



# Opteon™ XP10

## Refrigerant

### Transport Properties of Opteon™ XP10 (R-513A) SI Units

#### Physical Properties

Molecular Weight	108.4 g/mole
Boiling Point at One Atmosphere	-29.2 °C
Critical Temperature	96.5 °C
Critical Pressure	3765.7 kPa
Critical Density	516.75 kg/m <sup>3</sup>
Critical Volume	0.0019 m <sup>3</sup> /kg
Ozone Depletion Potential	0
Global Warming Potential (AR5)	573
ASHRAE Standard 34 Safety Rating	A1

#### Units and Factors

t = temperature in °C
P = pressure in kiloPascals absolute (kPa [abs])
C <sub>p</sub> = Heat capacity at constant pressure in kJ/(kg-K)
C <sub>v</sub> = Heat capacity at constant volume in kJ/(kg-K)
C <sub>p</sub> /C <sub>v</sub> = Heat capacity ratio (dimensionless)
μ = Viscosity in μPa-sec
ν = Kinematic viscosity in cm <sup>2</sup> /sec
k = Thermal conductivity in mW/(m-K)
c = Velocity of sound in m/sec
γ = Surface Tension in mN/m
h <sub>f</sub> = enthalpy of saturated liquid in kJ/kg
s <sub>f</sub> = entropy of saturated liquid in kJ/(kg) (K)

One atmosphere = 101.325 kPa

Reference point for enthalpy and entropy:

h<sub>f</sub> = 200 kJ/kg at 0°C

s<sub>f</sub> = 1 kJ/kg-K at 0°C

This information is based on NIST Standard Database 23, Version 9.1 (Lemmon, E.W.; Huber, M.L.; McLinden, M.O.; REFPROP Reference Fluid Thermodynamic and Transport Properties - National Institute of Standards and Technology, 2013) using Chemours interaction parameters with R-1234yf.

**Opteon™ XP10 (R-513A)**  
**Saturation Properties - Transport Properties Table**

Temp °C	Heat Capacity, $c_p$ [kJ/kg-K]		$c_p/c_v$ Vapor	Viscosity [ $\mu$ Pa-sec]		Kinematic Viscosity [ $cm^2/sec$ ]		Thermal Conductivity [mW/m-K]		Vel. of Sound [m/sec]		Surface Tension [mN/m]
	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
-40	1.1987	0.7670	1.1358	421.9	8.972	0.0031	0.0258	100.57	8.371	763.0	138.0	16.84
-39	1.2012	0.7702	1.1361	415.4	9.011	0.0030	0.0247	100.13	8.453	758.3	138.2	16.68
-38	1.2037	0.7734	1.1364	409.1	9.049	0.0030	0.0237	99.69	8.535	753.7	138.3	16.52
-37	1.2062	0.7767	1.1367	402.9	9.088	0.0029	0.0227	99.25	8.618	749.0	138.5	16.36
-36	1.2088	0.7800	1.1370	396.8	9.127	0.0029	0.0218	98.81	8.700	744.4	138.6	16.19
-35	1.2113	0.7833	1.1374	390.9	9.165	0.0029	0.0209	98.37	8.783	739.8	138.7	16.03
-34	1.2139	0.7866	1.1378	385.1	9.204	0.0028	0.0201	97.93	8.865	735.1	138.9	15.87
-33	1.2164	0.7900	1.1382	379.4	9.243	0.0028	0.0193	97.49	8.948	730.5	139.0	15.71
-32	1.2190	0.7933	1.1387	373.9	9.282	0.0028	0.0186	97.05	9.030	725.9	139.1	15.55
-31	1.2216	0.7967	1.1391	368.5	9.320	0.0027	0.0178	96.62	9.113	721.3	139.2	15.39
-30	1.2242	0.8002	1.1396	363.2	9.359	0.0027	0.0172	96.18	9.196	716.8	139.3	15.24
-29	1.2269	0.8036	1.1401	358.0	9.398	0.0027	0.0165	95.75	9.278	712.2	139.4	15.08
-28	1.2295	0.8071	1.1406	352.9	9.436	0.0026	0.0159	95.32	9.361	707.6	139.5	14.92
-27	1.2322	0.8106	1.1412	347.9	9.475	0.0026	0.0153	94.89	9.444	703.0	139.6	14.76
-26	1.2349	0.8142	1.1417	343.0	9.514	0.0026	0.0147	94.46	9.527	698.5	139.7	14.60
-25	1.2375	0.8177	1.1423	338.2	9.552	0.0025	0.0142	94.03	9.611	693.9	139.8	14.45
-24	1.2403	0.8213	1.1429	333.5	9.591	0.0025	0.0137	93.60	9.694	689.4	139.9	14.29
-23	1.2430	0.8250	1.1436	328.9	9.629	0.0025	0.0132	93.17	9.777	684.9	140.0	14.14
-22	1.2457	0.8286	1.1442	324.4	9.668	0.0024	0.0127	92.74	9.861	680.3	140.1	13.98
-21	1.2485	0.8323	1.1449	319.9	9.707	0.0024	0.0123	92.32	9.944	675.8	140.1	13.83
-20	1.2513	0.8360	1.1457	315.6	9.745	0.0024	0.0119	91.89	10.028	671.3	140.2	13.67
-19	1.2541	0.8398	1.1464	311.3	9.784	0.0024	0.0114	91.47	10.112	666.8	140.2	13.52
-18	1.2569	0.8436	1.1472	307.1	9.822	0.0023	0.0111	91.05	10.196	662.3	140.3	13.36
-17	1.2598	0.8474	1.1480	303.0	9.861	0.0023	0.0107	90.63	10.280	657.8	140.3	13.21
-16	1.2627	0.8512	1.1488	299.0	9.900	0.0023	0.0103	90.21	10.364	653.3	140.4	13.06
-15	1.2655	0.8551	1.1497	295.0	9.938	0.0023	0.0100	89.79	10.448	648.8	140.4	12.90
-14	1.2685	0.8590	1.1506	291.1	9.977	0.0022	0.0096	89.37	10.533	644.3	140.5	12.75
-13	1.2714	0.8630	1.1515	287.3	10.015	0.0022	0.0093	88.95	10.617	639.8	140.5	12.60
-12	1.2743	0.8669	1.1524	283.6	10.054	0.0022	0.0090	88.53	10.702	635.4	140.5	12.45
-11	1.2773	0.8710	1.1534	279.9	10.092	0.0022	0.0087	88.12	10.787	630.9	140.5	12.30
-10	1.2803	0.8750	1.1544	276.2	10.131	0.0021	0.0084	87.70	10.872	626.4	140.5	12.15
-9	1.2834	0.8791	1.1554	272.7	10.169	0.0021	0.0082	87.29	10.957	622.0	140.5	12.00
-8	1.2864	0.8832	1.1565	269.2	10.208	0.0021	0.0079	86.88	11.043	617.5	140.5	11.85
-7	1.2895	0.8874	1.1576	265.7	10.246	0.0021	0.0077	86.46	11.128	613.0	140.5	11.70
-6	1.2926	0.8916	1.1588	262.3	10.284	0.0020	0.0074	86.05	11.214	608.6	140.5	11.55
-5	1.2957	0.8959	1.1600	259.0	10.323	0.0020	0.0072	85.64	11.300	604.1	140.5	11.41
-4	1.2989	0.9002	1.1612	255.7	10.361	0.0020	0.0070	85.23	11.386	599.7	140.5	11.26
-3	1.3021	0.9045	1.1625	252.5	10.400	0.0020	0.0068	84.82	11.473	595.2	140.4	11.11
-2	1.3053	0.9089	1.1638	249.3	10.438	0.0020	0.0066	84.42	11.560	590.8	140.4	10.97
-1	1.3086	0.9133	1.1651	246.1	10.476	0.0019	0.0064	84.01	11.646	586.3	140.3	10.82
0	1.3118	0.9178	1.1665	243.1	10.515	0.0019	0.0062	83.60	11.734	581.9	140.3	10.68
1	1.3152	0.9223	1.1679	240.0	10.553	0.0019	0.0060	83.20	11.821	577.4	140.2	10.53
2	1.3185	0.9269	1.1694	237.0	10.592	0.0019	0.0058	82.79	11.909	573.0	140.2	10.39
3	1.3219	0.9315	1.1709	234.1	10.630	0.0019	0.0057	82.39	11.997	568.5	140.1	10.24
4	1.3253	0.9362	1.1725	231.2	10.668	0.0019	0.0055	81.99	12.085	564.1	140.0	10.10
5	1.3288	0.9409	1.1741	228.3	10.706	0.0018	0.0053	81.59	12.174	559.7	139.9	9.96
6	1.3323	0.9457	1.1757	225.5	10.745	0.0018	0.0052	81.19	12.263	555.2	139.8	9.81
7	1.3358	0.9505	1.1774	222.7	10.783	0.0018	0.0050	80.79	12.352	550.8	139.7	9.67
8	1.3394	0.9554	1.1792	220.0	10.821	0.0018	0.0049	80.39	12.441	546.3	139.6	9.53
9	1.3430	0.9604	1.1810	217.3	10.860	0.0018	0.0048	79.99	12.532	541.9	139.5	9.39
10	1.3467	0.9654	1.1829	214.6	10.898	0.0018	0.0046	79.59	12.622	537.4	139.4	9.25
11	1.3504	0.9705	1.1849	212.0	10.936	0.0017	0.0045	79.20	12.713	533.0	139.3	9.11
12	1.3541	0.9756	1.1869	209.4	10.974	0.0017	0.0044	78.80	12.804	528.5	139.1	8.97
13	1.3579	0.9808	1.1889	206.8	11.012	0.0017	0.0042	78.41	12.896	524.1	139.0	8.83
14	1.3618	0.9861	1.1911	204.3	11.050	0.0017	0.0041	78.01	12.988	519.6	138.9	8.70
15	1.3657	0.9915	1.1933	201.8	11.089	0.0017	0.0040	77.62	13.080	515.2	138.7	8.56
16	1.3697	0.9970	1.1956	199.3	11.127	0.0017	0.0039	77.22	13.174	510.7	138.5	8.42
17	1.3737	1.0025	1.1979	196.9	11.165	0.0016	0.0038	76.83	13.267	506.2	138.4	8.28

