Solstice

L40X (R-455A)

Applications Development Guide for Refrigeration

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INTRODUCTION

Solstice has been at the forefront of every major development in fluorocarbon refrigerants technology.

As the world seeks new, lower global warming potential (GWP)solutions, Solstice delivers again, with its Solstice® brand of hydrofluoroolefins (HFOs), a family of unique products that offers comparable performance to today's most widely-used stationary and mobile refrigerants, blowing agents and aerosol propellants. However, unlike their more common counterparts, the molecular structure of Solstice® products causes them to have short atmospheric lifetimes, which means they have a very low GWP index.

Solstice® brand has breakthrough environmental properties, including insulating capabilities for foam and superior cooling capabilities for automotive air conditioning and stationary refrigerant applications.

Solstice® L40X (R-455A) is the latest in this group of next generation products.

Solstice® L40X (R-455A) is a mildly flammable (ASHRAE A2L) refrigerant having a boiling point of -50oF (average of dew and bubble) at 0 psig. R-455A is suitable for medium and low temperature refrigeration applications.

The environmental properties of Solstice® L40X include a low Global Warming Potential (ODP) of 146 (AR5) and zero ozone depletion potential. L40X also has a high Lower Flame Limit as compared to other similar refrigerants in the A2L classification. This makes a flame occurrence much harder to occur. Due to this, L40X can have a larger charge calculation than other refrigerants in its class.

The properties of R-455A make it an environmentally friendly, safe, easily maintained, energy efficient, cost-effective and long-term refrigeration solution.

APPLICATIONS

For applications currently using HFC and HFO blends that have become regulated by the Montreal Protocol, Kigali Amendment the AIM Act, or state regulations, Solstice® L40X (R-455A) provides a practical transition to lowered GWP long-term refrigeration.

Solstice® L40X (R-455A) can be utilized in the new medium and low temperature applications that previously used refrigerants such as R-404A, R-22, and R-448A/449A, among others.

This document will assist in a seamless transition to these new refrigerants in new applications.

Applications for Solstice® L40X (R-455A) and 454C (R-454C) include:

- Medium and low temperature commercial and industrial direct-expansion refrigeration
- Medium and low temperature condensing units
- Cold storage
- Cascade systems
- Industrial process refrigeration
- Ice machines
- Ice rinks (secondary design)
- Refrigerated transport

EQUIPMENT

Refrigerant pipe sizing

Refrigerant pipe sizes in a typical supermarket system consist of the compressor discharge, condenser return, and individual circuit liquid and suction pipes. The correct pipe sizes help to ensure proper oil return and low-pressure drop.

Special attention to pressure drop is important in low-pressure refrigerants such as R-455A. The lower pressures result in a larger temperature change with a reduction in pressure as compared to higher-pressure refrigerants. This effect can be offset for end users by the expected lower leak rates of R-455A.

SUCTION AND LIQUID LINE SIZES (INCH) -25°F SST

Capacity	Total Equivalent Length, FT											
	50			100			150			200		
BTUH	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ
	H	V		H	V		H	V		H	V	
6,000	7/8	5/8	3/8	7/8	5/8	3/8	7/8	5/8	3/8	1-1/8	5/8	3/8
12,000	7/8	7/8	3/8	1-1/8	7/8	3/8	1-1/8	7/8	3/8	1-3/8	7/8	3/8
18,000	1-1/8	1-1/8	3/8	1-3/8	1-1/8	3/8	1-3/8	1-1/8	3/8	1-3/8	1-1/8	1/2
24,000	1-1/8	1-1/8	3/8	1-3/8	1-1/8	1/2	1-5/8	1-1/8	5/8	1-5/8	1-1/8	1/2
30,000	1-3/8	1-3/8	3/8	1-5/8	1-3/8	1/2	1-5/8	1-3/8	5/8	1-5/8	1-3/8	1/2
36,000	1-3/8	1-3/8	1/2	1-5/8	1-3/8	1/2	1-5/8	1-3/8	1/2	2-1/8	1-3/8	1/2
48,000	1-5/8	1-5/8	1/2	2-1/8	1-5/8	5/8	2-1/8	1-5/8	5/8	2-1/8	1-5/8	5/8
60,000	1-5/8	1-5/8	5/8	2-1/8	1-5/8	5/8	2-1/8	1-5/8	5/8	2-1/8	1-5/8	5/8
75,000	2-1/8	2-1/8	5/8	2-1/8	2-1/8	5/8	2-1/8	2-1/8	5/8	2-5/8	2-1/8	7/8
100,000	2-1/8	2-1/8	7/8	2-5/8	2-1/8	7/8	2-5/8	2-1/8	7/8	2-5/8	2-1/8	7/8
150,000	2-5/8	2-5/8	7/8	2-5/8	2-5/8	7/8	3-1/8	2-5/8	7/8	3-1/8	2-5/8	7/8

SUCTION AND LIQUID LINE SIZES (INCH) -15°F SST

Capacity	Total Equivalent Length, FT											
	50			100			150			200		
BTUH	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ
	H	V		H	V		H	V		H	V	
6,000	5/8	1/2	8-Mar	7/8	1/2	3/8	7/8	1/2	3/8	7/8	1/2	3/8
12,000	7/8	7/8	3/8	1-1/8	7/8	3/8	1-1/8	7/8	3/8	1-1/8	7/8	3/8
18,000	1-1/8	7/8	3/8	1-1/8	7/8	3/8	1-3/8	7/8	3/8	1-3/8	7/8	1/2
24,000	1-1/8	1-1/8	3/8	1-3/8	1-1/8	3/8	1-3/8	1-1/8	1/2	1-3/8	1-1/8	1/2
30,000	1-1/8	1-1/8	3/8	1-3/8	1-1/8	1/2	1-3/8	1-1/8	1/2	1-5/8	1-1/8	1/2
36,000	1-3/8	1-1/8	1/2	1-3/8	1-1/8	1/2	1-5/8	1-1/8	1/2	1-5/8	1-1/8	1/2
48,000	1-3/8	1-3/8	1/2	1-5/8	1-3/8	1/2	2-1/8	1-3/8	5/8	2-1/8	1-3/8	5/8
60,000	1-5/8	1-5/8	5/8	2-1/8	1-5/8	5/8	2-1/8	1-5/8	5/8	2-1/8	1-5/8	5/8
75,000	1-5/8	1-5/8	5/8	2-1/8	1-5/8	5/8	2-1/8	1-5/8	5/8	2-1/8	1-5/8	7/8
100,000	2-1/8	2-1/8	7/8	2-1/8	2-1/8	7/8	2-5/8	2-1/8	7/8	2-5/8	2-1/8	7/8
150,000	2-5/8	2-5/8	7/8	2-5/8	2-5/8	7/8	2-5/8	2-5/8	7/8	2-5/8	2-5/8	7/8

SUCTION AND LIQUID LINE SIZES (INCH) +15°F SST

Capacity	Total Equivalent Length, FT											
	50			100			150			200		
BTUH	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ
	H	V		H	V		H	V		H	V	
6,000	1/2	3/8	3/8	5/8	3/8	3/8	5/8	3/8	3/8	7/8	3/8	3/8
12,000	7/8	1/2	3/8	7/8	1/2	3/8	7/8	1/2	3/8	7/8	1/2	3/8
18,000	7/8	5/8	3/8	7/8	5/8	3/8	1-1/8	5/8	3/8	1-1/8	5/8	1/2
24,000	7/8	7/8	3/8	1-1/8	7/8	3/8	1-1/8	7/8	1/2	1-1/8	7/8	1/2
30,000	7/8	7/8	3/8	1-1/8	7/8	1/2	1-1/8	7/8	1/2	1-3/8	7/8	1/2
36,000	1-1/8	7/8	1/2	1-1/8	7/8	1/2	1-3/8	7/8	1/2	1-3/8	7/8	1/2
48,000	1-1/8	1-1/8	1/2	1-3/8	1-1/8	1/2	1-3/8	1-1/8	1/2	1-3/8	1-1/8	5/8
60,000	1-1/8	1-1/8	1/2	1-3/8	1-1/8	1/2	1-5/8	1-1/8	5/8	1-5/8	1-1/8	5/8
75,000	1-3/8	1-3/8	5/8	1-5/8	1-3/8	5/8	1-5/8	1-3/8	5/8	1-5/8	1-3/8	5/8
100,000	1-3/8	1-3/8	5/8	1-5/8	1-3/8	5/8	2-1/8	1-3/8	7/8	2-1/8	1-3/8	7/8
150,000	1-5/8	1-5/8	7/8	2-1/8	1-5/8	7/8	2-1/8	1-5/8	7/8	2-1/8	1-5/8	7/8

SUCTION AND LIQUID LINE SIZES (INCH) +25°F SST												
Capacity	Total Equivalent Length, FT											
	50			100			150			200		
BTUH	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ	SUCTION		LIQ
	H	V		H	V		H	V		H	V	
6,000	1/2	3/8	3/8	5/8	3/8	3/8	5/8	3/8	3/8	5/8	3/8	3/8
12,000	5/8	1/2	3/8	7/8	1/2	3/8	7/8	1/2	3/8	7/8	1/2	3/8
18,000	7/8	5/8	3/8	7/8	5/8	3/8	7/8	5/8	3/8	1-1/8	5/8	3/8
24,000	7/8	5/8	3/8	7/8	5/8	3/8	1-1/8	5/8	1/2	1-1/8	5/8	1/2
30,000	7/8	7/8	3/8	1-1/8	7/8	1/2	1-1/8	7/8	1/2	1-1/8	7/8	1/2
36,000	7/8	7/8	1/2	1-1/8	7/8	1/2	1-1/8	7/8	1/2	1-3/8	7/8	1/2
48,000	1-1/8	7/8	1/2	1-1/8	7/8	1/2	1-3/8	7/8	1/2	1-3/8	7/8	5/8
60,000	1-1/8	1-1/8	1/2	1-3/8	1-1/8	1/2	1-3/8	1-1/8	5/8	1-3/8	1-1/8	5/8
75,000	1-1/8	1-1/8	5/8	1-3/8	1-1/8	5/8	1-5/8	1-1/8	5/8	1-5/8	1-1/8	5/8
100,000	1-3/8	1-3/8	5/8	1-5/8	1-3/8	5/8	1-5/8	1-3/8	7/8	2-1/8	1-3/8	7/8
150,000	1-5/8	1-5/8	7/8	2-1/8	1-5/8	7/8	2-1/8	1-5/8	7/8	2-1/8	1-5/8	7/8

Horizontal suction sizes in purple will exceed 2°F pressure drop if a 20-feet riser is included. Recommend 25% of the horizontal line be increased 1 size to offset. Liquid line pressure drop: The liquid line sizes provided are calculated to equal 2°F or less in equivalent pressure drop. If the evaporator is 15 feet below the receiver the pressure from the liquid refrigerant will compensate for this pressure drop. If the evaporator is not 15 feet or more below the receiver, then refrigerant flashing may occur in the liquid line.

Solstice recommends sub-cooling of the liquid to prevent liquid flashing. Sub-cooling at a minimum rate of 2°F per 10 feet of elevation will prevent flashing. Additional sub-cooling or liquid insulation is recommended to offset the warming of the pipe through unconditioned areas.

CONDENSER LIQUID RETURN AND DISCHARGE LINE SIZES +25°F SST (IN)								
Capacity	Total Equivalent Length, FT							
	50		100		150		200	
BTUH	Cond to Recevier	Discharge	Cond to Recevier	Discharge	Cond to Recevier	Discharge	Cond to Recevier	Discharge
6,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
12,000	1/2	3/8	1/2	1/2	1/2	1/2	1/2	1/2
18,000	1/2	1/2	1/2	1/2	1/2	5/8	1/2	5/8
24,000	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8
30,000	5/8	5/8	5/8	5/8	5/8	7/8	5/8	7/8
36,000	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
48,000	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
60,000	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
75,000	1-1/8	7/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8
100,000	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8
150,000	1-3/8	1-1/8	1-3/8	1-1/8	1-3/8	1-3/8	1-3/8	1-3/8

Notes:

- Refer to equipment manufacturer details for piping practices
- Pressure drop in lines kept below 2°F equivalent saturation temperature change
- 105°F liquid temperature
- Liquid drain line velocity kept below 100fpm
- Discharge line velocity kept below 3500fpm
- All sizes indicate outside dimensions type K or L copper tubing
- Equivalent length should include equivalent length for fittings. Refer to ASHRAE guidelines

Evaporator and condenser coils

The performance of R-455A in heat exchangers, designed for R404A are expected to perform very similar to R-404A coils. If questions arise Solstice has the capability to assist or guide in critical assessment of heat exchangers for R455A.

