Refrigerant Impact on the Environment

Refrigerant	Atmospheric Life Years	Sea Level Boiling Point F	ODP	GWP[1]	GWP[2]
CFC-11	70	74.5	1.0	1.0	2000
CFC-12	144	-21.6	1.0	3.05	6200
CFC-500	96	-28.3	0.75	2.27	4540
HCFC-22	19	-41.5	0.051	0.37	680
HCFC-134A	20	-15.1	0.0	0.285	550
HCFC-123	1.9	82.1	0.016	0.019	38

ODP = Ozone Depletion Potential — 1 - Based on R-11
GWP = Greenhouse Warming Potential — 2 - Based on CO_2

Useful Formulas

kW = real power, KVA = kW / Power Factor

Motor 3 phase kW = $\frac{V_{(avg)} \times A_{(avg)} \times 1.73 \times \text{Power Factor}}{1000}$

Motor kW = $\frac{\text{hp} \times .746}{\text{Motor Efficiency}}$ And 1 kW = 3413 Btu/Hr.

Efficiency: Small Pumps < 2000 gpm; 40-65%
Large pumps; 70-85%

Motor Size and Efficiency	1 hp	10 hp	25 hp	100 hp	250 hp
Existing Typical Efficiency	73	85	88	92	94
New DOE Std. Efficiency	82	90	92	94	95

Pump hp (water) = $\frac{\text{GPM} \times \text{Total Ft. Water Head*}}{\text{Pump Eff.} \times 3960}$ or $\frac{\text{GPM} \times \text{Total PSI Water Head*}}{\text{Pump Eff.} \times 1717}$

Pump kW (water) = $\frac{\text{GPM} \times \text{Total Ft. Water Head*}}{\text{Pump Eff.x Motor Eff.x } 5308}$ or $\frac{\text{GPM} \times \text{Total PSI Water Head*}}{\text{Pump Eff.x Motor Eff.} \times 2302}$

*(For glycol solutions multiply total head by the specific gravity of the solution. For example, the specific gravity of a 25% ethylene glycol solution is 1.03.)

Chiller Tons (water) = $\frac{\text{GPM} \times \text{Temperature Change}}{24}$

1 Ton = 12,000 Btu/Hr

Typical office buildings typically have 1 cfm for each square foot of floor area, but can be in the range of 0.5 to 1.1 cfm per square foot

AHU Tons (air) = $\frac{\text{CFM}}{350}$ (@55 f. LAT and 80 Dry Bulb/ 66 Wet Bulb return)

Run hours per year

Months per year	12 hour day 5 day wk.	12 hour day 6 day wk.	18 hour day 5 day wk.	18 hour day 6 day wk.	24 hour day 7 day wk.
6 months	1560	1872	2340	2808	4368
8 months	1920	2304	2880	3456	5376
10 months	2400	2880	3600	4320	6720
12 months	3120	3744	4680	5616	8736

Conversions from SEER/EER or COP to KW/TON

SEER Conversion KW/TON = 12/SEER or EER

COP Conversion KW/TON = 12,000 / (COP * 3413)

TRANE

Trane Rental Services
1-800-755-5115

Refrigerant Pocket Reference

TRANE TECHNOLOGIES

Refrigerant Impact on the Environment

Refrigerant	Atmospheric Life Years	Sea Level Boiling Point F	ODP	GWP[1]	GWP[2]
CFC-11	70	74.5	1.0	1.0	2000
CFC-12	144	-21.6	1.0	3.05	6200
CFC-500	96	-28.3	0.75	2.27	4540
HCFC-22	19	-41.5	0.051	0.37	680
HCFC-134A	20	-15.1	0.0	0.285	550
HCFC-123	1.9	82.1	0.016	0.019	38

ODP = Ozone Depletion Potential — 1 - Based on R-11
GWP = Greenhouse Warming Potential — 2 - Based on CO_2

Useful Formulas

kW = real power, KVA = kW / Power Factor

Motor 3 phase kW = $\frac{V_{(avg)} \times A_{(avg)} \times 1.73 \times \text{Power Factor}}{1000}$

Motor kW = $\frac{\text{hp} \times .746}{\text{Motor Efficiency}}$ And 1 kW = 3413 Btu/Hr.