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**Saturation Properties - Transport Properties Table**

Temp °C	Heat Capacity, $c_p$ [kJ/kg-K]		$c_p/c_v$ Vapor	Viscosity [ $\mu$ Pa-sec]		Kinematic Viscosity [ $cm^2/sec$ ]		Thermal Conductivity [mW/m-K]		Vel. of Sound [m/sec]		Surface Tension [mN/m]
	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
18	1.3778	1.0082	1.2004	194.5	11.203	0.0016	0.0037	76.44	13.362	501.8	138.2	8.15
19	1.3819	1.0139	1.2029	192.1	11.241	0.0016	0.0036	76.05	13.456	497.3	138.0	8.01
20	1.3861	1.0197	1.2055	189.8	11.279	0.0016	0.0035	75.66	13.552	492.8	137.8	7.88
21	1.3904	1.0256	1.2081	187.5	11.317	0.0016	0.0034	75.27	13.648	488.4	137.6	7.74
22	1.3947	1.0317	1.2109	185.2	11.355	0.0016	0.0033	74.88	13.745	483.9	137.4	7.61
23	1.3991	1.0378	1.2138	183.0	11.393	0.0016	0.0032	74.49	13.842	479.4	137.2	7.48
24	1.4036	1.0440	1.2168	180.7	11.431	0.0015	0.0032	74.11	13.941	474.9	137.0	7.35
25	1.4081	1.0504	1.2198	178.5	11.469	0.0015	0.0031	73.72	14.040	470.4	136.7	7.21
26	1.4127	1.0569	1.2230	176.3	11.507	0.0015	0.0030	73.33	14.140	465.9	136.5	7.08
27	1.4174	1.0636	1.2263	174.2	11.545	0.0015	0.0029	72.95	14.241	461.4	136.2	6.95
28	1.4222	1.0704	1.2297	172.1	11.583	0.0015	0.0029	72.56	14.342	456.9	136.0	6.82
29	1.4271	1.0773	1.2333	170.0	11.621	0.0015	0.0028	72.18	14.445	452.4	135.7	6.69
30	1.4321	1.0844	1.2369	167.9	11.659	0.0015	0.0027	71.80	14.549	447.9	135.4	6.56
31	1.4371	1.0916	1.2407	165.8	11.697	0.0014	0.0026	71.41	14.654	443.4	135.2	6.44
32	1.4423	1.0990	1.2447	163.8	11.735	0.0014	0.0026	71.03	14.760	438.9	134.9	6.31
33	1.4476	1.1066	1.2487	161.8	11.773	0.0014	0.0025	70.65	14.867	434.4	134.6	6.18
34	1.4530	1.1144	1.2530	159.8	11.810	0.0014	0.0024	70.27	14.975	429.8	134.2	6.06
35	1.4585	1.1224	1.2574	157.8	11.848	0.0014	0.0024	69.88	15.085	425.3	133.9	5.93
36	1.4641	1.1306	1.2619	155.8	11.886	0.0014	0.0023	69.50	15.196	420.8	133.6	5.81
37	1.4699	1.1390	1.2667	153.9	11.928	0.0014	0.0023	69.12	15.309	416.2	133.3	5.68
38	1.4758	1.1476	1.2716	152.0	11.972	0.0014	0.0022	68.74	15.423	411.7	132.9	5.56
39	1.4818	1.1565	1.2767	150.1	12.016	0.0013	0.0022	68.36	15.539	407.1	132.5	5.44
40	1.4881	1.1656	1.2821	148.2	12.069	0.0013	0.0021	67.98	15.656	402.6	132.2	5.31
41	1.4944	1.1750	1.2876	146.3	12.128	0.0013	0.0021	67.60	15.774	398.0	131.8	5.19
42	1.5010	1.1847	1.2934	144.5	12.188	0.0013	0.0020	67.23	15.895	393.4	131.4	5.07
43	1.5077	1.1947	1.2994	142.6	12.248	0.0013	0.0020	66.85	16.017	388.8	131.0	4.95
44	1.5147	1.2049	1.3057	140.8	12.310	0.0013	0.0019	66.47	16.142	384.3	130.6	4.83
45	1.5218	1.2156	1.3122	139.0	12.372	0.0013	0.0019	66.09	16.269	379.7	130.2	4.71
46	1.5292	1.2265	1.3190	137.2	12.436	0.0013	0.0018	65.71	16.403	375.1	129.8	4.60
47	1.5368	1.2379	1.3262	135.4	12.502	0.0013	0.0018	65.33	16.542	370.4	129.3	4.48
48	1.5447	1.2496	1.3336	133.7	12.569	0.0012	0.0018	64.96	16.685	365.8	128.9	4.36
49	1.5528	1.2617	1.3414	131.9	12.638	0.0012	0.0017	64.58	16.830	361.2	128.4	4.25
50	1.5612	1.2743	1.3496	130.2	12.708	0.0012	0.0017	64.20	16.980	356.5	127.9	4.13
51	1.5699	1.2874	1.3582	128.5	12.780	0.0012	0.0017	63.82	17.133	351.8	127.4	4.02
52	1.5790	1.3009	1.3671	126.8	12.854	0.0012	0.0016	63.45	17.290	347.1	126.9	3.90
53	1.5884	1.3150	1.3765	125.1	12.930	0.0012	0.0016	63.07	17.452	342.4	126.4	3.79
54	1.5982	1.3297	1.3864	123.4	13.008	0.0012	0.0015	62.69	17.618	337.7	125.9	3.68
55	1.6084	1.3450	1.3968	121.7	13.089	0.0012	0.0015	62.31	17.789	332.9	125.4	3.57
56	1.6190	1.3609	1.4078	120.0	13.171	0.0012	0.0015	61.93	17.966	328.2	124.8	3.46
57	1.6300	1.3776	1.4193	118.4	13.256	0.0012	0.0015	61.55	18.147	323.4	124.2	3.35
58	1.6416	1.3950	1.4315	116.7	13.344	0.0011	0.0014	61.17	18.334	318.5	123.7	3.24
59	1.6537	1.4133	1.4443	115.1	13.435	0.0011	0.0014	60.79	18.528	313.7	123.1	3.14
60	1.6663	1.4324	1.4579	113.5	13.528	0.0011	0.0014	60.41	18.728	308.7	122.5	3.03
61	1.6796	1.4525	1.4723	111.9	13.625	0.0011	0.0013	60.03	18.935	303.8	121.9	2.92
62	1.6935	1.4737	1.4876	110.2	13.725	0.0011	0.0013	59.65	19.149	298.8	121.2	2.82
63	1.7082	1.4960	1.5038	108.6	13.829	0.0011	0.0013	59.27	19.371	293.8	120.6	2.71
64	1.7236	1.5195	1.5211	107.0	13.936	0.0011	0.0013	58.88	19.601	288.7	119.9	2.61
65	1.7399	1.5445	1.5395	105.4	14.047	0.0011	0.0012	58.50	19.841	283.6	119.3	2.51
66	1.7572	1.5709	1.5592	103.8	14.163	0.0011	0.0012	58.11	20.090	278.5	118.6	2.41
67	1.7754	1.5990	1.5802	102.2	14.283	0.0011	0.0012	57.73	20.349	273.3	117.9	2.31
68	1.7948	1.6289	1.6028	100.6	14.408	0.0010	0.0012	57.34	20.619	268.0	117.1	2.21
69	1.8154	1.6609	1.6271	99.1	14.538	0.0010	0.0011	56.95	20.902	262.7	116.4	2.11
70	1.8374	1.6951	1.6532	97.5	14.674	0.0010	0.0011	56.56	21.197	257.3	115.7	2.02
71	1.8610	1.7319	1.6815	95.9	14.816	0.0010	0.0011	56.17	21.506	251.9	114.9	1.92
72	1.8862	1.7715	1.7121	94.3	14.964	0.0010	0.0011	55.78	21.830	246.4	114.1	1.83
73	1.9134	1.8143	1.7453	92.7	15.120	0.0010	0.0011	55.39	22.171	240.9	113.3	1.74
74	1.9428	1.8608	1.7816	91.1	15.283	0.0010	0.0010	54.99	22.529	235.3	112.5	1.64
75	1.9747	1.9114	1.8213	89.5	15.454	0.0010	0.0010	54.60	22.908	229.7	111.6	1.55