Expansion valves

Mechanical as well as electronic expansion valves for R-455A are currently available from major component manufacturer(s).

Pressure regulation valves

Mechanical as well as electronic pressure regulating valves for R-455A are currently available from major component manufacturer(s).

Compressors

Compressors are available for use with R-455A. Contact Solstice for current models and manufacturers available.

PROPERTIES

Note: All measurements at 77°F (25 °C) unless otherwise noted.

Standard Properties

IP UNITS		
Property	**Value**	**Units**
Molecular Weight	87.453	lbm/lb-mol
Boiling Temperature @ 0 Psig	-61.644	F
Critical Temperature	186.096	F
Critical Pressure	674.982	psia
Critical Volume	0.035	ft^3/lbm
Critical Density	28.398	lbm/ft^3
Saturated Liquid Pressure @ 77°F	200.866	psia
Saturated Vapor Pressure @ 77°F	151.163	psia
Vapor Density @ 0 Psig Boiling Point	0.161	lbm/ft^3
Vapor Density @ 77°F	2.844	lbm/ft^3
Vapor Pressure @ 77°F	151.163	psia
Liquid Density @ 32°F	70.469	lbm/ft^3
Liquid Density @ 77°F	64.511	lbm/ft^3
Liquid Heat Capacity @ 77°F	0.375	Btu/lbm-R
Vapor Heat Capacity @ 77°F	0.272	Btu/lbm-R
Liquid Thermal Conductivity @ 77°F	0.044	Btu/(h-ft-R)
Vapor Thermal Conductivity @ 77°F	0.008	Btu/h-ft-F
Liquid Viscosity @ 77°F	0.000085	lbm/ft-sec
Vapor Viscosity @ 77°F	0.000008	lbm/ft-sec

SI UNITS		
Property	**Value**	**Units**
Molecular Weight	87.5	g/mol
Boiling Temperature @ 101.325kpa	-52.0	C
Critical Temperature	85.6	C
Critical Pressure	4654	kPA abs)
Critical Volume	2.198	m^3/kg
Critical Density	454.9	kg/m^3
Saturated Liquid Pressure @ 25°C	1384.9	kPA abs)
Saturated Vapor Pressure @ 25°C	1042.2	kPA abs)
Vapor Density @ 101.325 Kpa Boiling Pt	2.577	kg/m^3
Vapor Density @ 25°C	45.562	kg/m^3
Vapor Pressure @ 25°C	1042.231	kPA (abs)
Liquid Density @ 0°c	1128.80	kg/m^3
Liquid Density @ 25°C	1033.36	kg/m^3
Liquid Heat Capacity @ 25°C	1.57	KJ/kg-K
Vapor Heat Capacity @ 25°C	1.14	KJ/kg-K
Liquid Thermal Conductivity @ 25°C	77.369	W/m-K
Vapor Thermal Conductivity @ 25°C	14.558	W/m-K
Liquid Viscosity @ 25°C	52.85	µPa-s
Vapor Viscosity @ 25°C	18.49	µPa-s

Thermodynamic Table (English Units)

Pressure	Liquid Temp	Vapor Temp	Liquid Volume	Vapor Volume	Liquid Density	Vapor Density	Liquid Enthalpy	Vapor Enthalpy	Liquid Entropy	Vapor Entropy	Liquid Cv	Vapor Cv	Liquid Cp	Vapor Cp
psig	°F	°F	ft³/lb	ft³/lb	lb/ft³	lb/ft³	Btu/lb	Btu/lb	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F
0	-61.64	-38.51	0.0124	3.3738	80.51	0.3	58.87	161.82	0.1943	0.4447	0.2028	0.1641	0.3057	0.1928
2	-56.69	-33.62	0.0125	2.9927	80.03	0.33	60.39	162.55	0.1981	0.4437	0.2029	0.1659	0.3069	0.1952
4	-52.18	-29.17	0.0126	2.6906	79.59	0.37	61.78	163.22	0.2015	0.4428	0.2031	0.1675	0.3081	0.1974
6	-48.04	-25.08	0.0126	2.445	79.18	0.41	63.06	163.83	0.2047	0.442	0.2033	0.1691	0.3092	0.1995
8	-44.19	-21.29	0.0127	2.2412	78.8	0.45	64.25	164.39	0.2075	0.4413	0.2036	0.1705	0.3104	0.2014
10	-40.6	-17.76	0.0128	2.0694	78.44	0.48	65.37	164.91	0.2102	0.4407	0.2038	0.1718	0.3114	0.2033
12	-37.23	-14.44	0.0128	1.9224	78.1	0.52	66.42	165.4	0.2127	0.4401	0.2041	0.1731	0.3125	0.205
14	-34.05	-11.31	0.0129	1.7953	77.78	0.56	67.42	165.85	0.215	0.4396	0.2044	0.1743	0.3135	0.2067
16	-31.03	-8.34	0.0129	1.6841	77.47	0.59	68.37	166.29	0.2173	0.4391	0.2047	0.1754	0.3145	0.2083
18	-28.16	-5.53	0.013	1.5861	77.18	0.63	69.28	166.69	0.2194	0.4387	0.205	0.1765	0.3155	0.2099
20	-25.43	-2.84	0.013	1.4989	76.89	0.67	70.14	167.08	0.2213	0.4383	0.2052	0.1775	0.3165	0.2114
22	-22.81	-0.27	0.0131	1.421	76.62	0.7	70.98	167.45	0.2232	0.4379	0.2055	0.1785	0.3174	0.2129
24	-20.29	2.19	0.0131	1.3508	76.36	0.74	71.78	167.8	0.2251	0.4376	0.2058	0.1795	0.3184	0.2143
26	-17.88	4.55	0.0131	1.2873	76.1	0.78	72.55	168.14	0.2268	0.4372	0.2061	0.1804	0.3193	0.2156
28	-15.55	6.83	0.0132	1.2295	75.86	0.81	73.29	168.46	0.2285	0.4369	0.2064	0.1813	0.3202	0.217
30	-13.31	9.03	0.0132	1.1767	75.62	0.85	74.01	168.77	0.2301	0.4366	0.2066	0.1821	0.321	0.2183
32	-11.14	11.15	0.0133	1.1283	75.38	0.89	74.71	169.07	0.2316	0.4364	0.2069	0.1829	0.3219	0.2196
34	-9.04	13.2	0.0133	1.0837	75.16	0.92	75.39	169.35	0.2331	0.4361	0.2072	0.1837	0.3227	0.2208
36	-7	15.19	0.0133	1.0425	74.94	0.96	76.05	169.63	0.2346	0.4359	0.2074	0.1845	0.3236	0.222
38	-5.02	17.12	0.0134	1.0043	74.72	1	76.69	169.89	0.236	0.4356	0.2077	0.1852	0.3244	0.2232
40	-3.1	18.99	0.0134	0.9688	74.51	1.03	77.32	170.15	0.2373	0.4354	0.2079	0.186	0.3252	0.2244
42	-1.23	20.82	0.0135	0.9358	74.31	1.07	77.93	170.4	0.2387	0.4352	0.2082	0.1867	0.326	0.2256
44	0.59	22.59	0.0135	0.9049	74.11	1.11	78.53	170.64	0.24	0.435	0.2084	0.1873	0.3268	0.2267
46	2.36	24.32	0.0135	0.8759	73.91	1.14	79.11	170.88	0.2412	0.4348	0.2087	0.188	0.3276	0.2278
48	4.09	26	0.0136	0.8488	73.72	1.18	79.68	171.1	0.2424	0.4346	0.2089	0.1887	0.3283	0.2289
50	5.78	27.64	0.0136	0.8232	73.53	1.21	80.23	171.32	0.2436	0.4344	0.2091	0.1893	0.3291	0.23
52	7.43	29.25	0.0136	0.7991	73.34	1.25	80.78	171.54	0.2448	0.4342	0.2094	0.1899	0.3299	0.2311
54	9.04	30.82	0.0137	0.7764	73.16	1.29	81.31	171.75	0.2459	0.4341	0.2096	0.1905	0.3306	0.2322
56	10.62	32.35	0.0137	0.7549	72.98	1.32	81.84	171.95	0.247	0.4339	0.2098	0.1911	0.3313	0.2332
58	12.17	33.85	0.0137	0.7346	72.8	1.36	82.35	172.15	0.2481	0.4337	0.2101	0.1917	0.3321	0.2343
60	13.69	35.32	0.0138	0.7153	72.63	1.4	82.86	172.34	0.2491	0.4336	0.2103	0.1923	0.3328	0.2353
62	15.17	36.76	0.0138	0.697	72.46	1.43	83.35	172.53	0.2502	0.4334	0.2105	0.1929	0.3335	0.2363
64	16.63	38.17	0.0138	0.6796	72.29	1.47	83.84	172.71	0.2512	0.4333	0.2107	0.1934	0.3342	0.2373
66	18.06	39.56	0.0139	0.663	72.12	1.51	84.32	172.89	0.2522	0.4331	0.2109	0.194	0.3349	0.2383
68	19.46	40.92	0.0139	0.6471	71.96	1.55	84.79	173.06	0.2532	0.433	0.2111	0.1945	0.3357	0.2393
70	20.84	42.25	0.0139	0.632	71.8	1.58	85.25	173.23	0.2541	0.4329	0.2113	0.195	0.3364	0.2403
72	22.19	43.56	0.014	0.6176	71.64	1.62	85.71	173.4	0.2551	0.4327	0.2116	0.1955	0.337	0.2413
74	23.52	44.85	0.014	0.6038	71.48	1.66	86.16	173.56	0.256	0.4326	0.2118	0.196	0.3377	0.2423
76	24.83	46.11	0.014	0.5906	71.33	1.69	86.61	173.72	0.2569	0.4325	0.212	0.1965	0.3384	0.2432
78	26.12	47.36	0.014	0.5779	71.18	1.73	87.04	173.87	0.2578	0.4324	0.2122	0.197	0.3391	0.2442
80	27.39	48.58	0.0141	0.5658	71.02	1.77	87.47	174.02	0.2587	0.4323	0.2124	0.1975	0.3398	0.2452
82	28.64	49.78	0.0141	0.5541	70.87	1.8	87.9	174.17	0.2595	0.4321	0.2125	0.198	0.3405	0.2461
84	29.87	50.97	0.0141	0.5429	70.73	1.84	88.32	174.32	0.2604	0.432	0.2127	0.1984	0.3411	0.2471
86	31.08	52.14	0.0142	0.5321	70.58	1.88	88.73	174.46	0.2612	0.4319	0.2129	0.1989	0.3418	0.248
88	32.27	53.28	0.0142	0.5217	70.43	1.92	89.14	174.6	0.262	0.4318	0.2131	0.1994	0.3425	0.249
90	33.45	54.42	0.0142	0.5117	70.29	1.95	89.55	174.73	0.2628	0.4317	0.2133	0.1998	0.3431	0.2499
92	34.61	55.53	0.0143	0.5021	70.15	1.99	89.94	174.87	0.2636	0.4316	0.2135	0.2003	0.3438	0.2508
94	35.75	56.63	0.0143	0.4928	70.01	2.03	90.34	175	0.2644	0.4315	0.2137	0.2007	0.3445	0.2518
96	36.88	57.72	0.0143	0.4838	69.87	2.07	90.73	175.13	0.2652	0.4314	0.2139	0.2012	0.3451	0.2527
98	37.99	58.79	0.0143	0.4751	69.73	2.1	91.11	175.25	0.266	0.4313	0.214	0.2016	0.3458	0.2536

