	83.2	181.8	6.30	914	R-32	flam					0.000	500
----	R-32/600a (95.0/5.0)	52.30	-52.7	-62.9	80.7	177.3	6.07	880	R-32	flam					0.000	520
32	CH2F2 - methylene fluoride	52.02	-51.7	-61.1	78.2	172.8	5.80	841	1000	12.7	9.4	4041	A2	5.0	0.000	550
410A	R-32/125 (50.0/50.0) - Suva 9100; AZ-20	72.58	-51.6	-60.9	72.5	162.5	4.95	718	none	none	-4.4	-1892	A1		0.000	2000
410B	R-32/125 (45.0/55.0)	75.57	-51.5	-60.7	71.0	159.8	4.78	693		none			A1		0.000	2100
----	R-32/600 (95.0/5.0)	52.30	-51.4	-60.5	81.4	178.5	5.99	869	R-32	flam					0.000	520
----	R-32/600 (90.0/10.0)	52.58	-51.2	-60.2	84.8	184.6	6.15	892	R-32	flam					0.000	500
----	R-170/290 (6.0/94.0) - ER22/502	42.90	-50.0	-58.0	91.2	196.2	4.29	622		1.9					0.000	~20
----	R-32/125/143a/134a (10.0/33.0/36.0/21.0) - HX4	90.80	-49.4	-56.9	77.5	171.5	4.01	582		none					0.000	3000
402A	R-125/290/22 (60.0/2.0/38.0) - HP80	101.55	-49.2	-56.6	76.0	168.8	4.23	614	1000	none	-1.4	-602	A1		0.013	2700
----	R-23/22/152a (5.0/90.0/5.0) - NARM-502	84.18	-48.4	-55.1	94.4	201.9	5.10	740	1000	none					0.031	2100
----	R-32/125/143a (10.0/45.0/45.0) - FX-40	90.69	-48.4	-55.1	72.0	161.6	4.05	587		none					0.000	3500
125	CHF2CF3	120.02	-48.1	-54.6	66.2	151.2	3.63	526	1000	none	-1.5	-645	A1	29	0.000	3400
1270	CH3CH=CH2 - propylene	42.08	-47.7	-53.9	92.4	198.3	4.67	677	660	2.0			A3		0.000	~20
----	R-125/143a/290/22 (42.0/6.0/2.0/50.0) - DI-44	95.70	-47.7	-53.9	81.0	177.8	4.45	645	1000	none					0.017	2500
----	R-125/22 (70.0/30.0) - FX-20	107.51	-47.4	-53.3	73.7	164.7	4.04	586		none					0.010	2900
143a	CH3CF3	84.04	-47.2	-53.0	72.9	163.2	3.78	548	1000	7.0	10.3	4428	A2	52	0.000	4300
402B	R-125/290/22 (38.0/2.0/60.0) - HP81	94.71	-47.2	-53.0	83.0	181.4	4.53	657	1000	none	-1.6	-688	A1		0.020	2300
507A	R-125/143a (50.0/50.0) - AZ-50	98.86	-47.1	-52.8	70.9	159.6	3.79	550	none	none	-5.5	-2365	A1		0.000	3900
----	R-23/22/152a (5.0/80.0/15.0) - NARM-22	81.72	-47.0	-52.6	97.2	207.0	5.04	731	1000	none					0.027	2000
407B	R-32/125/134a (10.0/70.0/20.0) - Klea 61	102.94	-46.8	-52.2	74.4	165.9	4.08	592	none	none	-1.8	-774	A1		0.000	2700
----	R-32/125/143a/134a (2.0/41.0/50.0/7.0) - FX-48B	95.82	-46.8	-52.2	72.9	163.2	3.81	553		none					0.000	3600
404A	R-125/143a/134a (44.0/52.0/4.0) - HP62 and FX-70	97.60	-46.6	-51.9	72.1	161.8	3.74	542	none	none	-6.6	-2837	A1		0.000	3800
408A	R-125/143a/22 (7.0/46.0/47.0) - FX-10	87.01	-45.5	-49.9	83.3	181.9	4.42	641	1000	none	5.7	2451	A1		0.016	3000
502	R-22/115 (48.8/51.2)	111.63	-45.3	-49.5	80.7	177.3	4.02	583	1000	none			A1		0.221	4500
407A	R-32/125/134a (20.0/40.0/40.0) - Klea 60	90.11	-45.2	-49.4	81.9	179.4	4.49	651	none	none	-3.6	-1548	A1		0.000	2000
----	R-23/22/152a (5.0/65.0/30.0) - NARM-12	78.29	-44.8	-48.6	100.8	213.4	4.95	718							0.022	1700