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Saturation Properties - Transport Properties Table

Temp °C	Heat Capacity, $c_p$ [kJ/kg-K]		$c_p/c_v$ Vapor	Viscosity [ $\mu$ Pa-sec]		Kinematic Viscosity [cm <sup>2</sup> /sec]		Thermal Conductivity [mW/m-K]		Vel. of Sound [m/sec]		Surface Tension [mN/m]
	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
76	2.0094	1.9667	1.8649	87.9	15.635	0.0010	0.0010	54.20	23.307	224.0	110.7	1.46
77	2.0474	2.0275	1.9130	86.3	15.825	0.0010	0.0010	53.81	23.730	218.2	109.9	1.38
78	2.0892	2.0947	1.9664	84.7	16.026	0.0009	0.0010	53.42	24.180	212.3	109.0	1.29
79	2.1354	2.1693	2.0259	83.0	16.240	0.0009	0.0009	53.02	24.658	206.4	108.0	1.20
80	2.1870	2.2528	2.0926	81.4	16.466	0.0009	0.0009	52.63	25.169	200.5	107.1	1.12
81	2.2447	2.3467	2.1680	79.7	16.708	0.0009	0.0009	52.24	25.716	194.4	106.1	1.04
82	2.3101	2.4534	2.2538	78.0	16.966	0.0009	0.0009	51.86	26.306	188.3	105.1	0.96
83	2.3848	2.5755	2.3522	76.3	17.243	0.0009	0.0009	51.48	26.942	182.1	104.1	0.88
84	2.4709	2.7168	2.4664	74.6	17.542	0.0009	0.0009	51.11	27.633	175.9	103.0	0.80
85	2.5716	2.8824	2.6003	72.8	17.865	0.0009	0.0008	50.75	28.389	169.5	101.9	0.72
86	2.6910	3.0790	2.7595	71.0	18.217	0.0009	0.0008	50.41	29.220	163.1	100.8	0.65
87	2.8351	3.3165	2.9519	69.2	18.602	0.0009	0.0008	50.09	30.143	156.5	99.7	0.58
88	3.0127	3.6094	3.1892	67.3	19.028	0.0008	0.0008	49.81	31.178	149.9	98.5	0.51
89	3.2374	3.9796	3.4890	65.3	19.504	0.0008	0.0008	49.58	32.356	143.1	97.3	0.44
90	3.5315	4.4628	3.8801	63.2	20.040	0.0008	0.0008	49.42	33.719	136.1	96.0	0.38