Pressure	Liquid Temp	Vapor Temp	Liquid Volume	Vapor Volume	Liquid Density	Vapor Density	Liquid Enthalpy	Vapor Enthalpy	Liquid Entropy	Vapor Entropy	Liquid Cv	Vapor Cv	Liquid Cp	Vapor Cp
psig	°F	°F	ft³/lb	ft³/lb	lb/ft³	lb/ft³	Btu/lb	Btu/lb	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F
100	39.09	59.84	0.0144	0.4667	69.6	2.14	91.49	175.38	0.2667	0.4312	0.2142	0.202	0.3464	0.2546
102	40.18	60.89	0.0144	0.4586	69.46	2.18	91.87	175.5	0.2675	0.4311	0.2144	0.2024	0.3471	0.2555
104	41.25	61.91	0.0144	0.4508	69.33	2.22	92.24	175.62	0.2682	0.431	0.2146	0.2029	0.3477	0.2564
106	42.31	62.93	0.0144	0.4432	69.19	2.26	92.61	175.73	0.2689	0.4309	0.2147	0.2033	0.3484	0.2573
108	43.35	63.93	0.0145	0.4359	69.06	2.29	92.98	175.85	0.2696	0.4308	0.2149	0.2037	0.349	0.2583
110	44.39	64.92	0.0145	0.4287	68.93	2.33	93.34	175.96	0.2703	0.4307	0.2151	0.2041	0.3497	0.2592
112	45.41	65.9	0.0145	0.4218	68.8	2.37	93.7	176.07	0.271	0.4306	0.2152	0.2045	0.3503	0.2601
114	46.42	66.86	0.0146	0.4151	68.67	2.41	94.05	176.18	0.2717	0.4306	0.2154	0.2049	0.351	0.261
116	47.42	67.82	0.0146	0.4086	68.54	2.45	94.4	176.29	0.2724	0.4305	0.2156	0.2053	0.3516	0.2619
118	48.4	68.76	0.0146	0.4023	68.42	2.49	94.75	176.39	0.2731	0.4304	0.2157	0.2057	0.3523	0.2629
120	49.38	69.7	0.0146	0.3962	68.29	2.52	95.09	176.49	0.2737	0.4303	0.2159	0.2061	0.3529	0.2638
122	50.35	70.62	0.0147	0.3902	68.17	2.56	95.43	176.59	0.2744	0.4302	0.2161	0.2064	0.3535	0.2647
124	51.3	71.53	0.0147	0.3844	68.04	2.6	95.77	176.69	0.2751	0.4301	0.2162	0.2068	0.3542	0.2656
126	52.25	72.43	0.0147	0.3788	67.92	2.64	96.11	176.79	0.2757	0.43	0.2164	0.2072	0.3548	0.2666
128	53.18	73.32	0.0148	0.3733	67.8	2.68	96.44	176.88	0.2763	0.43	0.2165	0.2076	0.3555	0.2675
130	54.11	74.21	0.0148	0.3679	67.67	2.72	96.77	176.98	0.277	0.4299	0.2167	0.2079	0.3561	0.2684
132	55.03	75.08	0.0148	0.3627	67.55	2.76	97.1	177.07	0.2776	0.4298	0.2169	0.2083	0.3567	0.2693
134	55.94	75.95	0.0148	0.3576	67.43	2.8	97.42	177.16	0.2782	0.4297	0.217	0.2087	0.3574	0.2703
136	56.84	76.8	0.0148	0.3527	67.31	2.84	97.74	177.25	0.2788	0.4296	0.2172	0.209	0.358	0.2712
138	57.73	77.65	0.0149	0.3479	67.19	2.87	98.06	177.34	0.2794	0.4296	0.2173	0.2094	0.3587	0.2721
140	58.61	78.49	0.0149	0.3432	67.08	2.91	98.38	177.42	0.28	0.4295	0.2175	0.2098	0.3593	0.273
142	59.48	79.32	0.0149	0.3386	66.96	2.95	98.69	177.51	0.2806	0.4294	0.2176	0.2101	0.3599	0.274
144	60.35	80.14	0.015	0.3341	66.84	2.99	99	177.59	0.2812	0.4293	0.2178	0.2105	0.3606	0.2749
146	61.21	80.95	0.015	0.3298	66.73	3.03	99.31	177.67	0.2818	0.4292	0.2179	0.2108	0.3612	0.2758
148	62.06	81.76	0.015	0.3255	66.61	3.07	99.62	177.75	0.2824	0.4292	0.2181	0.2112	0.3619	0.2768
150	62.9	82.56	0.015	0.3214	66.5	3.11	99.92	177.83	0.2829	0.4291	0.2182	0.2115	0.3625	0.2777
152	63.73	83.35	0.0151	0.3173	66.38	3.15	100.22	177.91	0.2835	0.429	0.2184	0.2118	0.3632	0.2786
154	64.56	84.14	0.0151	0.3133	66.27	3.19	100.52	177.99	0.2841	0.4289	0.2185	0.2122	0.3638	0.2796
156	65.38	84.91	0.0151	0.3094	66.16	3.23	100.82	178.06	0.2846	0.4289	0.2187	0.2125	0.3644	0.2805
158	66.2	85.68	0.0151	0.3056	66.04	3.27	101.12	178.13	0.2852	0.4288	0.2188	0.2129	0.3651	0.2815
160	67	86.45	0.0152	0.3019	65.93	3.31	101.41	178.21	0.2857	0.4287	0.219	0.2132	0.3657	0.2824
162	67.81	87.2	0.0152	0.2983	65.82	3.35	101.7	178.28	0.2863	0.4287	0.2191	0.2135	0.3664	0.2834
164	68.6	87.95	0.0152	0.2947	65.71	3.39	101.99	178.35	0.2868	0.4286	0.2193	0.2139	0.367	0.2843
166	69.39	88.7	0.0152	0.2912	65.6	3.43	102.28	178.42	0.2873	0.4285	0.2194	0.2142	0.3677	0.2853
168	70.17	89.44	0.0153	0.2878	65.49	3.47	102.57	178.48	0.2879	0.4284	0.2196	0.2145	0.3683	0.2863
170	70.94	90.17	0.0153	0.2845	65.38	3.51	102.85	178.55	0.2884	0.4284	0.2197	0.2148	0.369	0.2872
172	71.71	90.89	0.0153	0.2812	65.27	3.56	103.14	178.62	0.2889	0.4283	0.2198	0.2152	0.3697	0.2882
174	72.48	91.61	0.0153	0.278	65.16	3.6	103.42	178.68	0.2894	0.4282	0.22	0.2155	0.3703	0.2892
176	73.23	92.33	0.0154	0.2749	65.05	3.64	103.7	178.74	0.29	0.4282	0.2201	0.2158	0.371	0.2901
178	73.99	93.03	0.0154	0.2718	64.95	3.68	103.98	178.81	0.2905	0.4281	0.2203	0.2161	0.3716	0.2911
180	74.73	93.74	0.0154	0.2688	64.84	3.72	104.25	178.87	0.291	0.428	0.2204	0.2164	0.3723	0.2921
182	75.47	94.43	0.0154	0.2658	64.73	3.76	104.53	178.93	0.2915	0.4279	0.2205	0.2167	0.373	0.2931
184	76.21	95.12	0.0155	0.2629	64.62	3.8	104.8	178.99	0.292	0.4279	0.2207	0.217	0.3736	0.2941
186	76.94	95.81	0.0155	0.2601	64.52	3.84	105.07	179.04	0.2925	0.4278	0.2208	0.2174	0.3743	0.2951
188	77.66	96.49	0.0155	0.2573	64.41	3.89	105.34	179.1	0.293	0.4277	0.221	0.2177	0.375	0.2961
190	78.38	97.17	0.0156	0.2546	64.31	3.93	105.61	179.16	0.2935	0.4277	0.2211	0.218	0.3757	0.2971
192	79.1	97.84	0.0156	0.2519	64.2	3.97	105.87	179.21	0.2939	0.4276	0.2212	0.2183	0.3764	0.2981
194	79.81	98.5	0.0156	0.2492	64.1	4.01	106.14	179.27	0.2944	0.4275	0.2214	0.2186	0.377	0.2991
196	80.51	99.16	0.0156	0.2466	63.99	4.05	106.4	179.32	0.2949	0.4275	0.2215	0.2189	0.3777	0.3001
198	81.21	99.82	0.0157	0.2441	63.89	4.1	106.67	179.37	0.2954	0.4274	0.2216	0.2192	0.3784	0.3011
200	81.91	100.47	0.0157	0.2416	63.79	4.14	106.93	179.42	0.2958	0.4273	0.2218	0.2195	0.3791	0.3021