403A	R-290/22/218 (5.0/75.0/20.0) - 69-S	91.99	-44.0	-47.2	91.2	196.2	4.69	680	1000	none			A1		0.026	3000
403B	R-290/22/218 (5.0/56.0/39.0) - 69-L	103.26	-43.8	-46.8	88.7	191.7	4.40	638	1000	none			A1		0.019	4300
407C	R-32/125/134a (23.0/25.0/52.0) - Klea 66; Suva 9000	86.20	-43.8	-46.8	87.3	189.1	4.63	672	none	none	-4.9	-2107	A1		0.000	1700
407E	R-32/125/134a (25.0/15.0/60.0)	83.78	-42.8	-45.0	88.8	191.8	4.73	686	none	none	-4.8	-2064	A1		0.000	1400
----	R-23/32/134a (4.5/21.5/74.0) - FX-220	83.14	-42.2	-44.0	89.0	192.2	4.90	711		none					0.000	1600
290	CH3CH2CH3 - propane	44.10	-42.2	-44.0	96.7	206.1	4.25	616	2500	2.1	50.3	21625	A3		0.000	~20
----	R-32/125/134a/600 (10.0/42.0/45.0/3.0)	96.64	-42.2	-44.0	87.2	189.0	4.40	638							0.000	2100
E125	CHF2-O-CF3	136.02	-42.0	-43.6	81.3	178.3	3.35	486						150	0.000	14900
----	R-32/134a (30.0/70.0)	79.19	-41.8	-43.2	92.4	198.3	4.94	716	compo	wff					0.000	1100
----	R-1270/22/152a (3.0/95.5/1.5) - G2018C	83.44	-41.8	-43.2	95.5	203.9	4.95	718		none			A1 r		0.032	1600
----	R-290/22/152a (1.5/96.0/2.5)	84.60	-41.7	-43.1	96.2	205.2	4.98	722		8.9	1.7	731			0.033	1600
411B	R-1270/22/152a (3.0/94.0/3.0)	83.07	-41.6	-42.9	96.0	204.8	4.95	718	1000	none	6.5	2794	A2		0.032	1600
22	CHClF2	86.47	-40.8	-41.4	96.2	205.2	4.99	724	1000	none	2.2	946	A1	11.9	0.034	1700
501	R-22/12 (75.0/25.0)	93.10	-40.5	-40.9	96.2	205.2	4.76	690		none			A1		0.231	3900
509A	R-22/218 (44.0/56.0) - Arcton TP5R2	123.96	-40.4	-40.7	87.2	189.0	4.03	585	1000	none			A1		0.015	5600
----	R-32/134a (25.0/75.0)	82.26	-40.3	-40.5	93.7	200.7	4.83	701	compo	wff					0.000	1100
411A	R-1270/22/152a (1.5/87.5/11.0)	82.36	-39.7	-39.5	99.1	210.4	4.95	718	1000	none			A2		0.030	1500
407D	R-32/125/134a (15.0/15.0/70.0)	90.96	-39.4	-38.9	91.6	196.9	4.48	650	none	none	-4.3	-1849	A1		0.000	1500
115	CClF2CF3	154.47	-38.9	-38.0	80.0	176.0	3.12	453	1000	none	-2.1	-903	A1	1700	0.400	7200
----	R-125/152a/227ea (40.0/5.0/55.0) - GHG-X7	136.53	-38.6	-37.5	87.2	189.0	3.58	519	1000	none					0.000	3300
417A	R-125/134a/600 (46.6/50.0/3.4) - Isceon 59; NU-22	106.75	-38.0	-36.4	89.9	193.8	4.10	595		none			A1 r		0.000	2200
----	R-22/152a (82.0/18.0)	81.91	-37.6	-35.7	101.9	215.4	4.96	719		5.6	2.7	1161			0.028	1400
161	CH3CH2F - ethyl fluoride	48.06	-37.1	-34.8	102.2	216.0	4.70	682		3.8				0.3	0.000	12
218	CF3CF2CF3 - perfluoropropane	188.02	-36.6	-33.9	71.9	161.4	2.68	389	1000	none			A1	2600	0.000	8600
409B	R-22/124/142b (65.0/25.0/10.0) - FX-57	96.67	-36.5	-33.7	104.4	219.9	4.71	683		none			A1		0.033	1500

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Refrigerant Data Summary

TABLE 2 continued. Summary physical, safety, and environmental data for refrigerants (sorted by normal boiling point).