Opteon™ XP10 (R-513A)  
Superheated Vapor - Viscosity Table

Viscosity in  $\mu\text{Pa}\cdot\text{sec}$

Saturation Properties in Light Blue

Temp °C	ABSOLUTE PRESSURE, kPa												
	50	101.325	200	300	400	500	600	800	1000	1500	2000	2500	3000
	-43.6 °C	-29.1 °C	-12.9 °C	-2.0 °C	6.4 °C	13.3 °C	19.3 °C	29.2 °C	37.5 °C	53.7 °C	66.2 °C	76.5 °C	85.3 °C
	8.831	9.393	10.019	10.439	10.761	11.025	11.252	11.630	11.948	12.981	14.182	15.723	17.954
-40	8.972												
-35	9.165												
-30	9.359												
-25	9.552	9.552											
-20	9.745	9.745											
-15	9.938	9.938											
-10	10.131	10.131	10.131										
-5	10.323	10.323	10.323										
0	10.515	10.515	10.515	10.515									
5	10.706	10.706	10.706	10.706									
10	10.898	10.898	10.898	10.898	10.898								
15	11.089	11.089	11.089	11.089	11.089	11.089							
20	11.279	11.279	11.279	11.279	11.279	11.279	11.279						
25	11.469	11.469	11.469	11.469	11.469	11.469	11.469						
30	11.659	11.659	11.659	11.659	11.659	11.659	11.659	11.659					
35	11.848	11.848	11.848	11.848	11.848	11.848	11.848	11.848					
40	12.037	12.037	12.037	12.037	12.037	12.037	12.037	12.037	12.049				
45	12.225	12.225	12.225	12.225	12.225	12.225	12.225	12.225	12.258				
50	12.413	12.413	12.413	12.413	12.413	12.413	12.413	12.419	12.474				
55	12.601	12.601	12.601	12.601	12.601	12.601	12.601	12.625	12.687	13.031			
60	12.788	12.788	12.788	12.788	12.788	12.788	12.795	12.834	12.897	13.221			
65	12.974	12.974	12.974	12.974	12.975	12.985	12.999	13.041	13.106	13.415			
70	13.160	13.160	13.160	13.164	13.172	13.184	13.200	13.245	13.312	13.611	14.260		
75	13.345	13.346	13.350	13.357	13.368	13.382	13.399	13.448	13.517	13.808	14.390		
80	13.532	13.534	13.540	13.549	13.562	13.578	13.598	13.649	13.720	14.005	14.538	15.635	
85	13.717	13.720	13.729	13.740	13.755	13.773	13.794	13.849	13.921	14.202	14.699	15.622	
90	13.902	13.907	13.917	13.931	13.947	13.967	13.990	14.047	14.121	14.398	14.866	15.677	17.321
95	14.086	14.092	14.104	14.120	14.138	14.160	14.184	14.244	14.320	14.594	15.039	15.768	17.075
100	14.270	14.277	14.291	14.308	14.328	14.351	14.377	14.440	14.517	14.789	15.215	15.883	16.988
105	14.453	14.461	14.477	14.496	14.518	14.542	14.570	14.634	14.713	14.983	15.394	16.014	16.981
110	14.636	14.644	14.662	14.683	14.706	14.732	14.761	14.827	14.907	15.177	15.574	16.155	17.022
115	14.818	14.827	14.847	14.869	14.894	14.921	14.951	15.019	15.101	15.369	15.756	16.305	17.095
120	15.000	15.010	15.031	15.054	15.080	15.109	15.140	15.210	15.293	15.561	15.938	16.460	17.191
125	15.181	15.191	15.214	15.239	15.266	15.296	15.328	15.400	15.484	15.752	16.120	16.621	17.302
130	15.361	15.372	15.396	15.423	15.451	15.482	15.515	15.589	15.674	15.942	16.303	16.784	17.425
135	15.541	15.553	15.578	15.606	15.635	15.667	15.701	15.777	15.864	16.131	16.485	16.950	17.557
140	15.720	15.733	15.759	15.788	15.819	15.852	15.887	15.964	16.052	16.319	16.668	17.118	17.696
145	15.899	15.912	15.940	15.970	16.001	16.035	16.072	16.150	16.239	16.506	16.851	17.288	17.841
150	16.077	16.091	16.120	16.151	16.183	16.218	16.255	16.336	16.425	16.693	17.033	17.459	17.990
155	16.254	16.269	16.299	16.331	16.365	16.401	16.438	16.520	16.611	16.879	17.214	17.631	18.143
160	16.431	16.447	16.477	16.510	16.545	16.582	16.621	16.704	16.795	17.064	17.396	17.803	18.299
165	16.608	16.624	16.655	16.689	16.725	16.763	16.802	16.887	16.979	17.248	17.577	17.976	18.457
170	16.783	16.800	16.833	16.868	16.904	16.943	16.983	17.068	17.162	17.431	17.758	18.150	18.617
175	16.959	16.976	17.010	17.045	17.083	17.122	17.163	17.250	17.344	17.614	17.938	18.323	18.779
180	17.134	17.151	17.186	17.222	17.261	17.301	17.342	17.430	17.525	17.796	18.117	18.497	18.942
185	17.308	17.326	17.361	17.399	17.438	17.479	17.521	17.610	17.706	17.977	18.297	18.671	19.106
190	17.482	17.500	17.536	17.575	17.615	17.656	17.699	17.789	17.886	18.157	18.475	18.845	19.271
195	17.655	17.674	17.711	17.750	17.791	17.833	17.876	17.967	18.065	18.337	18.654	19.018	19.437
200	17.828	17.847	17.885	17.925	17.966	18.009	18.053	18.145	18.243	18.516	18.831	19.192	19.603
205	18.000	18.020	18.058	18.099	18.141	18.184	18.229	18.322	18.421	18.695	19.008	19.366	19.770
210	18.172	18.192	18.231	18.272	18.315	18.359	18.404	18.498	18.598	18.873	19.185	19.539	19.937
215	18.343	18.363	18.403	18.445	18.489	18.533	18.579	18.674	18.775	19.050	19.361	19.712	20.105
220	18.513	18.534	18.575	18.618	18.662	18.707	18.753	18.849	18.950	19.226	19.537	19.885	20.273
225	18.684	18.705	18.746	18.790	18.834	18.880	18.927	19.024	19.126	19.402	19.712	20.058	20.441
230	18.853	18.875	18.917	18.961	19.006	19.052	19.100	19.198	19.300	19.578	19.887	20.230	20.609
235	19.023	19.044	19.087	19.132	19.178	19.224	19.272	19.371	19.474	19.753	20.061	20.402	20.777
240	19.191	19.214	19.257	19.302	19.348	19.396	19.444	19.544	19.648	19.927	20.235	20.574	20.945
245	19.360	19.382	19.426	19.472	19.519	19.567	19.615	19.716	19.820	20.101	20.409	20.746	21.113
250	19.527	19.550	19.595	19.641	19.689	19.737	19.786	19.887	19.993	20.274	20.582	20.917	21.281
255	19.695	19.718	19.763	19.810	19.858	19.907	19.956	20.059	20.164	20.447	20.754	21.088	21.450
260	19.862	19.885	19.931	19.979	20.027	20.076	20.126	20.229	20.336	20.619	20.926	21.259	21.618
265	20.028	20.052	20.098	20.146	20.195	20.245	20.295	20.399	20.506	20.790	21.098	21.429	21.785
270	20.194	20.218	20.265	20.314	20.363	20.413	20.464	20.569	20.677	20.962	21.269	21.599	21.953
275	20.360	20.384	20.432	20.481	20.530	20.581	20.633	20.738	20.846	21.132	21.440	21.769	22.121
280	20.525	20.549	20.598	20.647	20.697	20.748	20.800	20.906	21.016	21.303	21.610	21.938	22.289
285	20.689	20.714	20.763	20.813	20.864	20.915	20.968	21.074	21.184	21.472	21.780	22.108	22.456
290	20.854	20.879	20.928	20.979	21.030	21.082	21.135	21.242	21.353	21.642	21.949	22.277	22.623
295	21.017	21.043	21.093	21.144	21.195	21.248	21.301	21.409	21.520	21.810	22.119	22.445	22.790