Pressure	Liquid Temp	Vapor Temp	Liquid Volume	Vapor Volume	Liquid Density	Vapor Density	Liquid Enthalpy	Vapor Enthalpy	Liquid Entropy	Vapor Entropy	Liquid Cv	Vapor Cv	Liquid Cp	Vapor Cp
psig	°F	°F	ft³/lb	ft³/lb	lb/ft³	lb/ft³	Btu/lb	Btu/lb	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F	Btu/lb-F
202	82.6	101.12	0.0157	0.2391	63.68	4.18	107.19	179.47	0.2963	0.4272	0.2219	0.2198	0.3798	0.3032
204	83.28	101.76	0.0157	0.2367	63.58	4.22	107.45	179.52	0.2968	0.4272	0.222	0.2201	0.3805	0.3042
206	83.97	102.39	0.0157	0.2344	63.48	4.27	107.7	179.57	0.2972	0.4271	0.2222	0.2204	0.3812	0.3052
208	84.64	103.03	0.0158	0.232	63.38	4.31	107.96	179.62	0.2977	0.427	0.2223	0.2207	0.3819	0.3063
210	85.32	103.65	0.0158	0.2297	63.27	4.35	108.22	179.67	0.2982	0.427	0.2224	0.221	0.3826	0.3073
212	85.98	104.28	0.0158	0.2275	63.17	4.4	108.47	179.71	0.2986	0.4269	0.2226	0.2212	0.3833	0.3084
214	86.65	104.9	0.0159	0.2253	63.07	4.44	108.72	179.76	0.2991	0.4268	0.2227	0.2215	0.3841	0.3094
216	87.31	105.51	0.0159	0.2231	62.97	4.48	108.97	179.8	0.2995	0.4268	0.2228	0.2218	0.3848	0.3105
218	87.96	106.12	0.0159	0.2209	62.87	4.53	109.22	179.84	0.3	0.4267	0.223	0.2221	0.3855	0.3116
220	88.62	106.73	0.0159	0.2188	62.77	4.57	109.47	179.89	0.3004	0.4266	0.2231	0.2224	0.3862	0.3127
222	89.26	107.34	0.016	0.2168	62.67	4.61	109.72	179.93	0.3008	0.4266	0.2232	0.2227	0.387	0.3137
224	89.91	107.93	0.016	0.2147	62.57	4.66	109.97	179.97	0.3013	0.4265	0.2233	0.223	0.3877	0.3148
226	90.55	108.53	0.016	0.2127	62.47	4.7	110.21	180.01	0.3017	0.4264	0.2235	0.2232	0.3885	0.3159
228	91.19	109.12	0.016	0.2107	62.37	4.75	110.46	180.05	0.3022	0.4264	0.2236	0.2235	0.3892	0.317
230	91.82	109.71	0.0161	0.2088	62.27	4.79	110.7	180.09	0.3026	0.4263	0.2237	0.2238	0.39	0.3181
232	92.45	110.29	0.0161	0.2069	62.17	4.83	110.94	180.12	0.303	0.4262	0.2238	0.2241	0.3907	0.3193
234	93.07	110.87	0.0161	0.205	62.07	4.88	111.18	180.16	0.3034	0.4261	0.224	0.2244	0.3915	0.3204
236	93.7	111.45	0.0161	0.2031	61.97	4.92	111.42	180.2	0.3039	0.4261	0.2241	0.2246	0.3923	0.3215
238	94.31	112.02	0.0162	0.2013	61.87	4.97	111.66	180.23	0.3043	0.426	0.2242	0.2249	0.393	0.3226
240	94.93	112.59	0.0162	0.1995	61.77	5.01	111.9	180.27	0.3047	0.4259	0.2243	0.2252	0.3938	0.3238
242	95.54	113.16	0.0162	0.1977	61.68	5.06	112.14	180.3	0.3051	0.4259	0.2245	0.2254	0.3946	0.3249
244	96.15	113.72	0.0162	0.196	61.58	5.1	112.38	180.33	0.3055	0.4258	0.2246	0.2257	0.3954	0.3261
246	96.75	114.28	0.0163	0.1942	61.48	5.15	112.61	180.37	0.3059	0.4257	0.2247	0.226	0.3962	0.3273
248	97.35	114.83	0.0163	0.1925	61.38	5.19	112.85	180.4	0.3064	0.4257	0.2248	0.2263	0.397	0.3284
250	97.95	115.39	0.0163	0.1908	61.29	5.24	113.08	180.43	0.3068	0.4256	0.225	0.2265	0.3978	0.3296
252	98.55	115.94	0.0163	0.1892	61.19	5.29	113.31	180.46	0.3072	0.4255	0.2251	0.2268	0.3986	0.3308
254	99.14	116.48	0.0164	0.1876	61.09	5.33	113.54	180.49	0.3076	0.4255	0.2252	0.2271	0.3994	0.332
256	99.73	117.02	0.0164	0.186	60.99	5.38	113.78	180.52	0.308	0.4254	0.2253	0.2273	0.4002	0.3332
258	100.31	117.56	0.0164	0.1844	60.9	5.42	114.01	180.54	0.3084	0.4253	0.2254	0.2276	0.401	0.3344
260	100.9	118.1	0.0165	0.1828	60.8	5.47	114.24	180.57	0.3088	0.4252	0.2256	0.2279	0.4019	0.3356
262	101.48	118.63	0.0165	0.1813	60.7	5.52	114.46	180.6	0.3092	0.4252	0.2257	0.2281	0.4027	0.3369
264	102.05	119.16	0.0165	0.1797	60.61	5.56	114.69	180.62	0.3096	0.4251	0.2258	0.2284	0.4036	0.3381
266	102.63	119.69	0.0165	0.1782	60.51	5.61	114.92	180.65	0.31	0.425	0.2259	0.2286	0.4044	0.3394
268	103.2	120.22	0.0165	0.1767	60.41	5.66	115.15	180.67	0.3104	0.425	0.226	0.2289	0.4053	0.3406
270	103.77	120.74	0.0166	0.1753	60.32	5.7	115.37	180.7	0.3107	0.4249	0.2262	0.2292	0.4062	0.3419
272	104.33	121.26	0.0166	0.1738	60.22	5.75	115.6	180.72	0.3111	0.4248	0.2263	0.2294	0.407	0.3432
274	104.89	121.77	0.0166	0.1724	60.13	5.8	115.82	180.74	0.3115	0.4247	0.2264	0.2297	0.4079	0.3445
276	105.45	122.28	0.0167	0.171	60.03	5.85	116.04	180.77	0.3119	0.4247	0.2265	0.2299	0.4088	0.3458
278	106.01	122.79	0.0167	0.1696	59.93	5.9	116.27	180.79	0.3123	0.4246	0.2266	0.2302	0.4097	0.3471
280	106.56	123.3	0.0167	0.1683	59.84	5.94	116.49	180.81	0.3127	0.4245	0.2267	0.2305	0.4106	0.3484
282	107.11	123.81	0.0167	0.1669	59.74	5.99	116.71	180.83	0.3131	0.4245	0.2269	0.2307	0.4115	0.3497
284	107.66	124.31	0.0168	0.1656	59.65	6.04	116.93	180.85	0.3134	0.4244	0.227	0.231	0.4124	0.351
286	108.21	124.81	0.0168	0.1643	59.55	6.09	117.15	180.87	0.3138	0.4243	0.2271	0.2312	0.4133	0.3524
288	108.75	125.3	0.0168	0.163	59.46	6.14	117.37	180.88	0.3142	0.4242	0.2272	0.2315	0.4143	0.3538
290	109.29	125.8	0.0169	0.1617	59.36	6.19	117.59	180.9	0.3146	0.4242	0.2273	0.2317	0.4152	0.3551
292	109.83	126.29	0.0169	0.1604	59.26	6.23	117.81	180.92	0.3149	0.4241	0.2274	0.232	0.4162	0.3565
294	110.37	126.78	0.0169	0.1591	59.17	6.28	118.03	180.93	0.3153	0.424	0.2276	0.2322	0.4171	0.3579
296	110.9	127.26	0.0169	0.1579	59.07	6.33	118.24	180.95	0.3157	0.4239	0.2277	0.2325	0.4181	0.3593
298	111.43	127.75	0.0169	0.1567	58.98	6.38	118.46	180.96	0.316	0.4239	0.2278	0.2327	0.4191	0.3607
300	111.96	128.23	0.017	0.1555	58.88	6.43	118.67	180.98	0.3164	0.4238	0.2279	0.233	0.42	0.3622

Thermodynamic Table (International Units)

Pressure	Liquid Temp	Vapor Temp	Liquid Volume	Vapor Volume	Liquid Density	Vapor Density	Liquid Enthalpy	Vapor Enthalpy	Liquid Entropy	Vapor Entropy	Liquid Cv	Vapor Cv	Liquid Cp	Vapor Cp
kPa	°C	°C	m³/kg	m³/kg	kg/m³	kg/m³	kJ/kg	kJ/kg	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K
105	-51.26	-38.42	0.0008	0.2037	1287.61	4.91	137.9	376.86	0.8181	1.8608	0.8492	0.689	1.2812	0.81
120	-48.36	-35.55	0.0008	0.1797	1279.47	5.57	141.63	378.66	0.8348	1.8562	0.8499	0.697	1.2867	0.8206
135	-45.73	-32.96	0.0008	0.1608	1272.03	6.22	145.03	380.28	0.8497	1.8524	0.8508	0.7044	1.292	0.8304
150	-43.31	-30.58	0.0008	0.1456	1265.14	6.87	148.16	381.76	0.8634	1.849	0.8518	0.7111	1.2972	0.8396
165	-41.08	-28.38	0.0008	0.1331	1258.71	7.51	151.07	383.12	0.8759	1.846	0.853	0.7174	1.3022	0.8482
180	-39	-26.33	0.0008	0.1226	1252.68	8.16	153.79	384.39	0.8875	1.8434	0.8542	0.7232	1.3071	0.8563
195	-37.05	-24.41	0.0008	0.1136	1246.98	8.8	156.35	385.56	0.8984	1.841	0.8555	0.7287	1.3118	0.8641
210	-35.21	-22.61	0.0008	0.1059	1241.56	9.44	158.77	386.66	0.9085	1.8388	0.8568	0.7339	1.3165	0.8715
225	-33.47	-20.9	0.0008	0.0992	1236.4	10.08	161.07	387.7	0.9181	1.8368	0.8581	0.7389	1.3209	0.8786
240	-31.82	-19.27	0.0008	0.0933	1231.47	10.72	163.26	388.68	0.9272	1.835	0.8594	0.7436	1.3253	0.8854
255	-30.24	-17.73	0.0008	0.088	1226.73	11.36	165.36	389.61	0.9358	1.8333	0.8606	0.748	1.3296	0.892
270	-28.74	-16.25	0.0008	0.0834	1222.17	11.99	167.37	390.49	0.944	1.8317	0.8619	0.7523	1.3338	0.8984
285	-27.29	-14.84	0.0008	0.0792	1217.78	12.63	169.31	391.33	0.9518	1.8302	0.8632	0.7564	1.3379	0.9046
300	-25.9	-13.48	0.0008	0.0754	1213.53	13.27	171.17	392.13	0.9593	1.8288	0.8644	0.7603	1.3419	0.9107
315	-24.57	-12.17	0.0008	0.0719	1209.42	13.9	172.97	392.9	0.9666	1.8276	0.8657	0.7641	1.3459	0.9166
330	-23.28	-10.91	0.0008	0.0688	1205.42	14.54	174.71	393.64	0.9735	1.8263	0.8669	0.7678	1.3498	0.9223
345	-22.04	-9.7	0.0008	0.0659	1201.55	15.17	176.4	394.35	0.9802	1.8252	0.8681	0.7713	1.3536	0.9279
360	-20.83	-8.52	0.0008	0.0633	1197.77	15.81	178.04	395.03	0.9866	1.8241	0.8692	0.7748	1.3573	0.9334
375	-19.66	-7.38	0.0008	0.0608	1194.1	16.44	179.63	395.68	0.9929	1.8231	0.8704	0.7781	1.361	0.9388
390	-18.53	-6.28	0.0008	0.0585	1190.51	17.08	181.17	396.32	0.9989	1.8221	0.8715	0.7813	1.3647	0.9441
405	-17.43	-5.21	0.0008	0.0564	1187.01	17.72	182.68	396.93	1.0048	1.8211	0.8727	0.7844	1.3683	0.9493
420	-16.36	-4.16	0.0008	0.0545	1183.58	18.35	184.15	397.52	1.0105	1.8202	0.8738	0.7875	1.3718	0.9544
435	-15.32	-3.15	0.0008	0.0527	1180.23	18.99	185.59	398.09	1.016	1.8194	0.8749	0.7905	1.3753	0.9594
450	-14.3	-2.16	0.0008	0.051	1176.95	19.63	186.99	398.64	1.0214	1.8186	0.8759	0.7933	1.3788	0.9644
465	-13.31	-1.2	0.0009	0.0493	1173.73	20.26	188.36	399.18	1.0266	1.8178	0.877	0.7962	1.3822	0.9692
480	-12.35	-0.26	0.0009	0.0478	1170.58	20.9	189.7	399.7	1.0317	1.817	0.878	0.7989	1.3856	0.9741
495	-11.4	0.66	0.0009	0.0464	1167.48	21.54	191.01	400.21	1.0367	1.8163	0.8791	0.8016	1.3889	0.9788
510	-10.48	1.55	0.0009	0.0451	1164.44	22.18	192.3	400.7	1.0415	1.8156	0.8801	0.8042	1.3923	0.9836
525	-9.58	2.43	0.0009	0.0438	1161.45	22.82	193.56	401.18	1.0463	1.8149	0.8811	0.8068	1.3956	0.9882
540	-8.69	3.28	0.0009	0.0426	1158.5	23.46	194.8	401.64	1.0509	1.8142	0.8821	0.8093	1.3988	0.9928
555	-7.82	4.12	0.0009	0.0415	1155.61	24.1	196.02	402.09	1.0555	1.8136	0.883	0.8118	1.4021	0.9974
570	-6.98	4.94	0.0009	0.0404	1152.76	24.75	197.21	402.53	1.0599	1.8129	0.884	0.8142	1.4053	1.0019
585	-6.14	5.75	0.0009	0.0394	1149.95	25.39	198.38	402.96	1.0643	1.8123	0.8849	0.8166	1.4085	1.0064
600	-5.33	6.54	0.0009	0.0384	1147.18	26.03	199.54	403.38	1.0685	1.8117	0.8859	0.819	1.4116	1.0109
615	-4.53	7.31	0.0009	0.0375	1144.45	26.68	200.67	403.79	1.0727	1.8112	0.8868	0.8213	1.4148	1.0154
630	-3.74	8.08	0.0009	0.0366	1141.76	27.32	201.79	404.19	1.0768	1.8106	0.8877	0.8235	1.4179	1.0198
645	-2.96	8.82	0.0009	0.0357	1139.1	27.97	202.89	404.58	1.0808	1.8101	0.8886	0.8257	1.421	1.0241
660	-2.2	9.56	0.0009	0.0349	1136.47	28.62	203.97	404.96	1.0848	1.8095	0.8895	0.8279	1.4241	1.0285
675	-1.46	10.28	0.0009	0.0342	1133.88	29.27	205.04	405.33	1.0887	1.809	0.8904	0.8301	1.4272	1.0328
690	-0.72	10.99	0.0009	0.0334	1131.32	29.92	206.1	405.69	1.0925	1.8085	0.8912	0.8322	1.4302	1.0372
705	0	11.68	0.0009	0.0327	1128.79	30.57	207.13	406.04	1.0963	1.808	0.8921	0.8343	1.4333	1.0415
720	0.72	12.37	0.0009	0.032	1126.29	31.22	208.16	406.39	1.1	1.8075	0.893	0.8364	1.4363	1.0458
735	1.42	13.05	0.0009	0.0314	1123.81	31.88	209.17	406.73	1.1036	1.807	0.8938	0.8384	1.4393	1.05
750	2.11	13.71	0.0009	0.0307	1121.36	32.53	210.17	407.06	1.1072	1.8066	0.8946	0.8404	1.4423	1.0543
765	2.79	14.36	0.0009	0.0301	1118.94	33.19	211.15	407.39	1.1107	1.8061	0.8954	0.8424	1.4453	1.0585
780	3.46	15.01	0.0009	0.0295	1116.54	33.85	212.12	407.7	1.1142	1.8057	0.8963	0.8444	1.4483	1.0628
795	4.12	15.65	0.0009	0.029	1114.17	34.5	213.09	408.01	1.1176	1.8052	0.8971	0.8463	1.4513	1.067
810	4.78	16.27	0.0009	0.0284	1111.82	35.16	214.03	408.32	1.121	1.8048	0.8979	0.8482	1.4543	1.0712
825	5.42	16.89	0.0009	0.0279	1109.49	35.83	214.97	408.62	1.1243	1.8043	0.8987	0.8501	1.4572	1.0754
840	6.06	17.5	0.0009	0.0274	1107.18	36.49	215.9	408.91	1.1276	1.8039	0.8994	0.852	1.4602	1.0796