refrigerant		physical data								safety data				environmental data		
			NBP		Tc		Pc				HOC			atmos-pheric		
number	chemical formula or blend composition - common name	molec-ular mass	(˚C)	(˚F)	(˚C)	(˚F)	(MPa)	(psia)	TLV-TWA (PPM)	LFL (%)	MJ/kg	Btu/lb	Std 34 safety group	life (yr)	ODP	GWP 100 yr
412A	R-22/218/142b (70.0/5.0/25.0) - Arcton TP5R	92.17	-36.4	-33.5	107.5	225.5	4.88	708	1000	none			A2		0.035	2200
401B	R-22/152a/124 (61.0/11.0/28.0) - MP66	92.84	-35.7	-32.3	103.5	218.3	4.68	679	1000	none	-2.7	-1161	A1		0.028	1200
409A	R-22/124/142b (60.0/25.0/15.0) - FX-56	97.43	-35.4	-31.7	106.9	224.4	4.69	680	1000	none	3.0	1290	A1		0.039	1500
----	R-125/134a/152a (35.0/40.0/25.0) - GHG-X8	94.15	-35.0	-31.0	95.5	203.9	4.14	600	1000	wff					0.000	1700
----	R-218/152a (83.5/16.5)	144.11	-34.8	-30.6	86.8	188.2	3.38	490							0.000	7200
----	R-22/124/600 (50.0/47.0/3.0) - DI-36	102.64	-34.8	-30.6	102.6	216.7	4.56	661	900	none					0.029	1100
401A	R-22/152a/124 (53.0/13.0/34.0) - MP39	94.44	-34.4	-29.9	105.3	221.5	4.61	669	1000	none			A1		0.027	1100
414B	R-22/124/600a/142b (50.0/39.0/1.5/9.5) - HOT SHOT	101.59	-34.4	-29.9	108.0	226.4	4.59	666		none			A1 r		0.031	1300
414A	R-22/124/600a/142b (51.0/28.5/4.0/16.5) - GHG-X4	96.93	-34.0	-29.2	110.7	231.3	4.70	682	1000		3.6	1548	A1		0.032	1400
----	R-22/152a (60.0/40.0)	76.95	-33.6	-28.5	106.7	224.1	4.86	705	1000	none	16.2	6965			0.020	1100
500	R-12/152a (73.8/26.2)	99.30	-33.6	-28.5	102.1	215.8	4.17	605	1000	none			A1		0.605	7900
C270	-CH2-CH2-CH2- - cyclopropane	42.08	-33.5	-28.3	125.2	257.4	5.58	809		2.4	49.7	21367			0.000	
6666	R-22/142b (60.0/40.0)	91.58	-33.4	-28.1	114.8	238.6	4.90	711		wff					0.038	2000
717	NH3 - ammonia	17.03	-33.3	-27.9	132.3	270.1	11.34	1645	25	15.0	22.5	9673	B2		0.000	<1
405A	R-22/152a/142b/C318 (45.0/7.0/5.5/42.5) - G2015	111.91	-32.9	-27.2	106.0	222.8	4.29	622	1000	none			d		0.018	5200
----	R-290/600a (50.0/50.0)	50.15	-32.8	-27.0	114.8	238.6	4.04	586		2.0	49.8	21410			0.000	~20
406A	R-22/600a/142b (55.0/4.0/41.0) - GHG	89.86	-32.7	-26.9	116.5	241.7	4.88	708		none			A2		0.036	1900
----	R-22/152a (52.0/48.0) - THR01	75.30	-32.2	-26.0	108.0	226.4	4.82	699	1000	12.4	9.7	4170			0.018	940
----	R-218/134a/600 (32.7/62.8/4.5) - CM1	115.36	-31.4	-24.5	99.8	211.6	4.15	602							0.000	3600
401C	R-22/152a/124 (33.0/15.0/52.0) - MP52	101.03	-30.5	-22.9	109.9	229.8	4.40	638		none			A1		0.025	900
505	R-12/31 (78.0/22.0)	103.48	-30.0	-22.0	117.8	244.0	4.73	686		none					0.642	