**Opteon™ XP10 (R-513A)**  
**Superheated Vapor - Heat Capacity Table**

Heat Capacity,  $C_p$ , in kJ/kg-K

Saturation Properties in Light Blue

Temp °C	ABSOLUTE PRESSURE, kPa												
	50	101.325	200	300	400	500	600	800	1000	1500	2000	2500	3000
	-43.6 °C	-29.1 °C	-12.9 °C	-2.0 °C	6.4 °C	13.3 °C	19.3 °C	29.2 °C	37.5 °C	53.7 °C	66.2 °C	76.5 °C	85.3 °C
	0.7555	0.8033	0.8634	0.9090	0.9477	0.9826	1.0156	1.0790	1.1430	1.3245	1.5753	1.9945	2.9306
-40	0.7604												
-35	0.7679												
-30	0.7759												
-25	0.7843	0.8069											
-20	0.7928	0.8125											
-15	0.8015	0.8189											
-10	0.8103	0.8258	0.8637										
-5	0.8192	0.8332	0.8658										
0	0.8281	0.8408	0.8695	0.9077									
5	0.8370	0.8486	0.8741	0.9067									
10	0.8460	0.8565	0.8795	0.9077	0.9436								
15	0.8549	0.8646	0.8854	0.9103	0.9408	0.9794							
20	0.8638	0.8727	0.8917	0.9139	0.9403	0.9727	1.0136						
25	0.8726	0.8809	0.8982	0.9183	0.9415	0.9693	1.0031						
30	0.8815	0.8891	0.9051	0.9232	0.9440	0.9681	0.9968	1.0757					
35	0.8903	0.8974	0.9121	0.9286	0.9473	0.9686	0.9935	1.0586					
40	0.8990	0.9056	0.9192	0.9344	0.9513	0.9703	0.9921	1.0472	1.1280				
45	0.9077	0.9139	0.9264	0.9404	0.9558	0.9730	0.9923	1.0398	1.1057				
50	0.9164	0.9221	0.9338	0.9467	0.9608	0.9763	0.9936	1.0351	1.0904				
55	0.9250	0.9303	0.9412	0.9531	0.9661	0.9802	0.9958	1.0326	1.0798	1.3045			
60	0.9335	0.9385	0.9487	0.9597	0.9717	0.9846	0.9988	1.0316	1.0725	1.2484			
65	0.9420	0.9467	0.9562	0.9665	0.9775	0.9894	1.0023	1.0319	1.0679	1.2108			
70	0.9504	0.9548	0.9637	0.9733	0.9835	0.9945	1.0064	1.0331	1.0651	1.1846	1.4614		
75	0.9588	0.9629	0.9713	0.9802	0.9897	0.9999	1.0108	1.0352	1.0638	1.1660	1.3701		
80	0.9671	0.9710	0.9788	0.9872	0.9961	1.0055	1.0156	1.0379	1.0638	1.1524	1.3121	1.7367	
85	0.9753	0.9790	0.9864	0.9942	1.0025	1.0113	1.0206	1.0412	1.0647	1.1427	1.2724	1.5507	
90	0.9835	0.9870	0.9939	1.0013	1.0091	1.0173	1.0259	1.0449	1.0664	1.1357	1.2441	1.4466	2.0269
95	0.9916	0.9949	1.0014	1.0084	1.0157	1.0233	1.0314	1.0490	1.0687	1.1309	1.2234	1.3801	1.7222
100	0.9997	1.0028	1.0090	1.0155	1.0224	1.0295	1.0371	1.0534	1.0715	1.1278	1.2080	1.3343	1.5692
105	1.0077	1.0106	1.0164	1.0226	1.0291	1.0358	1.0429	1.0581	1.0748	1.1260	1.1965	1.3013	1.4764
110	1.0156	1.0184	1.0239	1.0297	1.0358	1.0422	1.0488	1.0630	1.0785	1.1253	1.1879	1.2769	1.4143
115	1.0234	1.0261	1.0313	1.0368	1.0426	1.0486	1.0548	1.0681	1.0826	1.1255	1.1816	1.2584	1.3702
120	1.0312	1.0337	1.0387	1.0439	1.0494	1.0550	1.0609	1.0733	1.0869	1.1264	1.1771	1.2442	1.3376
125	1.0389	1.0413	1.0461	1.0510	1.0562	1.0615	1.0670	1.0787	1.0914	1.1280	1.1740	1.2334	1.3130
130	1.0466	1.0489	1.0534	1.0581	1.0630	1.0680	1.0732	1.0843	1.0961	1.1301	1.1721	1.2252	1.2941
135	1.0542	1.0564	1.0606	1.0651	1.0698	1.0745	1.0795	1.0899	1.1010	1.1327	1.1712	1.2190	1.2794
140	1.0617	1.0638	1.0679	1.0721	1.0765	1.0811	1.0858	1.0956	1.1061	1.1357	1.1712	1.2144	1.2680
145	1.0692	1.0711	1.0750	1.0791	1.0833	1.0876	1.0921	1.1014	1.1112	1.1390	1.1718	1.2112	1.2591
150	1.0765	1.0784	1.0822	1.0861	1.0900	1.0941	1.0984	1.1072	1.1165	1.1425	1.1730	1.2091	1.2523
155	1.0839	1.0857	1.0893	1.0930	1.0968	1.1007	1.1047	1.1131	1.1219	1.1464	1.1747	1.2079	1.2471
160	1.0911	1.0929	1.0963	1.0998	1.1035	1.1072	1.1110	1.1190	1.1273	1.1504	1.1769	1.2076	1.2433
165	1.0983	1.1000	1.1033	1.1067	1.1101	1.1137	1.1173	1.1249	1.1329	1.1546	1.1794	1.2079	1.2406
170	1.1055	1.1071	1.1102	1.1134	1.1168	1.1202	1.1236	1.1309	1.1384	1.1590	1.1823	1.2088	1.2389
175	1.1125	1.1141	1.1171	1.1202	1.1234	1.1266	1.1299	1.1368	1.1440	1.1635	1.1854	1.2101	1.2380
180	1.1195	1.1210	1.1239	1.1269	1.1299	1.1331	1.1362	1.1428	1.1497	1.1682	1.1888	1.2119	1.2378
185	1.1265	1.1279	1.1307	1.1335	1.1365	1.1395	1.1425	1.1488	1.1553	1.1729	1.1924	1.2141	1.2382
190	1.1334	1.1347	1.1374	1.1402	1.1430	1.1458	1.1488	1.1548	1.1610	1.1777	1.1962	1.2166	1.2391
195	1.1402	1.1415	1.1441	1.1467	1.1494	1.1522	1.1550	1.1607	1.1667	1.1827	1.2002	1.2194	1.2404
200	1.1469	1.1482	1.1507	1.1532	1.1558	1.1585	1.1612	1.1667	1.1724	1.1876	1.2042	1.2224	1.2422
205	1.1536	1.1549	1.1573	1.1597	1.1622	1.1648	1.1673	1.1726	1.1781	1.1927	1.2084	1.2256	1.2442
210	1.1603	1.1615	1.1638	1.1661	1.1685	1.1710	1.1735	1.1786	1.1838	1.1977	1.2128	1.2290	1.2466
215	1.1669	1.1680	1.1702	1.1725	1.1748	1.1772	1.1796	1.1845	1.1895	1.2028	1.2172	1.2326	1.2492
220	1.1734	1.1745	1.1766	1.1789	1.1811	1.1834	1.1857	1.1904	1.1952	1.2080	1.2217	1.2363	1.2521
225	1.1799	1.1809	1.1830	1.1851	1.1873	1.1895	1.1917	1.1962	1.2009	1.2131	1.2262	1.2402	1.2551
230	1.1863	1.1873	1.1893	1.1914	1.1935	1.1956	1.1977	1.2021	1.2066	1.2183	1.2308	1.2442	1.2583
235	1.1926	1.1936	1.1956	1.1976	1.1996	1.2016	1.2037	1.2079	1.2122	1.2235	1.2355	1.2482	1.2617
240	1.1989	1.1999	1.2018	1.2037	1.2057	1.2076	1.2096	1.2137	1.2179	1.2287	1.2402	1.2524	1.2652
245	1.2052	1.2061	1.2080	1.2098	1.2117	1.2136	1.2155	1.2195	1.2235	1.2339	1.2450	1.2566	1.2689
250	1.2114	1.2123	1.2141	1.2159	1.2177	1.2195	1.2214	1.2252	1.2291	1.2391	1.2497	1.2609	1.2726
255	1.2175	1.2184	1.2201	1.2219	1.2236	1.2254	1.2272	1.2309	1.2346	1.2444	1.2545	1.2652	1.2764
260	1.2236	1.2245	1.2261	1.2278	1.2296	1.2313	1.2330	1.2366	1.2402	1.2496	1.2594	1.2696	1.2804
265	1.2297	1.2305	1.2321	1.2338	1.2354	1.2371	1.2388	1.2422	1.2457	1.2548	1.2642	1.2741	1.2844
270	1.2357	1.2365	1.2380	1.2396	1.2412	1.2429	1.2445	1.2478	1.2512	1.2600	1.2691	1.2786	1.2884
275	1.2416	1.2424	1.2439	1.2455	1.2470	1.2486	1.2502	1.2534	1.2567	1.2651	1.2739	1.2831	1.2925
280	1.2475	1.2483	1.2497	1.2512	1.2528	1.2543	1.2558	1.2590	1.2621	1.2703	1.2788	1.2876	1.2967
285	1.2533	1.2541	1.2555	1.2570	1.2585	1.2599	1.2614	1.2645	1.2676	1.2755	1.2837	1.2921	1.3009
290	1.2591	1.2599	1.2613	1.2627	1.2641	1.2656	1.2670	1.2700	1.2729	1.2806	1.2885	1.2967	1.3052
295	1.2649	1.2656	1.2670	1.2683	1.2697	1.2711	1.2725	1.2754	1.2783	1.2857	1.2934	1.3013	1.3094