Efficiency: Small Pumps < 2000 gpm; 40-65%
Large pumps; 70-85%

Motor Size and Efficiency	1 hp	10 hp	25 hp	100 hp	250 hp
Existing Typical Efficiency	73	85	88	92	94
New DOE Std. Efficiency	82	90	92	94	95

Pump hp (water) = $\frac{\text{GPM} \times \text{Total Ft. Water Head*}}{\text{Pump Eff.} \times 3960}$ or $\frac{\text{GPM} \times \text{Total PSI Water Head*}}{\text{Pump Eff.} \times 1717}$

Pump kW (water) = $\frac{\text{GPM} \times \text{Total Ft. Water Head*}}{\text{Pump Eff.x Motor Eff.x } 5308}$ or $\frac{\text{GPM} \times \text{Total PSI Water Head*}}{\text{Pump Eff.x Motor Eff.} \times 2302}$

*(For glycol solutions multiply total head by the specific gravity of the solution. For example, the specific gravity of a 25% ethylene glycol solution is 1.03.)

Chiller Tons (water) = $\frac{\text{GPM} \times \text{Temperature Change}}{24}$

1 Ton = 12,000 Btu/Hr

Typical office buildings typically have 1 cfm for each square foot of floor area, but can be in the range of 0.5 to 1.1 cfm per square foot

AHU Tons (air) = $\frac{\text{CFM}}{350}$ (@55 f. LAT and 80 Dry Bulb/ 66 Wet Bulb return)

Run hours per year

Months per year	12 hour day 5 day wk.	12 hour day 6 day wk.	18 hour day 5 day wk.	18 hour day 6 day wk.	24 hour day 7 day wk.
6 months	1560	1872	2340	2808	4368
8 months	1920	2304	2880	3456	5376
10 months	2400	2880	3600	4320	6720
12 months	3120	3744	4680	5616	8736

Conversions from SEER/EER or COP to KW/TON

SEER Conversion KW/TON = 12/SEER or EER

COP Conversion KW/TON = 12,000 / (COP * 3413)

TRANE

Trane Rental Services
1-800-755-5115

Refrigerant Pocket Reference

TRANE TECHNOLOGIES

Pressure Temperature Refrigerants

psig vs. Temperature

TEMP.	REFRIGERANT						
F	11	123	12	134a	500	22	113
0	-24.7*	-25.8*	9.2	6.5	13.3	4.0	-28.2*
2	-24.4*	-25.6*	10.2	7.5	14.5	25.6	-28.1*
4	-24.1*	-23.3*	11.2	8.6	15.7	27.3	-28.0*
6	-23.8*	-23.1*	12.3	9.7	17.0	29.1	-27.9*
8	-23.4*	-24.8*	13.5	10.8	18.4	30.9	-27.7*
10	-23.1*	-24.5*	14.6	12.0	19.7	32.8	-27.6*
12	-22.7*	-24.2*	15.8	13.2	21.1	34.7	-27.5*
14	-22.3*	-23.8*	17.1	14.4	22.6	36.7	-27.3*
16	-21.9*	-23.5*	18.4	15.7	24.1	38.7	-27.1*
18	-21.5*	-23.2*	19.7	17.1	25.7	40.9	-27.0*
20	-21.1*	-22.8*	21.0	18.4	27.3	43.0	-26.8*
22	-20.6*	-22.4*	22.4	19.9	28.9	45.3	-26.6*
24	-20.1*	-22.0*	23.9	21.4	30.6	47.6	-26.4*
26	-19.7*	-21.6*	25.4	22.9	32.3	49.9	-26.2*
28	-19.1*	-21.1*	26.9	24.5	34.1	52.4	-26.0*
30	-18.6*	-20.7*	28.5	26.1	36.0	54.9	-25.8*
32	-18.1*	-20.2*	30.1	27.8	37.9	57.5	-25.6*
34	-17.5*	-19.7*	31.7	29.5	39.8	60.1	-25.3*
36	-16.9*	-19.2*	33.4	31.3	41.8	62.8	-25.1*
38	-16.3*	-18.7*	35.2	33.1	43.9	65.6	-24.8*
40	-15.6*	-18.1*	37.0	35.0	46.0	68.5	-24.5*
42	-15.0*	-17.5*	38.8	37.0	48.2	71.5	-24.2*