Pressure	Liquid Temp	Vapor Temp	Liquid Volume	Vapor Volume	Liquid Density	Vapor Density	Liquid Enthalpy	Vapor Enthalpy	Liquid Entropy	Vapor Entropy	Liquid Cv	Vapor Cv	Liquid Cp	Vapor Cp
kPa	°C	°C	m³/kg	m³/kg	kg/m³	kg/m³	kJ/kg	kJ/kg	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K
855	6.69	18.1	0.0009	0.0269	1104.89	37.15	216.82	409.2	1.1308	1.8035	0.9002	0.8539	1.4631	1.0838
870	7.3	18.69	0.0009	0.0264	1102.62	37.82	217.73	409.48	1.134	1.8031	0.901	0.8557	1.4661	1.088
885	7.92	19.28	0.0009	0.026	1100.38	38.48	218.62	409.75	1.1372	1.8027	0.9018	0.8575	1.469	1.0922
900	8.52	19.86	0.0009	0.0255	1098.15	39.15	219.51	410.02	1.1403	1.8023	0.9025	0.8593	1.4719	1.0964
915	9.12	20.43	0.0009	0.0251	1095.93	39.82	220.39	410.28	1.1433	1.8019	0.9033	0.8611	1.4749	1.1006
930	9.71	20.99	0.0009	0.0247	1093.74	40.49	221.26	410.54	1.1464	1.8015	0.904	0.8628	1.4778	1.1048
945	10.29	21.55	0.0009	0.0243	1091.56	41.17	222.13	410.8	1.1494	1.8011	0.9047	0.8646	1.4807	1.109
960	10.87	22.1	0.0009	0.0239	1089.4	41.84	222.98	411.05	1.1523	1.8007	0.9055	0.8663	1.4836	1.1132
975	11.44	22.64	0.0009	0.0235	1087.26	42.51	223.82	411.29	1.1552	1.8004	0.9062	0.868	1.4865	1.1174
990	12	23.18	0.0009	0.0232	1085.13	43.19	224.66	411.53	1.1581	1.8	0.9069	0.8697	1.4894	1.1216
1005	12.56	23.71	0.0009	0.0228	1083.01	43.87	225.49	411.77	1.161	1.7996	0.9077	0.8714	1.4924	1.1258
1020	13.11	24.23	0.0009	0.0224	1080.91	44.55	226.31	412	1.1638	1.7993	0.9084	0.8731	1.4953	1.13
1035	13.65	24.75	0.0009	0.0221	1078.83	45.23	227.13	412.22	1.1666	1.7989	0.9091	0.8748	1.4982	1.1342
1050	14.19	25.27	0.0009	0.0218	1076.75	45.92	227.94	412.45	1.1694	1.7985	0.9098	0.8764	1.5011	1.1385
1065	14.73	25.77	0.0009	0.0215	1074.69	46.6	228.74	412.66	1.1721	1.7982	0.9105	0.878	1.504	1.1427
1080	15.25	26.27	0.0009	0.0211	1072.65	47.29	229.53	412.88	1.1748	1.7978	0.9112	0.8796	1.5069	1.1469
1095	15.78	26.77	0.0009	0.0208	1070.62	47.98	230.32	413.09	1.1775	1.7975	0.9119	0.8812	1.5098	1.1512
1110	16.3	27.26	0.0009	0.0205	1068.59	48.67	231.1	413.29	1.1802	1.7971	0.9126	0.8828	1.5128	1.1554
1125	16.81	27.75	0.0009	0.0203	1066.59	49.36	231.88	413.5	1.1828	1.7968	0.9132	0.8844	1.5157	1.1597
1140	17.32	28.23	0.0009	0.02	1064.59	50.05	232.65	413.7	1.1854	1.7964	0.9139	0.886	1.5186	1.164
1155	17.82	28.71	0.0009	0.0197	1062.6	50.75	233.41	413.89	1.188	1.7961	0.9146	0.8875	1.5216	1.1683
1170	18.32	29.18	0.0009	0.0194	1060.63	51.45	234.17	414.08	1.1905	1.7958	0.9153	0.8891	1.5245	1.1726
1185	18.81	29.65	0.0009	0.0192	1058.66	52.14	234.92	414.27	1.1931	1.7954	0.9159	0.8906	1.5274	1.1769
1200	19.3	30.11	0.0009	0.0189	1056.71	52.85	235.66	414.45	1.1956	1.7951	0.9166	0.8921	1.5304	1.1812
1215	19.79	30.57	0.0009	0.0187	1054.76	53.55	236.4	414.64	1.198	1.7948	0.9173	0.8937	1.5333	1.1855
1230	20.27	31.02	0.001	0.0184	1052.83	54.25	237.14	414.81	1.2005	1.7944	0.9179	0.8952	1.5363	1.1899
1245	20.74	31.47	0.001	0.0182	1050.9	54.96	237.87	414.99	1.2029	1.7941	0.9186	0.8967	1.5393	1.1942
1260	21.22	31.92	0.001	0.018	1048.99	55.67	238.59	415.16	1.2053	1.7938	0.9192	0.8981	1.5423	1.1986
1275	21.68	32.36	0.001	0.0177	1047.08	56.38	239.31	415.33	1.2077	1.7935	0.9199	0.8996	1.5452	1.203
1290	22.15	32.8	0.001	0.0175	1045.18	57.09	240.03	415.49	1.2101	1.7931	0.9205	0.9011	1.5482	1.2074
1305	22.61	33.23	0.001	0.0173	1043.29	57.8	240.74	415.65	1.2125	1.7928	0.9212	0.9025	1.5512	1.2118
1320	23.07	33.66	0.001	0.0171	1041.41	58.52	241.44	415.81	1.2148	1.7925	0.9218	0.904	1.5543	1.2163
1335	23.52	34.09	0.001	0.0169	1039.54	59.24	242.15	415.97	1.2171	1.7922	0.9225	0.9054	1.5573	1.2207
1350	23.97	34.51	0.001	0.0167	1037.67	59.96	242.84	416.12	1.2194	1.7918	0.9231	0.9068	1.5603	1.2252
1365	24.41	34.93	0.001	0.0165	1035.82	60.68	243.53	416.27	1.2217	1.7915	0.9237	0.9083	1.5634	1.2297
1380	24.86	35.35	0.001	0.0163	1033.97	61.41	244.22	416.42	1.224	1.7912	0.9244	0.9097	1.5664	1.2342
1395	25.29	35.76	0.001	0.0161	1032.13	62.13	244.91	416.57	1.2262	1.7909	0.925	0.9111	1.5695	1.2388
1410	25.73	36.17	0.001	0.0159	1030.29	62.86	245.58	416.71	1.2284	1.7906	0.9256	0.9125	1.5726	1.2433
1425	26.16	36.57	0.001	0.0157	1028.46	63.59	246.26	416.85	1.2306	1.7903	0.9262	0.9139	1.5757	1.2479
1440	26.59	36.97	0.001	0.0155	1026.64	64.32	246.93	416.98	1.2328	1.7899	0.9269	0.9152	1.5788	1.2525
1455	27.02	37.37	0.001	0.0154	1024.83	65.06	247.6	417.12	1.235	1.7896	0.9275	0.9166	1.582	1.2571
1470	27.44	37.77	0.001	0.0152	1023.02	65.8	248.26	417.25	1.2372	1.7893	0.9281	0.918	1.5851	1.2618
1485	27.86	38.16	0.001	0.015	1021.22	66.54	248.92	417.38	1.2393	1.789	0.9287	0.9193	1.5883	1.2665
1500	28.27	38.55	0.001	0.0149	1019.42	67.28	249.58	417.5	1.2414	1.7887	0.9293	0.9207	1.5915	1.2712
1515	28.69	38.94	0.001	0.0147	1017.63	68.02	250.23	417.63	1.2436	1.7884	0.9299	0.922	1.5946	1.2759
1530	29.1	39.32	0.001	0.0145	1015.85	68.77	250.88	417.75	1.2457	1.788	0.9305	0.9234	1.5979	1.2806
1545	29.51	39.7	0.001	0.0144	1014.07	69.51	251.53	417.87	1.2477	1.7877	0.9311	0.9247	1.6011	1.2854
1560	29.91	40.08	0.001	0.0142	1012.3	70.27	252.17	417.99	1.2498	1.7874	0.9317	0.926	1.6043	1.2902
1575	30.31	40.45	0.001	0.0141	1010.53	71.02	252.81	418.1	1.2519	1.7871	0.9323	0.9273	1.6076	1.295
1590	30.71	40.83	0.001	0.0139	1008.77	71.77	253.44	418.21	1.2539	1.7868	0.9329	0.9287	1.6109	1.2999
1605	31.11	41.2	0.001	0.0138	1007.01	72.53	254.08	418.32	1.256	1.7865	0.9335	0.93	1.6142	1.3047