Opteon™ XP10 (R-513A)  
Superheated Vapor - Heat Capacity Ratio Table

Heat Capacity Ratio,  $C_p/C_v$

Saturation Properties in Light Blue

Temp °C	ABSOLUTE PRESSURE, kPa												
	50	101.325	200	300	400	500	600	800	1000	1500	2000	2500	3000
	-43.6 °C	-29.1 °C	-12.9 °C	-2.0 °C	6.4 °C	13.3 °C	19.3 °C	29.2 °C	37.5 °C	53.7 °C	66.2 °C	76.5 °C	85.3 °C
-40	1.1320												
-35	1.1285												
-30	1.1253												
-25	1.1224	1.1361											
-20	1.1197	1.1318											
-15	1.1172	1.1280											
-10	1.1148	1.1245	1.1477										
-5	1.1127	1.1214	1.1417										
0	1.1106	1.1185	1.1366	1.1603									
5	1.1087	1.1159	1.1321	1.1527									
10	1.1069	1.1135	1.1280	1.1461	1.1690								
15	1.1051	1.1112	1.1244	1.1405	1.1603	1.1854							
20	1.1035	1.1091	1.1211	1.1355	1.1528	1.1742	1.2014						
25	1.1020	1.1071	1.1181	1.1310	1.1464	1.1649	1.1877						
30	1.1005	1.1052	1.1153	1.1271	1.1407	1.1569	1.1764	1.2309					
35	1.0991	1.1035	1.1127	1.1234	1.1357	1.1500	1.1669	1.2122					
40	1.0977	1.1018	1.1104	1.1201	1.1313	1.1440	1.1588	1.1972	1.2548				
45	1.0964	1.1002	1.1082	1.1171	1.1272	1.1387	1.1518	1.1848	1.2319				
50	1.0952	1.0987	1.1061	1.1144	1.1236	1.1339	1.1456	1.1745	1.2138				
55	1.0940	1.0973	1.1042	1.1118	1.1202	1.1296	1.1402	1.1656	1.1991	1.3661			
60	1.0929	1.0960	1.1024	1.1094	1.1172	1.1258	1.1353	1.1579	1.1869	1.3172			
65	1.0918	1.0947	1.1006	1.1072	1.1144	1.1222	1.1309	1.1512	1.1766	1.2822			
70	1.0907	1.0935	1.0990	1.1051	1.1118	1.1190	1.1269	1.1452	1.1677	1.2557	1.4693		
75	1.0897	1.0923	1.0975	1.1032	1.1094	1.1160	1.1233	1.1399	1.1599	1.2347	1.3920		
80	1.0888	1.0912	1.0961	1.1014	1.1071	1.1133	1.1200	1.1351	1.1531	1.2177	1.3401	1.6781	
85	1.0878	1.0901	1.0947	1.0997	1.1050	1.1108	1.1169	1.1308	1.1471	1.2035	1.3025	1.5235	
90	1.0869	1.0891	1.0934	1.0981	1.1031	1.1084	1.1141	1.1269	1.1417	1.1915	1.2736	1.4336	1.9052
95	1.0860	1.0881	1.0921	1.0965	1.1012	1.1062	1.1115	1.1233	1.1368	1.1812	1.2507	1.3737	1.6511
100	1.0852	1.0871	1.0910	1.0951	1.0995	1.1041	1.1091	1.1200	1.1324	1.1723	1.2321	1.3303	1.5196
105	1.0843	1.0862	1.0898	1.0937	1.0979	1.1022	1.1068	1.1169	1.1283	1.1644	1.2165	1.2973	1.4372
110	1.0836	1.0853	1.0887	1.0924	1.0963	1.1004	1.1047	1.1141	1.1247	1.1574	1.2033	1.2712	1.3800
115	1.0828	1.0844	1.0877	1.0912	1.0949	1.0987	1.1028	1.1115	1.1213	1.1512	1.1920	1.2500	1.3376
120	1.0820	1.0836	1.0867	1.0900	1.0935	1.0971	1.1009	1.1091	1.1182	1.1456	1.1821	1.2324	1.3048
125	1.0813	1.0828	1.0858	1.0889	1.0922	1.0956	1.0992	1.1069	1.1153	1.1405	1.1735	1.2176	1.2786
130	1.0806	1.0820	1.0848	1.0878	1.0909	1.0941	1.0975	1.1048	1.1127	1.1359	1.1658	1.2048	1.2572
135	1.0799	1.0813	1.0839	1.0868	1.0897	1.0928	1.0960	1.1028	1.1102	1.1318	1.1590	1.1938	1.2392
140	1.0792	1.0805	1.0831	1.0858	1.0886	1.0915	1.0945	1.1009	1.1079	1.1279	1.1528	1.1841	1.2240
145	1.0786	1.0798	1.0823	1.0848	1.0875	1.0903	1.0931	1.0992	1.1057	1.1244	1.1473	1.1756	1.2110
150	1.0780	1.0791	1.0815	1.0839	1.0865	1.0891	1.0918	1.0975	1.1037	1.1211	1.1423	1.1680	1.1996
155	1.0774	1.0785	1.0807	1.0830	1.0855	1.0880	1.0905	1.0959	1.1017	1.1181	1.1377	1.1612	1.1897
160	1.0768	1.0778	1.0800	1.0822	1.0845	1.0869	1.0893	1.0945	1.1000	1.1153	1.1335	1.1551	1.1808
165	1.0762	1.0772	1.0793	1.0814	1.0836	1.0859	1.0882	1.0931	1.0983	1.1127	1.1297	1.1495	1.1730
170	1.0756	1.0766	1.0786	1.0806	1.0827	1.0849	1.0871	1.0917	1.0967	1.1103	1.1261	1.1445	1.1659
175	1.0751	1.0760	1.0779	1.0798	1.0819	1.0839	1.0860	1.0905	1.0951	1.1080	1.1228	1.1399	1.1596
180	1.0745	1.0754	1.0772	1.0791	1.0810	1.0830	1.0850	1.0893	1.0937	1.1059	1.1198	1.1357	1.1538
185	1.0740	1.0749	1.0766	1.0784	1.0803	1.0821	1.0841	1.0881	1.0923	1.1039	1.1169	1.1318	1.1485
190	1.0735	1.0743	1.0760	1.0777	1.0795	1.0813	1.0832	1.0870	1.0910	1.1020	1.1143	1.1281	1.1437
195	1.0730	1.0738	1.0754	1.0771	1.0788	1.0805	1.0823	1.0859	1.0898	1.1002	1.1118	1.1248	1.1393
200	1.0725	1.0733	1.0748	1.0764	1.0780	1.0797	1.0814	1.0849	1.0886	1.0985	1.1095	1.1217	1.1353
205	1.0720	1.0728	1.0743	1.0758	1.0774	1.0790	1.0806	1.0840	1.0875	1.0969	1.1073	1.1188	1.1315
210	1.0715	1.0723	1.0737	1.0752	1.0767	1.0782	1.0798	1.0830	1.0864	1.0954	1.1053	1.1161	1.1280
215	1.0711	1.0718	1.0732	1.0746	1.0761	1.0775	1.0790	1.0821	1.0854	1.0939	1.1033	1.1136	1.1248
220	1.0706	1.0713	1.0727	1.0740	1.0754	1.0769	1.0783	1.0813	1.0844	1.0926	1.1015	1.1112	1.1217
225	1.0702	1.0709	1.0722	1.0735	1.0748	1.0762	1.0776	1.0805	1.0834	1.0912	1.0998	1.1090	1.1189
230	1.0698	1.0704	1.0717	1.0729	1.0742	1.0756	1.0769	1.0797	1.0825	1.0900	1.0981	1.1069	1.1163
235	1.0694	1.0700	1.0712	1.0724	1.0737	1.0749	1.0762	1.0789	1.0816	1.0888	1.0966	1.1049	1.1138
240	1.0690	1.0696	1.0707	1.0719	1.0731	1.0743	1.0756	1.0781	1.0808	1.0877	1.0951	1.1030	1.1115
245	1.0686	1.0691	1.0703	1.0714	1.0726	1.0738	1.0750	1.0774	1.0800	1.0866	1.0937	1.1012	1.1093
250	1.0682	1.0687	1.0698	1.0709	1.0721	1.0732	1.0744	1.0767	1.0792	1.0855	1.0923	1.0995	1.1072
255	1.0678	1.0683	1.0694	1.0705	1.0716	1.0727	1.0738	1.0761	1.0784	1.0845	1.0910	1.0979	1.1052
260	1.0674	1.0679	1.0690	1.0700	1.0711	1.0721	1.0732	1.0754	1.0777	1.0836	1.0898	1.0964	1.1033
265	1.0670	1.0676	1.0685	1.0696	1.0706	1.0716	1.0727	1.0748	1.0770	1.0826	1.0886	1.0949	1.1016
270	1.0667	1.0672	1.0681	1.0691	1.0701	1.0711	1.0721	1.0742	1.0763	1.0818	1.0875	1.0936	1.0999
275	1.0663	1.0668	1.0677	1.0687	1.0696	1.0706	1.0716	1.0736	1.0756	1.0809	1.0864	1.0922	1.0983
280	1.0660	1.0665	1.0673	1.0683	1.0692	1.0701	1.0711	1.0730	1.0750	1.0801	1.0854	1.0910	1.0968
285	1.0656	1.0661	1.0670	1.0679	1.0688	1.0697	1.0706	1.0725	1.0744	1.0793	1.0844	1.0898	1.0953
290	1.0653	1.0658	1.0666	1.0675	1.0683	1.0692	1.0701	1.0719	1.0738	1.0785	1.0835	1.0886	1.0940
295	1.0650	1.0654	1.0662	1.0671	1.0679	1.0688	1.0696	1.0714	1.0732	1.0778	1.0825	1.0875	1.0926