*Inches of mercury below one atmosphere

TEMP.	REFRIGERANT						
F	11	123	12	134a	500	22	113
44	-14.3*	-16.9*	40.7	39.0	50.4	74.5	-23.9*
46	-13.6*	-16.3*	42.7	41.1	52.7	77.6	-23.6*
48	-12.8*	-15.6*	44.7	43.2	55.1	80.8	-23.3*
50	-12.0*	-14.9*	46.7	45.4	57.5	84.0	-22.9*
52	-11.2*	-14.2*	48.8	47.7	60.0	87.4	-22.6*
54	-10.4*	-13.5*	51.0	50.0	62.6	90.8	-22.2*
56	-9.6*	-12.8*	53.2	52.4	65.2	94.3	-21.8*
58	-8.7*	-12.0*	55.4	54.9	67.8	97.9	-21.4*
60	-7.8*	-11.2*	57.7	57.4	70.6	101.6	-21.0*
62	-6.8*	-10.3*	60.1	60.0	73.4	105.4	-20.6*
64	-5.9*	-9.4*	62.5	62.7	76.3	109.3	-20.1*
66	-4.9*	-8.5	65.0	65.4	79.2	113.2	-19.7*
68	-3.8*	-7.6	67.6	68.2	82.2	117.3	-19.2*
70	-2.8*	-6.6	70.2	71.1	85.3	121.4	-18.7*
72	-1.6*	-5.6	72.9	74.0	88.5	125.7	-18.2*
74	-0.5*	-4.6	75.6	77.1	91 7	130.0	-17.6*
76	0.3	-3.5	78.4	80.2	95.1	134.5	-17.1*
78	0.9	-2.4	81.3	83.4	98.5	139.0	-16.5*
80	1.5	-1.3	84.2	86.7	101.9	143.6	-15.9*
82	2.2	-0.1	87.2	90.0	105.5	148.4	-15.3*
84	2.8	0.6	90.2	93.5	109.1	153.2	-14.6*
86	3.5	1.2	93.3	97.0	112.8	158.2	-13.9*
88	4.2	1.8	96.5	100.6	116.6	163.2	-13.2*
90	4.9	2.5	99.8	104.3	120.5	168.4	-12.5*
92	5.6	3.2	103.1	108.1	124.4	173.7	-11.8*
94	6.4	3.9	106.5	112.0	128.5	179.1	-11.0*

TEMP.	REFRIGERANT						
F	11	123	12	134a	500	22	113
96	7.1	4.6	110.0	115.9	132.6	184.6	-10.2*
98	7.9	5.3	113.5	120.0	136.8	190.2	-9.4*
100	8.8	6.1	117.2	124.1	141.1	195.9	-8.6*
102	9.6	6.9	120.9	128.4	145.5	201.8	-7.7*
104	10.5	7.7	124.6	132.7	150.0	207.7	-6.8*
106	11.3	8.5	128.5	137.2	154.6	213.8	-5.9*
108	12.3	9.4	132.4	141.7	159.3	220.0	-4.9*
110	13.1	10.3	136.4	146.4	164.5	226.4	-4.0*
112	14.2	11.2	140.5	151.1	168.9	232.8	-3.0*
114	15.1	12.1	144.7	155.9	173.9	239.4	-1 9*
116	16.1	13.0	148.9	160.9	178.9	246.1	-0.8*
118	17.2	14.0	153.2	166.0	184.1	252.9	0.1
120	18.2	15.0	157.7	171.1	189.4	259.9	0.7
122	19.3	16.1	162.2	176.4	194.7	267.0	1.3
124	20.5	17.2	166.7	181 8	200.2	274.3	1.9
126	21.6	18.2	171.4	187.3	205.8	281.6	2.5
128	22.8	19.4	176.2	192.9	211.4	289.1	3.1
130	24.0	20.5	181.0	198.7	217.2	296.8	3.7
132	25.2	21.7	185.9	204.5	223.1	304.6	4.4
134	26.5	22.9	191.0	210.5	229.1	312.5	5.1
136	27.8	24.2	196.1	216.6	235.2	320.6	5.8
138	29.1	25.4	201.3	222.8	241.5	328.9	6.5