Pressure	Liquid Temp	Vapor Temp	Liquid Volume	Vapor Volume	Liquid Density	Vapor Density	Liquid Enthalpy	Vapor Enthalpy	Liquid Entropy	Vapor Entropy	Liquid Cv	Vapor Cv	Liquid Cp	Vapor Cp
kPa	°C	°C	m³/kg	m³/kg	kg/m³	kg/m³	kJ/kg	kJ/kg	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K	kJ/kg-K
1620	31.5	41.56	0.001	0.0136	1005.26	73.29	254.71	418.43	1.258	1.7862	0.9341	0.9313	1.6175	1.3096
1635	31.89	41.93	0.001	0.0135	1003.51	74.05	255.33	418.53	1.26	1.7859	0.9347	0.9325	1.6209	1.3146
1650	32.28	42.29	0.001	0.0134	1001.76	74.82	255.96	418.64	1.262	1.7855	0.9352	0.9338	1.6243	1.3196
1665	32.67	42.65	0.001	0.0132	1000.02	75.59	256.58	418.74	1.264	1.7852	0.9358	0.9351	1.6277	1.3246
1680	33.05	43	0.001	0.0131	998.29	76.36	257.19	418.83	1.2659	1.7849	0.9364	0.9364	1.6311	1.3296
1695	33.43	43.36	0.001	0.013	996.56	77.13	257.81	418.93	1.2679	1.7846	0.937	0.9377	1.6345	1.3347
1710	33.81	43.71	0.001	0.0128	994.83	77.9	258.42	419.03	1.2698	1.7843	0.9376	0.9389	1.638	1.3397
1725	34.19	44.06	0.001	0.0127	993.11	78.68	259.03	419.12	1.2718	1.784	0.9381	0.9402	1.6415	1.3449
1740	34.56	44.4	0.001	0.0126	991.39	79.46	259.64	419.21	1.2737	1.7837	0.9387	0.9414	1.645	1.35
1755	34.93	44.75	0.001	0.0125	989.68	80.25	260.24	419.29	1.2756	1.7833	0.9393	0.9427	1.6485	1.3552
1770	35.3	45.09	0.001	0.0123	987.96	81.03	260.84	419.38	1.2775	1.783	0.9398	0.9439	1.6521	1.3605
1785	35.67	45.43	0.001	0.0122	986.26	81.82	261.44	419.46	1.2794	1.7827	0.9404	0.9451	1.6557	1.3658
1800	36.04	45.77	0.001	0.0121	984.55	82.61	262.03	419.55	1.2813	1.7824	0.9409	0.9464	1.6593	1.3711
1815	36.4	46.1	0.001	0.012	982.85	83.4	262.63	419.63	1.2831	1.7821	0.9415	0.9476	1.6629	1.3764
1830	36.76	46.44	0.001	0.0119	981.15	84.2	263.22	419.7	1.285	1.7818	0.9421	0.9488	1.6666	1.3818
1845	37.12	46.77	0.001	0.0118	979.45	85	263.81	419.78	1.2868	1.7814	0.9426	0.95	1.6703	1.3872
1860	37.48	47.1	0.001	0.0117	977.76	85.8	264.39	419.85	1.2887	1.7811	0.9432	0.9513	1.674	1.3927
1875	37.83	47.42	0.001	0.0115	976.07	86.61	264.98	419.92	1.2905	1.7808	0.9437	0.9525	1.6778	1.3982
1890	38.18	47.75	0.001	0.0114	974.38	87.41	265.56	419.99	1.2923	1.7805	0.9442	0.9537	1.6816	1.4038
1905	38.53	48.07	0.001	0.0113	972.7	88.22	266.14	420.06	1.2941	1.7802	0.9448	0.9549	1.6854	1.4094
1920	38.88	48.39	0.001	0.0112	971.01	89.04	266.72	420.13	1.2959	1.7798	0.9453	0.9561	1.6893	1.415
1935	39.23	48.71	0.001	0.0111	969.33	89.85	267.29	420.19	1.2977	1.7795	0.9459	0.9573	1.6932	1.4207
1950	39.57	49.03	0.001	0.011	967.65	90.67	267.86	420.25	1.2995	1.7792	0.9464	0.9584	1.6971	1.4264
1965	39.92	49.34	0.001	0.0109	965.98	91.5	268.44	420.31	1.3013	1.7789	0.947	0.9596	1.701	1.4322
1980	40.26	49.66	0.001	0.0108	964.3	92.32	269	420.37	1.3031	1.7786	0.9475	0.9608	1.705	1.4381
1995	40.6	49.97	0.001	0.0107	962.63	93.15	269.57	420.43	1.3048	1.7782	0.948	0.962	1.709	1.4439
2010	40.94	50.28	0.001	0.0106	960.96	93.98	270.14	420.48	1.3066	1.7779	0.9486	0.9632	1.7131	1.4499
2025	41.27	50.58	0.001	0.0105	959.29	94.82	270.7	420.54	1.3083	1.7776	0.9491	0.9643	1.7172	1.4558
2040	41.61	50.89	0.001	0.0105	957.62	95.65	271.26	420.59	1.31	1.7772	0.9496	0.9655	1.7213	1.4619
2055	41.94	51.19	0.001	0.0104	955.96	96.5	271.82	420.64	1.3118	1.7769	0.9502	0.9666	1.7255	1.4679
2070	42.27	51.49	0.001	0.0103	954.29	97.34	272.38	420.68	1.3135	1.7766	0.9507	0.9678	1.7297	1.4741
2085	42.6	51.79	0.001	0.0102	952.63	98.19	272.93	420.73	1.3152	1.7762	0.9512	0.969	1.7339	1.4803
2100	42.92	52.09	0.0011	0.0101	950.96	99.04	273.49	420.77	1.3169	1.7759	0.9518	0.9701	1.7382	1.4865
2115	43.25	52.39	0.0011	0.01	949.3	99.89	274.04	420.81	1.3186	1.7756	0.9523	0.9713	1.7425	1.4928
2130	43.57	52.69	0.0011	0.0099	947.64	100.75	274.59	420.85	1.3203	1.7752	0.9528	0.9724	1.7469	1.4992
2145	43.9	52.98	0.0011	0.0098	945.98	101.61	275.14	420.89	1.322	1.7749	0.9533	0.9735	1.7513	1.5056
2160	44.22	53.27	0.0011	0.0098	944.32	102.48	275.68	420.93	1.3236	1.7746	0.9539	0.9747	1.7557	1.5121
2175	44.54	53.56	0.0011	0.0097	942.66	103.34	276.23	420.96	1.3253	1.7742	0.9544	0.9758	1.7602	1.5186
2190	44.85	53.85	0.0011	0.0096	941.01	104.21	276.77	421	1.327	1.7739	0.9549	0.9769	1.7647	1.5252

Transport Properties (English Units)

Pressure	Liquid Temp	Vapor Temp	Liquid Speed Of Sound	Vapor Speed Of Sound	Liquid Thermal Conductivity	Vapor Thermal Conductivity	Liquid Viscosity	Vapor Viscosity
psig	°F	°F	ft/s	ft/s	Btu/h-ft-F	Btu/h-ft-F	lb/ft-hr	lb/ft-hr
0	-61.64	-38.51	2596.87	508.48	0.066	0.005	0.8235	0.0227
2	-56.69	-33.62	2557.87	509.72	0.065	0.005	0.7907	0.023
4	-52.18	-29.17	2522.13	510.73	0.064	0.005	0.7624	0.0232
6	-48.04	-25.08	2489.06	511.57	0.063	0.006	0.7377	0.0235
8	-44.19	-21.29	2458.26	512.27	0.063	0.006	0.7158	0.0237
10	-40.6	-17.76	2429.38	512.85	0.062	0.006	0.6962	0.0239
12	-37.23	-14.44	2402.16	513.33	0.062	0.006	0.6785	0.024

Pressure	Liquid Temp	Vapor Temp	Liquid Speed Of Sound	Vapor Speed Of Sound	Liquid Thermal Conductivity	Vapor Thermal Conductivity	Liquid Viscosity	Vapor Viscosity
psig	°F	°F	ft/s	ft/s	Btu/h-ft-F	Btu/h-ft-F	lb/ft-hr	lb/ft-hr
14	-34.05	-11.31	2376.41	513.73	0.061	0.006	0.6623	0.0242
16	-31.03	-8.34	2351.93	514.05	0.061	0.006	0.6475	0.0244
18	-28.16	-5.53	2328.6	514.31	0.06	0.006	0.6338	0.0245
20	-25.43	-2.84	2306.3	514.51	0.06	0.006	0.6211	0.0247
22	-22.81	-0.27	2284.92	514.66	0.059	0.006	0.6093	0.0248
24	-20.29	2.19	2264.37	514.76	0.059	0.006	0.5983	0.025
26	-17.88	4.55	2244.59	514.83	0.059	0.006	0.5879	0.0251
28	-15.55	6.83	2225.51	514.86	0.058	0.006	0.5782	0.0252
30	-13.31	9.03	2207.07	514.85	0.058	0.006	0.5689	0.0253
22	44.11	49.22	1943.76	442.59	0.045	0.007	0.624	0.0282
24	46.86	51.92	1922.83	442.43	0.044	0.007	0.6125	0.0283
26	49.49	54.52	1902.72	442.25	0.044	0.007	0.6017	0.0285
28	52.03	57.02	1883.36	442.03	0.044	0.008	0.5916	0.0286
30	54.48	59.44	1864.68	441.78	0.044	0.008	0.5819	0.0288
32	-11.14	11.15	2189.22	514.82	0.058	0.006	0.5602	0.0255
34	-9.04	13.2	2171.92	514.76	0.057	0.006	0.5519	0.0256
36	-7	15.19	2155.13	514.67	0.057	0.007	0.5441	0.0257
38	-5.02	17.12	2138.81	514.56	0.057	0.007	0.5365	0.0258
40	-3.1	18.99	2122.94	514.43	0.056	0.007	0.5294	0.0259
42	-1.23	20.82	2107.48	514.28	0.056	0.007	0.5225	0.026
44	0.59	22.59	2092.41	514.12	0.056	0.007	0.5159	0.0261
46	2.36	24.32	2077.71	513.93	0.055	0.007	0.5096	0.0262
48	4.09	26	2063.35	513.73	0.055	0.007	0.5034	0.0263
50	5.78	27.64	2049.31	513.52	0.055	0.007	0.4975	0.0264
52	7.43	29.25	2035.59	513.29	0.055	0.007	0.4919	0.0265
54	9.04	30.82	2022.15	513.04	0.054	0.007	0.4864	0.0265
56	10.62	32.35	2009	512.79	0.054	0.007	0.4811	0.0266
58	12.17	33.85	1996.1	512.52	0.054	0.007	0.476	0.0267
60	13.69	35.32	1983.46	512.25	0.054	0.007	0.4711	0.0268
62	15.17	36.76	1971.05	511.96	0.053	0.007	0.4663	0.0269
64	16.63	38.17	1958.87	511.67	0.053	0.007	0.4617	0.027
66	18.06	39.56	1946.91	511.36	0.053	0.007	0.4572	0.027
68	19.46	40.92	1935.15	511.05	0.053	0.007	0.4528	0.0271
70	20.84	42.25	1923.59	510.72	0.053	0.007	0.4486	0.0272
72	22.19	43.56	1912.23	510.39	0.052	0.007	0.4445	0.0272
74	23.52	44.85	1901.04	510.06	0.052	0.007	0.4405	0.0273
76	24.83	46.11	1890.03	509.71	0.052	0.007	0.4366	0.0274
78	26.12	47.36	1879.19	509.36	0.052	0.007	0.4328	0.0275
80	27.39	48.58	1868.52	509.01	0.052	0.007	0.4291	0.0275
82	28.64	49.78	1857.99	508.64	0.051	0.008	0.4255	0.0276
84	29.87	50.97	1847.62	508.27	0.051	0.008	0.4219	0.0277
86	31.08	52.14	1837.39	507.9	0.051	0.008	0.4185	0.0277
88	32.27	53.28	1827.3	507.52	0.051	0.008	0.4152	0.0278
90	33.45	54.42	1817.35	507.13	0.051	0.008	0.4119	0.0278
92	34.61	55.53	1807.52	506.74	0.051	0.008	0.4087	0.0279
94	35.75	56.63	1797.83	506.35	0.05	0.008	0.4055	0.028
96	36.88	57.72	1788.25	505.95	0.05	0.008	0.4025	0.028
98	37.99	58.79	1778.79	505.55	0.05	0.008	0.3995	0.0281
100	39.09	59.84	1769.45	505.14	0.05	0.008	0.3965	0.0281
102	40.18	60.89	1760.21	504.73	0.05	0.008	0.3937	0.0282
104	41.25	61.91	1751.08	504.31	0.05	0.008	0.3908	0.0283