12	CCl2F2	120.91	-29.8	-21.6	112.0	233.6	4.14	600	1000	none	-0.8	-344	A1	100	0.820	10600
----	R-134a/600a (80.0/20.0) - Electrolux RC	88.64	-29.5	-21.1	111.3	232.3	4.81	698		3.9					0.000	1000
413A	R-218/134a/600a (9.0/88.0/3.0) - ISCEON 49	103.95	-29.3	-20.7	101.4	214.5	4.24	615		wff			A2		0.000	1900
----	R-22/142b (40.0/60.0)	94.37	-27.9	-18.2	123.1	253.6	4.72	685		wff					0.039	2100
134a	CH2FCF3	102.03	-26.1	-15.0	101.1	214.0	4.06	589	1000	none	4.2	1806	A1	13.8	0.000	1300
E170	CH3-O-CH3 - dimethyl ether	46.07	-24.8	-12.6	128.8	263.8	5.32	772	1000	3.3				0.015	0.000	1
----	R-134a/142b (80.6/19.4) - RB-276	101.73	-24.2	-11.6	107.3	225.1	4.12	598		none					0.008	1500
40	CH3Cl - methyl chloride	50.49	-24.2	-11.6	143.1	289.6	6.67	967	50	8.0			B2	1.3	0.020	16
----	R-134a/142b (80.0/20.0)	101.71	-24.1	-11.4	107.5	225.5	4.12	598							0.010	1500
E143a	CH3-O-CF3	100.04	-24.1	-11.4	104.9	220.8	3.63	526		flam				4.4	0.000	750
152a	CH3CHF2	66.05	-24.0	-11.2	113.3	235.9	4.52	656	1000	3.7	17.4	7481	A2	1.4	0.000	120
416A	R-134a/124/600 (59.0/39.5/1.5)	111.92	-23.4	-10.1	108.2	226.8	4.02	583			7.8	3353	A1 r		0.010	1000
400 >>	R-12/114 (60.0/40.0) - R-400(60/40)	136.94	-23.2	-9.8	125.4	257.7	3.99	579		none			A1		0.832	10000
13I1	CF3I	195.91	-21.8	-7.2	123.3	253.9	3.95	573		none				<0.1	0.000	1
400 >>	R-12/114 (50.0/50.0) - R-400(50/50)	141.63	-20.8	-5.4	128.9	264.0	3.92	569		none			A1		0.835	10000
227ea	CF3CHFCF3	170.03	-15.6	3.9	102.8	217.0	2.98	432	1000	none	3.3	1419		33	0.000	3500
506	R-31/114 (55.1/44.9)	93.69	-12.3	9.9	142.2	288.0	5.16	748		none					0.387	
124	CHClFCF3	136.48	-12.0	10.4	122.3	252.1	3.62	525	1000	none	0.9	387	A1	6.1	0.026	620
600a	CH(CH3)2-CH3 - isobutane	58.12	-11.7	10.9	134.7	274.5	3.64	528	800	1.7	49.4	21238	A3		0.000	~20
764	SO2 - sulfur dioxide	64.06	-10.0	14.0	157.5	315.5	7.88	1143	2	none			B1		0.000	
31	CH2ClF	68.48	-9.1	15.6					0.1						0.010	
142b	CH3CClF2	100.49	-9.0	15.8	137.2	279.0	4.12	598	1000	6.0	9.8	4213	A2	19	0.043	2400
630	CH3(NH2) - methylamine	31.06	-6.7	19.9	156.9	314.4	7.46	1082	5	4.9					0.000	
----	R-600a/600 (50.0/50.0) - isobutane/butane	58.12	-6.5	20.3	143.6	290.5	3.73	541		1.6					0.000	~20
C318	-CF2-CF2-CF2-CF2-	200.03	-6.0	21.2	115.2	239.4	2.78	403	1000	none			A1 r	3200	0.000	10000
12B1	CBrClF2 - halon 1211	165.36	-4.0	24.8	154.0	309.2	4.10	595		none				11	5.100	1300
236fa	CF3CH2CF3	152.04	-1.4	29.5	124.9	256.8	3.20	464	1000	none			A1	220	0.000	9400
600	CH3-CH2-CH2-CH3 - butane	58.12	-0.5	31.1	152.0	305.6	3.80	551	800	1.5	49.5	21281	A3		0.000	~20