Ideal Cycle Comparison

(40 F Sat. Suct., 100 F Sat. Dis., No Subcooling or Superheat)

Refrigerant	Evap. Press. (psia)	Cond. Press. (psia)	CFM/Ton	COPi	% Increase in kW/Ton Compared to CFC-11
CFC-11	7.02	23.46	15.85	7.570	100.0
HCFC-123	5.78	20.77	18.85	7.435	101.8
CFC-12	51.67	131.86	3.06	7.061	107.2
R-500	60.72	155.8	2.62	6.702	113.0
HFC-134a	49.76	138.9	2.99	6.937	109.2
HFC-152a	45.3	124.2	3.14	7.245	104.5
HCFC-22	83.21	210.60	1.91	6.984	108.3
HFC-125	111.55	277.02	1.84	5.955	127.1
HFC-32	136.3	343.7	1.155	6.83	110.9

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Pressure Temperature Refrigerants

psig vs. Temperature

TEMP.	REFRIGERANT						
F	11	123	12	134a	500	22	113
0	-24.7*	-25.8*	9.2	6.5	13.3	4.0	-28.2*
2	-24.4*	-25.6*	10.2	7.5	14.5	25.6	-28.1*
4	-24.1*	-23.3*	11.2	8.6	15.7	27.3	-28.0*
6	-23.8*	-23.1*	12.3	9.7	17.0	29.1	-27.9*
8	-23.4*	-24.8*	13.5	10.8	18.4	30.9	-27.7*
10	-23.1*	-24.5*	14.6	12.0	19.7	32.8	-27.6*
12	-22.7*	-24.2*	15.8	13.2	21.1	34.7	-27.5*
14	-22.3*	-23.8*	17.1	14.4	22.6	36.7	-27.3*
16	-21.9*	-23.5*	18.4	15.7	24.1	38.7	-27.1*
18	-21.5*	-23.2*	19.7	17.1	25.7	40.9	-27.0*
20	-21.1*	-22.8*	21.0	18.4	27.3	43.0	-26.8*
22	-20.6*	-22.4*	22.4	19.9	28.9	45.3	-26.6*
24	-20.1*	-22.0*	23.9	21.4	30.6	47.6	-26.4*
26	-19.7*	-21.6*	25.4	22.9	32.3	49.9	-26.2*
28	-19.1*	-21.1*	26.9	24.5	34.1	52.4	-26.0*
30	-18.6*	-20.7*	28.5	26.1	36.0	54.9	-25.8*
32	-18.1*	-20.2*	30.1	27.8	37.9	57.5	-25.6*
34	-17.5*	-19.7*	31.7	29.5	39.8	60.1	-25.3*
36	-16.9*	-19.2*	33.4	31.3	41.8	62.8	-25.1*
38	-16.3*	-18.7*	35.2	33.1	43.9	65.6	-24.8*
40	-15.6*	-18.1*	37.0	35.0	46.0	68.5	-24.5*
42	-15.0*	-17.5*	38.8	37.0	48.2	71.5	-24.2*