Opteon™ XP10 (R-513A)  
Superheated Vapor - Thermal Conductivity Table

Thermal Conductivity in mW/m-K

Saturation Properties in Light Blue

Temp °C	ABSOLUTE PRESSURE, kPa												
	50	101.325	200	300	400	500	600	800	1000	1500	2000	2500	3000
	-43.6 °C	-29.1 °C	-12.9 °C	-2.0 °C	6.4 °C	13.3 °C	19.3 °C	29.2 °C	37.5 °C	53.7 °C	66.2 °C	76.5 °C	85.3 °C
	8.072	9.269	10.626	11.561	12.300	12.927	13.484	14.470	15.362	17.560	20.131	23.503	28.599
-40	8.367												
-35	8.773												
-30	9.179												
-25	9.585	9.602											
-20	9.991	10.007											
-15	10.397	10.413											
-10	10.804	10.818	10.859										
-5	11.211	11.224	11.262										
0	11.618	11.631	11.666	11.719									
5	12.025	12.038	12.070	12.118									
10	12.433	12.445	12.475	12.519	12.581								
15	12.840	12.852	12.880	12.921	12.977	13.055							
20	13.248	13.259	13.286	13.324	13.374	13.443	13.537						
25	13.656	13.667	13.693	13.727	13.774	13.835	13.916						
30	14.064	14.075	14.099	14.132	14.174	14.229	14.301	14.523					
35	14.473	14.483	14.506	14.537	14.576	14.626	14.690	14.880					
40	14.881	14.891	14.914	14.943	14.979	15.025	15.083	15.248	15.522				
45	15.290	15.300	15.321	15.349	15.383	15.425	15.478	15.624	15.854				
50	15.699	15.708	15.729	15.756	15.788	15.827	15.875	16.005	16.202				
55	16.108	16.117	16.137	16.163	16.193	16.230	16.274	16.391	16.568	17.599			
60	16.517	16.526	16.546	16.570	16.599	16.633	16.674	16.785	16.951	17.803			
65	16.927	16.935	16.955	16.978	17.005	17.039	17.081	17.189	17.342	18.070			
70	17.336	17.345	17.365	17.389	17.417	17.452	17.492	17.596	17.739	18.377	19.973		
75	17.747	17.756	17.777	17.802	17.831	17.865	17.905	18.006	18.141	18.712	19.978		
80	18.158	18.168	18.190	18.215	18.245	18.280	18.320	18.419	18.547	19.065	20.117	22.714	
85	18.569	18.580	18.603	18.630	18.661	18.696	18.736	18.833	18.957	19.434	20.333	22.242	
90	18.980	18.992	19.017	19.045	19.077	19.113	19.153	19.249	19.369	19.814	20.601	22.107	25.700
95	19.392	19.404	19.431	19.460	19.493	19.530	19.571	19.666	19.783	20.202	20.905	22.147	24.634
100	19.804	19.817	19.845	19.876	19.910	19.948	19.989	20.085	20.199	20.597	21.234	22.291	24.188
105	20.216	20.230	20.260	20.292	20.328	20.366	20.408	20.504	20.617	20.998	21.582	22.503	24.032
110	20.628	20.643	20.674	20.708	20.745	20.785	20.828	20.924	21.036	21.403	21.945	22.763	24.041
115	21.040	21.056	21.089	21.125	21.163	21.204	21.248	21.345	21.456	21.812	22.320	23.057	24.154
120	21.453	21.470	21.504	21.542	21.581	21.623	21.668	21.766	21.877	22.224	22.704	23.377	24.338
125	21.865	21.884	21.920	21.959	21.999	22.043	22.088	22.188	22.299	22.639	23.095	23.716	24.573
130	22.278	22.297	22.335	22.376	22.418	22.462	22.509	22.610	22.721	23.055	23.493	24.071	24.846
135	22.691	22.711	22.751	22.793	22.836	22.882	22.930	23.032	23.144	23.474	23.895	24.439	25.147
140	23.104	23.125	23.167	23.210	23.255	23.302	23.351	23.454	23.567	23.894	24.302	24.816	25.471
145	23.518	23.540	23.582	23.627	23.674	23.722	23.772	23.877	23.990	24.315	24.712	25.201	25.812
150	23.931	23.954	23.998	24.045	24.093	24.142	24.193	24.300	24.414	24.737	25.124	25.594	26.167
155	24.345	24.368	24.414	24.462	24.512	24.562	24.614	24.723	24.838	25.160	25.540	25.992	26.534
160	24.759	24.783	24.831	24.880	24.931	24.982	25.036	25.146	25.263	25.584	25.957	26.394	26.910
165	25.173	25.198	25.247	25.298	25.350	25.403	25.457	25.569	25.687	26.009	26.377	26.801	27.294
170	25.587	25.613	25.664	25.716	25.769	25.823	25.879	25.993	26.112	26.434	26.797	27.211	27.684
175	26.001	26.028	26.080	26.134	26.188	26.244	26.300	26.416	26.537	26.860	27.219	27.624	28.081
180	26.416	26.443	26.497	26.552	26.608	26.664	26.722	26.840	26.962	27.286	27.643	28.039	28.482
185	26.830	26.859	26.914	26.970	27.027	27.085	27.144	27.263	27.387	27.712	28.067	28.456	28.887
190	27.245	27.274	27.331	27.388	27.447	27.506	27.565	27.687	27.812	28.139	28.492	28.876	29.295
195	27.660	27.690	27.748	27.807	27.866	27.926	27.987	28.111	28.237	28.566	28.918	29.297	29.707
200	28.075	28.106	28.165	28.225	28.286	28.347	28.409	28.535	28.662	28.994	29.345	29.719	30.121
205	28.490	28.522	28.582	28.644	28.706	28.768	28.831	28.958	29.088	29.421	29.772	30.143	30.538
210	28.906	28.938	29.000	29.062	29.126	29.189	29.253	29.382	29.513	29.849	30.199	30.567	30.956
215	29.321	29.354	29.417	29.481	29.546	29.610	29.675	29.806	29.939	30.277	30.627	30.993	31.376
220	29.737	29.771	29.835	29.900	29.966	30.031	30.097	30.230	30.364	30.705	31.056	31.420	31.798
225	30.153	30.187	30.253	30.319	30.386	30.453	30.520	30.654	30.790	31.133	31.485	31.847	32.221
230	30.569	30.604	30.671	30.738	30.806	30.874	30.942	31.078	31.215	31.561	31.914	32.275	32.646
235	30.985	31.021	31.089	31.157	31.226	31.295	31.364	31.502	31.641	31.990	32.343	32.703	33.071
240	31.402	31.438	31.507	31.577	31.647	31.717	31.787	31.927	32.067	32.418	32.773	33.132	33.497
245	31.818	31.855	31.925	31.996	32.067	32.138	32.209	32.351	32.493	32.847	33.203	33.561	33.924
250	32.235	32.272	32.344	32.416	32.488	32.560	32.632	32.775	32.918	33.275	33.632	33.991	34.352
255	32.652	32.690	32.762	32.836	32.909	32.982	33.054	33.199	33.344	33.704	34.062	34.421	34.780
260	33.069	33.107	33.181	33.255	33.329	33.403	33.477	33.624	33.770	34.133	34.493	34.851	35.209
265	33.486	33.525	33.600	33.675	33.750	33.825	33.900	34.048	34.196	34.561	34.923	35.281	35.637
270	33.904	33.943	34.019	34.095	34.171	34.247	34.323	34.473	34.622	34.990	35.353	35.711	36.066
275	34.321	34.361	34.438	34.515	34.592	34.669	34.745	34.897	35.048	35.418	35.782	36.141	36.495
280	34.739	34.780	34.857	34.936	35.014	35.091	35.168	35.322	35.473	35.846	36.211	36.569	36.921
285	35.157	35.198	35.277	35.356	35.435	35.513	35.591	35.746	35.899	36.273	36.639	36.995	37.344
290	35.575	35.617	35.696	35.777	35.856	35.936	36.015	36.171	36.325	36.704	37.072	37.430	37.780
295	35.993	36.035	36.116	36.197	36.278	36.358	36.438	36.596	36.752	37.134	37.505	37.865	38.217