Pressure	Liquid Temp	Vapor Temp	Liquid Speed Of Sound	Vapor Speed Of Sound	Liquid Thermal Conductivity	Vapor Thermal Conductivity	Liquid Viscosity	Vapor Viscosity
psig	°F	°F	ft/s	ft/s	Btu/h-ft-F	Btu/h-ft-F	lb/ft-hr	lb/ft-hr
106	42.31	62.93	1742.06	503.89	0.049	0.008	0.3881	0.0283
108	43.35	63.93	1733.14	503.47	0.049	0.008	0.3854	0.0284
110	44.39	64.92	1724.32	503.04	0.049	0.008	0.3827	0.0284
112	45.41	65.9	1715.59	502.61	0.049	0.008	0.3801	0.0285
114	46.42	66.86	1706.95	502.18	0.049	0.008	0.3775	0.0285
116	47.42	67.82	1698.41	501.74	0.049	0.008	0.375	0.0286
118	48.4	68.76	1689.95	501.3	0.049	0.008	0.3726	0.0286
120	49.38	69.7	1681.58	500.86	0.048	0.008	0.3701	0.0287
122	50.35	70.62	1673.29	500.42	0.048	0.008	0.3677	0.0287
124	51.3	71.53	1665.08	499.97	0.048	0.008	0.3654	0.0288
126	52.25	72.43	1656.95	499.52	0.048	0.008	0.3631	0.0288
128	53.18	73.32	1648.9	499.06	0.048	0.008	0.3608	0.0289
130	54.11	74.21	1640.92	498.61	0.048	0.008	0.3586	0.0289
132	55.03	75.08	1633.02	498.15	0.048	0.008	0.3564	0.029
134	55.94	75.95	1625.19	497.69	0.047	0.008	0.3542	0.029
136	56.84	76.8	1617.43	497.22	0.047	0.008	0.3521	0.0291
138	57.73	77.65	1609.74	496.76	0.047	0.008	0.35	0.0291
140	58.61	78.49	1602.12	496.29	0.047	0.008	0.3479	0.0292
142	59.48	79.32	1594.56	495.82	0.047	0.009	0.3459	0.0292
144	60.35	80.14	1587.06	495.35	0.047	0.009	0.3439	0.0293
146	61.21	80.95	1579.63	494.88	0.047	0.009	0.3419	0.0293
148	62.06	81.76	1572.26	494.4	0.047	0.009	0.34	0.0294
150	62.9	82.56	1564.95	493.92	0.046	0.009	0.338	0.0295
152	63.73	83.35	1557.7	493.44	0.046	0.009	0.3361	0.0295
154	64.56	84.14	1550.51	492.96	0.046	0.009	0.3343	0.0296
156	65.38	84.91	1543.37	492.48	0.046	0.009	0.3324	0.0297
158	66.2	85.68	1536.29	491.99	0.046	0.009	0.3306	0.0297
160	67	86.45	1529.26	491.51	0.046	0.009	0.3288	0.0298
162	67.81	87.2	1522.29	491.02	0.046	0.009	0.327	0.0299
164	68.6	87.95	1515.37	490.53	0.046	0.009	0.3253	0.0299
166	69.39	88.7	1508.5	490.04	0.046	0.009	0.3236	0.03
168	70.17	89.44	1501.68	489.54	0.045	0.009	0.3219	0.0301
170	70.94	90.17	1494.91	489.05	0.045	0.009	0.3202	0.0301
172	71.71	90.89	1488.19	488.55	0.045	0.009	0.3185	0.0302
174	72.48	91.61	1481.51	488.06	0.045	0.009	0.3169	0.0303
176	73.23	92.33	1474.89	487.56	0.045	0.009	0.3152	0.0303
178	73.99	93.03	1468.31	487.06	0.045	0.009	0.3136	0.0304
180	74.73	93.74	1461.77	486.55	0.045	0.009	0.312	0.0304
182	75.47	94.43	1455.28	486.05	0.045	0.009	0.3105	0.0305
184	76.21	95.12	1448.83	485.55	0.045	0.009	0.3089	0.0306
186	76.94	95.81	1442.42	485.04	0.045	0.009	0.3074	0.0306
188	77.66	96.49	1436.05	484.53	0.044	0.009	0.3059	0.0307
190	78.38	97.17	1429.73	484.03	0.044	0.009	0.3044	0.0308
192	79.1	97.84	1423.44	483.52	0.044	0.009	0.3029	0.0308
194	79.81	98.5	1417.2	483.01	0.044	0.009	0.3014	0.0309
196	80.51	99.16	1410.99	482.49	0.044	0.009	0.2999	0.0309
198	81.21	99.82	1404.82	481.98	0.044	0.009	0.2985	0.031
200	81.91	100.47	1398.69	481.47	0.044	0.009	0.2971	0.0311
202	82.6	101.12	1392.59	480.95	0.044	0.009	0.2957	0.0311
204	83.28	101.76	1386.53	480.44	0.044	0.01	0.2943	0.0312
206	83.97	102.39	1380.51	479.92	0.044	0.01	0.2929	0.0313

Pressure	Liquid Temp	Vapor Temp	Liquid Speed Of Sound	Vapor Speed Of Sound	Liquid Thermal Conductivity	Vapor Thermal Conductivity	Liquid Viscosity	Vapor Viscosity
psig	°F	°F	ft/s	ft/s	Btu/h-ft-F	Btu/h-ft-F	lb/ft-hr	lb/ft-hr
208	84.64	103.03	1374.52	479.4	0.043	0.01	0.2915	0.0313
210	85.32	103.65	1368.56	478.88	0.043	0.01	0.2902	0.0314
212	85.98	104.28	1362.64	478.36	0.043	0.01	0.2888	0.0314
214	86.65	104.9	1356.75	477.84	0.043	0.01	0.2875	0.0315
216	87.31	105.51	1350.89	477.32	0.043	0.01	0.2862	0.0316
218	87.96	106.12	1345.06	476.79	0.043	0.01	0.2849	0.0316
220	88.62	106.73	1339.26	476.27	0.043	0.01	0.2836	0.0317
222	89.26	107.34	1333.49	475.75	0.043	0.01	0.2823	0.0318
224	89.91	107.93	1327.76	475.22	0.043	0.01	0.281	0.0318
226	90.55	108.53	1322.05	474.69	0.043	0.01	0.2798	0.0319
228	91.19	109.12	1316.37	474.16	0.043	0.01	0.2785	0.032
230	91.82	109.71	1310.71	473.64	0.043	0.01	0.2773	0.032
232	92.45	110.29	1305.09	473.11	0.042	0.01	0.2761	0.0321
234	93.07	110.87	1299.49	472.58	0.042	0.01	0.2748	0.0321
236	93.7	111.45	1293.91	472.04	0.042	0.01	0.2736	0.0322
238	94.31	112.02	1288.37	471.51	0.042	0.01	0.2724	0.0323
240	94.93	112.59	1282.84	470.98	0.042	0.01	0.2713	0.0323
242	95.54	113.16	1277.34	470.45	0.042	0.01	0.2701	0.0324
244	96.15	113.72	1271.87	469.91	0.042	0.01	0.2689	0.0325
246	96.75	114.28	1266.42	469.38	0.042	0.01	0.2678	0.0325
248	97.35	114.83	1260.99	468.84	0.042	0.01	0.2666	0.0326
250	97.95	115.39	1255.58	468.3	0.042	0.01	0.2655	0.0327
252	98.55	115.94	1250.2	467.76	0.042	0.01	0.2644	0.0327
254	99.14	116.48	1244.84	467.23	0.042	0.01	0.2632	0.0328
256	99.73	117.02	1239.5	466.69	0.041	0.01	0.2621	0.0329
258	100.31	117.56	1234.18	466.15	0.041	0.01	0.261	0.0329
260	100.9	118.1	1228.88	465.61	0.041	0.011	0.2599	0.033
262	101.48	118.63	1223.59	465.06	0.041	0.011	0.2588	0.033
264	102.05	119.16	1218.33	464.52	0.041	0.011	0.2578	0.0331
266	102.63	119.69	1213.09	463.98	0.041	0.011	0.2567	0.0332
268	103.2	120.22	1207.87	463.44	0.041	0.011	0.2556	0.0332
270	103.77	120.74	1202.66	462.89	0.041	0.011	0.2546	0.0333
272	104.33	121.26	1197.47	462.35	0.041	0.011	0.2535	0.0334
274	104.89	121.77	1192.3	461.8	0.041	0.011	0.2525	0.0334
276	105.45	122.28	1187.15	461.25	0.041	0.011	0.2514	0.0335
278	106.01	122.79	1182.01	460.71	0.041	0.011	0.2504	0.0336
280	106.56	123.3	1176.89	460.16	0.041	0.011	0.2494	0.0336
282	107.11	123.81	1171.79	459.61	0.04	0.011	0.2484	0.0337
284	107.66	124.31	1166.7	459.06	0.04	0.011	0.2474	0.0338
286	108.21	124.81	1161.62	458.51	0.04	0.011	0.2464	0.0338
288	108.75	125.3	1156.56	457.96	0.04	0.011	0.2454	0.0339
290	109.29	125.8	1151.52	457.41	0.04	0.011	0.2444	0.034
292	109.83	126.29	1146.49	456.86	0.04	0.011	0.2434	0.0341
294	110.37	126.78	1141.47	456.31	0.04	0.011	0.2425	0.0341
296	110.9	127.26	1136.47	455.75	0.04	0.011	0.2415	0.0342
298	111.43	127.75	1131.48	455.2	0.04	0.011	0.2405	0.0343
300	111.96	128.23	1126.51	454.64	0.04	0.011	0.2396	0.0343

Transport Properties (International Units)

Pressure	Liquid Temp	Vapor Temp	Liquid Speed Of Sound	Vapor Speed Of Sound	Liquid Thermal Conductivity	Vapor Thermal Conductivity	Liquid Viscosity	Vapor Viscosity
kPa	°C	°C	m/s	m/s	W/m-K	W/m-K	µPa-s	µPa-s
105	-51.26	-38.42	788.25	155.093	0.11	0.01	336.6	9.42
120	-48.36	-35.55	775.677	155.478	0.11	0.01	322.52	9.54
135	-45.73	-32.96	764.197	155.791	0.11	0.01	310.5	9.64
150	-43.31	-30.58	753.613	156.046	0.11	0.01	300.04	9.74
165	-41.08	-28.38	743.776	156.254	0.11	0.01	290.8	9.83
180	-39	-26.33	734.574	156.424	0.11	0.01	282.56	9.92
195	-37.05	-24.41	725.919	156.562	0.11	0.01	275.12	10
210	-35.21	-22.61	717.738	156.672	0.11	0.01	268.37	10.07
225	-33.47	-20.9	709.976	156.759	0.1	0.01	262.18	10.14
240	-31.82	-19.27	702.584	156.825	0.1	0.01	256.48	10.21
255	-30.24	-17.73	695.524	156.874	0.1	0.01	251.21	10.27
270	-28.74	-16.25	688.762	156.906	0.1	0.01	246.3	10.33
285	-27.29	-14.84	682.269	156.924	0.1	0.01	241.72	10.39
300	-25.9	-13.48	676.022	156.93	0.1	0.01	237.42	10.45
315	-24.57	-12.17	669.998	156.924	0.1	0.01	233.38	10.5
330	-23.28	-10.91	664.18	156.908	0.1	0.01	229.56	10.55
345	-22.04	-9.7	658.551	156.882	0.1	0.01	225.96	10.6
360	-20.83	-8.52	653.098	156.848	0.1	0.01	222.53	10.65
375	-19.66	-7.38	647.806	156.806	0.1	0.01	219.28	10.7
390	-18.53	-6.28	642.666	156.757	0.1	0.01	216.18	10.74
405	-17.43	-5.21	637.667	156.701	0.1	0.01	213.22	10.79
420	-16.36	-4.16	632.799	156.64	0.1	0.01	210.36	10.83
435	-15.32	-3.15	628.055	156.572	0.1	0.01	207.62	10.87
450	-14.3	-2.16	623.427	156.5	0.09	0.01	204.99	10.91
465	-13.31	-1.2	618.909	156.422	0.09	0.01	202.47	10.95
480	-12.35	-0.26	614.493	156.34	0.09	0.01	200.05	10.99
495	-11.4	0.66	610.175	156.254	0.09	0.01	197.71	11.03
510	-10.48	1.55	605.949	156.164	0.09	0.01	195.46	11.06
525	-9.58	2.43	601.811	156.07	0.09	0.01	193.29	11.1
540	-8.69	3.28	597.755	155.973	0.09	0.01	191.2	11.14
555	-7.82	4.12	593.779	155.872	0.09	0.01	189.17	11.17
570	-6.98	4.94	589.877	155.768	0.09	0.01	187.2	11.2
585	-6.14	5.75	586.048	155.661	0.09	0.01	185.3	11.24
600	-5.33	6.54	582.286	155.552	0.09	0.01	183.46	11.27
615	-4.53	7.31	578.591	155.439	0.09	0.01	181.67	11.3
630	-3.74	8.08	574.957	155.325	0.09	0.01	179.93	11.33
645	-2.96	8.82	571.384	155.208	0.09	0.01	178.24	11.36
660	-2.2	9.56	567.867	155.088	0.09	0.01	176.6	11.39
675	-1.46	10.28	564.406	154.967	0.09	0.01	175	11.42
690	-0.72	10.99	560.998	154.843	0.09	0.01	173.44	11.45
705	0	11.68	557.642	154.718	0.09	0.01	171.92	11.48
720	0.72	12.37	554.333	154.59	0.09	0.01	170.44	11.51
735	1.42	13.05	551.072	154.461	0.09	0.01	169	11.54
750	2.11	13.71	547.857	154.33	0.09	0.01	167.59	11.56
765	2.79	14.36	544.685	154.198	0.09	0.01	166.22	11.59
780	3.46	15.01	541.555	154.064	0.09	0.01	164.87	11.62
795	4.12	15.65	538.467	153.928	0.09	0.01	163.56	11.64
810	4.78	16.27	535.417	153.791	0.09	0.01	162.27	11.67
825	5.42	16.89	532.406	153.653	0.09	0.01	161.02	11.69