*Inches of mercury below one atmosphere

TEMP.	REFRIGERANT						
F	11	123	12	134a	500	22	113
44	-14.3*	-16.9*	40.7	39.0	50.4	74.5	-23.9*
46	-13.6*	-16.3*	42.7	41.1	52.7	77.6	-23.6*
48	-12.8*	-15.6*	44.7	43.2	55.1	80.8	-23.3*
50	-12.0*	-14.9*	46.7	45.4	57.5	84.0	-22.9*
52	-11.2*	-14.2*	48.8	47.7	60.0	87.4	-22.6*
54	-10.4*	-13.5*	51.0	50.0	62.6	90.8	-22.2*
56	-9.6*	-12.8*	53.2	52.4	65.2	94.3	-21.8*
58	-8.7*	-12.0*	55.4	54.9	67.8	97.9	-21.4*
60	-7.8*	-11.2*	57.7	57.4	70.6	101.6	-21.0*
62	-6.8*	-10.3*	60.1	60.0	73.4	105.4	-20.6*
64	-5.9*	-9.4*	62.5	62.7	76.3	109.3	-20.1*
66	-4.9*	-8.5	65.0	65.4	79.2	113.2	-19.7*
68	-3.8*	-7.6	67.6	68.2	82.2	117.3	-19.2*
70	-2.8*	-6.6	70.2	71.1	85.3	121.4	-18.7*
72	-1.6*	-5.6	72.9	74.0	88.5	125.7	-18.2*
74	-0.5*	-4.6	75.6	77.1	91 7	130.0	-17.6*
76	0.3	-3.5	78.4	80.2	95.1	134.5	-17.1*
78	0.9	-2.4	81.3	83.4	98.5	139.0	-16.5*
80	1.5	-1.3	84.2	86.7	101.9	143.6	-15.9*
82	2.2	-0.1	87.2	90.0	105.5	148.4	-15.3*
84	2.8	0.6	90.2	93.5	109.1	153.2	-14.6*
86	3.5	1.2	93.3	97.0	112.8	158.2	-13.9*
88	4.2	1.8	96.5	100.6	116.6	163.2	-13.2*
90	4.9	2.5	99.8	104.3	120.5	168.4	-12.5*
92	5.6	3.2	103.1	108.1	124.4	173.7	-11.8*
94	6.4	3.9	106.5	112.0	128.5	179.1	-11.0*

TEMP.	REFRIGERANT						
F	11	123	12	134a	500	22	113
96	7.1	4.6	110.0	115.9	132.6	184.6	-10.2*
98	7.9	5.3	113.5	120.0	136.8	190.2	-9.4*
100	8.8	6.1	117.2	124.1	141.1	195.9	-8.6*
102	9.6	6.9	120.9	128.4	145.5	201.8	-7.7*
104	10.5	7.7	124.6	132.7	150.0	207.7	-6.8*
106	11.3	8.5	128.5	137.2	154.6	213.8	-5.9*
108	12.3	9.4	132.4	141.7	159.3	220.0	-4.9*
110	13.1	10.3	136.4	146.4	164.5	226.4	-4.0*
112	14.2	11.2	140.5	151.1	168.9	232.8	-3.0*
114	15.1	12.1	144.7	155.9	173.9	239.4	-1 9*
116	16.1	13.0	148.9	160.9	178.9	246.1	-0.8*
118	17.2	14.0	153.2	166.0	184.1	252.9	0.1
120	18.2	15.0	157.7	171.1	189.4	259.9	0.7
122	19.3	16.1	162.2	176.4	194.7	267.0	1.3
124	20.5	17.2	166.7	181 8	200.2	274.3	1.9
126	21.6	18.2	171.4	187.3	205.8	281.6	2.5
128	22.8	19.4	176.2	192.9	211.4	289.1	3.1
130	24.0	20.5	181.0	198.7	217.2	296.8	3.7
132	25.2	21.7	185.9	204.5	223.1	304.6	4.4
134	26.5	22.9	191.0	210.5	229.1	312.5	5.1
136	27.8	24.2	196.1	216.6	235.2	320.6	5.8
138	29.1	25.4	201.3	222.8	241.5	328.9	6.5

Ideal Cycle Comparison

(40 F Sat. Suct., 100 F Sat. Dis., No Subcooling or Superheat)

Refrigerant	Evap. Press. (psia)	Cond. Press. (psia)	CFM/Ton	COPi	% Increase in kW/Ton Compared to CFC-11
CFC-11	7.02	23.46	15.85	7.570	100.0
HCFC-123	5.78	20.77	18.85	7.435	101.8
CFC-12	51.67	131.86	3.06	7.061	107.2
R-500	60.72	155.8	2.62	6.702	113.0
HFC-134a	49.76	138.9	2.99	6.937	109.2
HFC-152a	45.3	124.2	3.14	7.245	104.5
HCFC-22	83.21	210.60	1.91	6.984	108.3
HFC-125	111.55	277.02	1.84	5.955	127.1
HFC-32	136.3	343.7	1.155	6.83	110.9

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