114	CClF2CClF2	170.92	3.6	38.5	145.7	294.3	3.26	473	1000	none	-3.1	-1333	A1	300	0.850	9800
E245cb1	CH3-O-CF2-CF3	150.05	5.9	42.6	133.7	272.7	2.89	419		flam				4.7	0.000	160
E134	CHF2-O-CHF2	118.03	6.2	43.2	160.8	321.4	4.23	614		none				26.2	0.000	6100
21	CHCl2F	102.92	8.9	48.0	178.3	352.9	5.18	751	10	none			B1	2.0	0.010	210
160	CH3CH2Cl - ethyl chloride	64.51	13.1	55.6	187.3	369.1	5.27	764	100	3.6	20.6	8856		<1	0.000	
245fa	CHF2CH2CF3	134.05	15.1	59.2	154.1	309.4	4.43	643	300	none	6.1	2623	B1 r	7.2	0.000	950
631	CH3-CH2(NH2) - ethylamine	45.08	16.6	61.9	183.0	361.4	5.62	815	5	3.5					0.000	
11	CCl3F	137.37	23.7	74.7	198.0	388.4	4.41	640	C1000	none	0.9	387	A1	45	1.000	4600
123	CHCl2CF3	152.93	27.8	82.0	183.8	362.8	3.66	531	50	none	2.1	903	B1	1.4	0.012	120
601a	(CH3)2CH-CH2-CH3 - isopentane	72.15	27.8	82.0	187.8	370.0	3.39	492	600	1.0					0.000	
E347mmy1	CF3-CF(OCH3)-CF3	200.05	29.4	84.9	160.8	321.4	2.55	370						3.4	0.000	330
611	HCOOCH3 - methyl formate	60.05	31.8	89.2	214.0	417.2	5.99	869	100	4.5			B2		0.000	
141b	CH3CCl2F	116.95	32.0	89.6	204.2	399.6	4.25	616	500	5.8	8.6	3697		9.3	0.086	700
610	CH3-CH2-O-CH2-CH3 - ethyl ether	74.12	34.6	94.3	214.0	417.2	6.00	870	400	1.9					0.000	
601	CH3-CH2-CH2-CH2-CH3 - pentane	72.15	36.0	96.8	196.6	385.9	3.37	489	600	1.4				<<1	0.000	11
30	CH2Cl2 - methylene chloride	84.93	40.2	104.4	237.0	458.6	6.08	882	50	13.0			B2	0.46	0.000	10
113	CCl2FCClF2	187.37	47.6	117.7	214.1	417.4	3.39	492	1000	none	0.1	43	A1	85	0.900	6000
1130	CHCl=CHCl - dielene	96.94	47.8	118.0	243.3	469.9	5.48	795	200	5.6						
718	H2O - water	18.02	100.0	212.0	373.9	705.0	22.06	3200		none			A1		0.000	<1

NBP = normal boiling point; Tc = critical temperature; Pc = critical pressure; TLV = ACGIH Threshold Limit Value or consistent chronic occupational exposure limit, such as AIHA Workplace Environmental Exposure Level (WEEL) or OSHA Permissible Exposure Limit (PEL), as Time-Weighted Average (TWA) unless value is preceded by C for Ceiling; LFL = lower flammability limit (% volume in air), "wff" signifies that the worst case of fractionation may become flammable; HOC = heat of combustion; ODP = ozone depletion potential (modeled); GWP = global warming potential (for 100 yr integration)

Suffixes to safety classifications indicate recommended changes that are not final yet ("d" for deletion and "r" for revision or addition) or classifications assigned as provisional ("p").

Data sources are identified in the Refrigerant Database; verify the data and associated limitations in those sources before use.