Pressure	Liquid Temp	Vapor Temp	Liquid Speed Of Sound	Vapor Speed Of Sound	Liquid Thermal Conductivity	Vapor Thermal Conductivity	Liquid Viscosity	Vapor Viscosity
kPa	°C	°C	m/s	m/s	W/m-K	W/m-K	µPa-s	µPa-s
840	6.06	17.5	529.432	153.513	0.09	0.01	159.79	11.72
855	6.69	18.1	526.494	153.372	0.09	0.01	158.58	11.74
870	7.3	18.69	523.591	153.23	0.08	0.01	157.4	11.77
885	7.92	19.28	520.721	153.087	0.08	0.01	156.24	11.79
900	8.52	19.86	517.884	152.942	0.08	0.01	155.11	11.82
915	9.12	20.43	515.079	152.796	0.08	0.01	154	11.84
930	9.71	20.99	512.305	152.65	0.08	0.01	152.91	11.86
945	10.29	21.55	509.56	152.502	0.08	0.01	151.84	11.89
960	10.87	22.1	506.845	152.353	0.08	0.01	150.79	11.91
975	11.44	22.64	504.158	152.203	0.08	0.01	149.75	11.93
990	12	23.18	501.498	152.053	0.08	0.01	148.74	11.95
1005	12.56	23.71	498.866	151.901	0.08	0.01	147.74	11.98
1020	13.11	24.23	496.26	151.749	0.08	0.01	146.76	12
1035	13.65	24.75	493.679	151.595	0.08	0.01	145.8	12.02
1050	14.19	25.27	491.123	151.441	0.08	0.01	144.85	12.04
1065	14.73	25.77	488.592	151.286	0.08	0.01	143.92	12.06
1080	15.25	26.27	486.084	151.131	0.08	0.01	143.01	12.08
1095	15.78	26.77	483.6	150.974	0.08	0.01	142.11	12.1
1110	16.3	27.26	481.138	150.817	0.08	0.01	141.22	12.12
1125	16.81	27.75	478.698	150.659	0.08	0.01	140.34	12.15
1140	17.32	28.23	476.28	150.5	0.08	0.01	139.48	12.18
1155	17.82	28.71	473.883	150.341	0.08	0.02	138.63	12.22
1170	18.32	29.18	471.507	150.181	0.08	0.02	137.8	12.25
1185	18.81	29.65	469.151	150.021	0.08	0.02	136.98	12.28
1200	19.3	30.11	466.814	149.86	0.08	0.02	136.16	12.31
1215	19.79	30.57	464.498	149.698	0.08	0.02	135.36	12.34
1230	20.27	31.02	462.2	149.536	0.08	0.02	134.57	12.37
1245	20.74	31.47	459.92	149.373	0.08	0.02	133.8	12.4
1260	21.22	31.92	457.659	149.209	0.08	0.02	133.03	12.43
1275	21.68	32.36	455.415	149.045	0.08	0.02	132.27	12.45
1290	22.15	32.8	453.189	148.881	0.08	0.02	131.52	12.48
1305	22.61	33.23	450.98	148.715	0.08	0.02	130.79	12.51
1320	23.07	33.66	448.788	148.55	0.08	0.02	130.06	12.54
1335	23.52	34.09	446.612	148.384	0.08	0.02	129.34	12.57
1350	23.97	34.51	444.452	148.217	0.08	0.02	128.63	12.6
1365	24.41	34.93	442.308	148.05	0.08	0.02	127.93	12.63
1380	24.86	35.35	440.179	147.883	0.08	0.02	127.23	12.66
1395	25.29	35.76	438.065	147.715	0.08	0.02	126.55	12.68
1410	25.73	36.17	435.966	147.546	0.08	0.02	125.87	12.71
1425	26.16	36.57	433.882	147.377	0.08	0.02	125.2	12.74
1440	26.59	36.97	431.811	147.208	0.08	0.02	124.54	12.77
1455	27.02	37.37	429.755	147.038	0.08	0.02	123.89	12.8
1470	27.44	37.77	427.712	146.868	0.08	0.02	123.24	12.83
1485	27.86	38.16	425.683	146.698	0.08	0.02	122.61	12.85
1500	28.27	38.55	423.666	146.527	0.08	0.02	121.97	12.88
1515	28.69	38.94	421.663	146.356	0.08	0.02	121.35	12.91
1530	29.1	39.32	419.671	146.184	0.08	0.02	120.73	12.94
1545	29.51	39.7	417.693	146.012	0.08	0.02	120.12	12.97
1560	29.91	40.08	415.726	145.839	0.07	0.02	119.51	12.99
1575	30.31	40.45	413.771	145.667	0.07	0.02	118.92	13.02

Pressure	Liquid Temp	Vapor Temp	Liquid Speed Of Sound	Vapor Speed Of Sound	Liquid Thermal Conductivity	Vapor Thermal Conductivity	Liquid Viscosity	Vapor Viscosity
kPa	°C	°C	m/s	m/s	W/m-K	W/m-K	µPa-s	µPa-s
1590	30.71	40.83	411.827	145.493	0.07	0.02	118.32	13.05
1605	31.11	41.2	409.895	145.32	0.07	0.02	117.74	13.08
1620	31.5	41.56	407.974	145.146	0.07	0.02	117.15	13.11
1635	31.89	41.93	406.063	144.972	0.07	0.02	116.58	13.14
1650	32.28	42.29	404.163	144.797	0.07	0.02	116.01	13.16
1665	32.67	42.65	402.274	144.623	0.07	0.02	115.45	13.19
1680	33.05	43	400.394	144.447	0.07	0.02	114.89	13.22
1695	33.43	43.36	398.524	144.272	0.07	0.02	114.33	13.25
1710	33.81	43.71	396.665	144.096	0.07	0.02	113.79	13.28
1725	34.19	44.06	394.814	143.92	0.07	0.02	113.24	13.31
1740	34.56	44.4	392.973	143.744	0.07	0.02	112.71	13.34
1755	34.93	44.75	391.141	143.567	0.07	0.02	112.17	13.36
1770	35.3	45.09	389.317	143.39	0.07	0.02	111.64	13.39
1785	35.67	45.43	387.502	143.213	0.07	0.02	111.12	13.42
1800	36.04	45.77	385.696	143.035	0.07	0.02	110.6	13.45
1815	36.4	46.1	383.898	142.857	0.07	0.02	110.09	13.48
1830	36.76	46.44	382.108	142.679	0.07	0.02	109.58	13.51
1845	37.12	46.77	380.326	142.501	0.07	0.02	109.07	13.54
1860	37.48	47.1	378.551	142.322	0.07	0.02	108.57	13.57
1875	37.83	47.42	376.784	142.143	0.07	0.02	108.07	13.6
1890	38.18	47.75	375.025	141.964	0.07	0.02	107.58	13.63
1905	38.53	48.07	373.272	141.784	0.07	0.02	107.09	13.66
1920	38.88	48.39	371.527	141.605	0.07	0.02	106.6	13.68
1935	39.23	48.71	369.788	141.425	0.07	0.02	106.12	13.71
1950	39.57	49.03	368.056	141.244	0.07	0.02	105.64	13.74
1965	39.92	49.34	366.331	141.064	0.07	0.02	105.17	13.77
1980	40.26	49.66	364.612	140.883	0.07	0.02	104.7	13.8
1995	40.6	49.97	362.899	140.702	0.07	0.02	104.23	13.83
2010	40.94	50.28	361.192	140.521	0.07	0.02	103.77	13.86
2025	41.27	50.58	359.492	140.339	0.07	0.02	103.31	13.89
2040	41.61	50.89	357.797	140.158	0.07	0.02	102.85	13.92
2055	41.94	51.19	356.107	139.976	0.07	0.02	102.4	13.96
2070	42.27	51.49	354.424	139.793	0.07	0.02	101.95	13.99
2085	42.6	51.79	352.745	139.611	0.07	0.02	101.5	14.02
2100	42.92	52.09	351.073	139.428	0.07	0.02	101.06	14.05
2115	43.25	52.39	349.405	139.245	0.07	0.02	100.62	14.08
2130	43.57	52.69	347.742	139.062	0.07	0.02	100.18	14.11
2145	43.9	52.98	346.084	138.879	0.07	0.02	99.74	14.14
2160	44.22	53.27	344.431	138.695	0.07	0.02	99.31	14.17
2175	44.54	53.56	342.783	138.511	0.07	0.02	98.88	14.2
2190	44.85	53.85	341.14	138.327	0.07	0.02	98.46	14.24

TOXICITY

R-455A is classified as Class A2L or lower toxicity refrigerant by ASHRAE 34. ASHRAE 34 has established a Occupational Exposure Level (OEL) of 650 ppm for R-455A. Anyone who uses or handles R-455A should carefully review the SDS and product label prior to use.

STABILITY

The thermal and chemical stability testing of R-455A was conducted in sealed glass tubes by accelerating their aging through elevated temperatures (AHRI Project 9016-1 "Materials Compatibility and Lubricants Research For Low GWP Refrigerants: Chemical Stability of Low GWP Refrigerants with Lubricants"). Sealed tube thermal- stability tests were conducted at 175C for two weeks. After exposure, the tube contents were analyzed by analytical methods such as high-performance liquid chromatography (HPLC) to quantify inorganic anion concentrations, gas chromatography mass spectrometry (GC-MS) to identify and quantify volatile components and lubricant acidity (TAN) was measured by titration. The results showed no signs of decomposition of refrigerant and oil after two weeks of exposure at 175C. As the basic components of R-455A showed no signs of concern in thermal-stability testing, it is expected for R-455A to exhibit similar results.

REGULATORY AND ENVIRONMENTAL

Environmental characteristics of the components of Solstice® L40X (R-455A), are presented in the table below:

Chemical Name	CAS Number	Concentration %	Ozone depletion	US EPA CAA VOC Status	ACGIH TLV	OSHA PEL	WEEL (AIHA) TWA 8 hrs	US DOT Hazard Class	TSCA inventory status
2,3,3,3-Tetrafluoroprop-1-ene	754-12-1	75.50	0	Exempt	NA	NA	500ppm	2.1	Active
Difluoromethane	75-10-5	21.50	0	Exempt	NA	NA	1000ppm	2.1	Active
Carbon dioxide	124-38-9	3.00	0	Exempt	5000 ppm	5000 ppm	None	2.2	Active

STORAGE & HANDLING

Solstice® L40X (R-455A), should be stored in a cool, well-ventilated area. The material should only be stored in an approved cylinder. Please consult Solstice's Technical Service Department prior to storage of the material in anything other than its original shipping cylinder to ensure the new container meets all safety requirements. The container and its fittings should be protected from physical damage. The container should not be punctured or dropped, or exposed to open flames, excessive heat or direct sunlight. The container's valves should be tightly closed after use and when the container is empty.

For More Information Visit
solstice.com

Solstice Advanced Materials Inc.
115 Tabor Rd. | Morris Plains, NJ 07950

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