Opteon™ XP10 (R-513A)  
Superheated Vapor - Velocity of Sound Table

Velocity of Sound in m/sec

Saturation Properties in Light Blue

Temp °C	ABSOLUTE PRESSURE, kPa													
	50	101.325	200	300	400	500	600	800	1000	1500	2000	2500	3000	
	-43.6 °C	-29.1 °C	-12.9 °C	-2.0 °C	6.4 °C	13.3 °C	19.3 °C	29.2 °C	37.5 °C	53.7 °C	66.2 °C	76.5 °C	85.3 °C	
	137.44	139.43	140.48	140.38	139.79	138.95	137.95	135.65	133.09	126.08	118.46	110.34	101.65	
-40	138.60													
-35	140.17													
-30	141.70													
-25	143.21	140.81												
-20	144.69	142.45												
-15	146.15	144.05												
-10	147.58	145.61	141.56											
-5	149.00	147.14	143.35											
0	150.39	148.65	145.09	141.18										
5	151.77	150.12	146.78	143.14										
10	153.13	151.57	148.43	145.02	141.35									
15	154.48	153.00	150.03	146.84	143.43	139.73								
20	155.80	154.40	151.60	148.60	145.42	142.00	138.31							
25	157.12	155.79	153.13	150.31	147.33	144.16	140.77							
30	158.42	157.15	154.64	151.97	149.17	146.22	143.08	136.09						
35	159.71	158.50	156.11	153.59	150.96	148.19	145.28	138.87						
40	160.98	159.83	157.56	155.18	152.69	150.10	147.38	141.47	134.74					
45	162.24	161.15	158.99	156.73	154.38	151.94	149.39	143.91	137.78					
50	163.49	162.45	160.39	158.24	156.02	153.72	151.32	146.22	140.60					
55	164.73	163.73	161.77	159.73	157.62	155.45	153.20	148.43	143.23	127.28				
60	165.95	165.00	163.13	161.19	159.19	157.13	155.01	150.54	145.71	131.37				
65	167.17	166.26	164.47	162.62	160.72	158.77	156.76	152.56	148.06	135.02				
70	168.38	167.50	165.80	164.03	162.23	160.37	158.47	154.51	150.31	138.35	122.85			
75	169.57	168.74	167.11	165.42	163.70	161.94	160.14	156.40	152.45	141.42	127.75			
80	170.76	169.96	168.40	166.79	165.15	163.47	161.76	158.22	154.51	144.28	132.02	115.80		
85	171.93	171.17	169.67	168.14	166.57	164.97	163.35	160.00	156.50	146.96	135.85	122.04		
90	173.10	172.37	170.94	169.46	167.97	166.45	164.90	161.72	158.42	149.50	139.34	127.23	111.32	
95	174.26	173.55	172.18	170.78	169.35	167.89	166.42	163.40	160.28	151.92	142.56	131.75	118.57	
100	175.41	174.73	173.42	172.07	170.70	169.32	167.91	165.04	162.08	154.22	145.56	135.80	124.42	
105	176.55	175.90	174.64	173.35	172.04	170.72	169.37	166.64	163.83	156.43	148.38	139.47	129.43	
110	177.69	177.06	175.85	174.61	173.36	172.09	170.81	168.21	165.54	158.55	151.04	142.86	133.85	
115	178.81	178.21	177.05	175.86	174.66	173.45	172.22	169.74	167.20	160.60	153.56	146.01	137.85	
120	179.93	179.35	178.23	177.09	175.94	174.78	173.61	171.24	168.83	162.57	155.97	148.96	141.50	
125	181.04	180.48	179.41	178.32	177.21	176.10	174.98	172.72	170.41	164.48	158.27	151.75	144.88	
130	182.14	181.61	180.58	179.52	178.47	177.40	176.33	174.16	171.97	166.34	160.48	154.39	148.04	
135	183.24	182.72	181.73	180.72	179.71	178.68	177.66	175.59	173.49	168.14	162.61	156.90	151.01	
140	184.32	183.83	182.88	181.91	180.93	179.95	178.97	176.99	174.98	169.89	164.66	159.30	153.81	
145	185.41	184.93	184.01	183.08	182.14	181.20	180.26	178.36	176.45	171.60	166.65	161.60	156.47	
150	186.48	186.02	185.14	184.24	183.34	182.44	181.54	179.72	177.89	173.27	168.58	163.82	159.01	
155	187.55	187.11	186.26	185.40	184.53	183.67	182.80	181.06	179.31	174.90	170.44	165.95	161.44	
160	188.61	188.19	187.37	186.54	185.71	184.88	184.04	182.37	180.70	176.49	172.26	168.01	163.77	
165	189.67	189.26	188.47	187.67	186.87	186.07	185.27	183.67	182.07	178.05	174.03	170.01	166.01	
170	190.72	190.32	189.56	188.80	188.03	187.26	186.49	184.95	183.42	179.58	175.75	171.94	168.17	
175	191.76	191.38	190.65	189.91	189.17	188.43	187.69	186.22	184.75	181.08	177.44	173.82	170.26	
180	192.80	192.43	191.73	191.01	190.30	189.59	188.89	187.47	186.06	182.55	179.08	175.65	172.28	
185	193.83	193.47	192.80	192.11	191.43	190.75	190.07	188.71	187.35	184.00	180.69	177.43	174.24	
190	194.85	194.51	193.86	193.20	192.54	191.89	191.23	189.93	188.63	185.42	182.26	179.17	176.14	
195	195.87	195.54	194.92	194.28	193.65	193.02	192.39	191.14	189.89	186.82	183.81	180.86	178.00	
200	196.89	196.57	195.96	195.35	194.74	194.14	193.53	192.33	191.14	188.20	185.32	182.52	179.80	
205	197.89	197.59	197.01	196.42	195.83	195.25	194.67	193.51	192.37	189.55	186.81	184.14	181.56	
210	198.90	198.60	198.04	197.48	196.91	196.35	195.79	194.68	193.59	190.89	188.27	185.73	183.28	
215	199.90	199.61	199.07	198.53	197.98	197.44	196.91	195.84	194.79	192.21	189.70	187.28	184.96	
220	200.89	200.62	200.10	199.57	199.05	198.53	198.01	196.99	195.98	193.51	191.11	188.81	186.60	
225	201.88	201.61	201.11	200.61	200.10	199.61	199.11	198.13	197.16	194.79	192.50	190.31	188.21	
230	202.86	202.61	202.12	201.64	201.15	200.67	200.20	199.25	198.32	196.05	193.87	191.78	189.78	
235	203.84	203.59	203.13	202.66	202.19	201.73	201.27	200.37	199.48	197.30	195.22	193.22	191.33	
240	204.81	204.58	204.13	203.68	203.23	202.79	202.35	201.47	200.62	198.54	196.54	194.64	192.84	
245	205.78	205.55	205.12	204.69	204.26	203.83	203.41	202.57	201.75	199.76	197.85	196.04	194.33	
250	206.74	206.52	206.11	205.69	205.28	204.87	204.46	203.66	202.87	200.96	199.15	197.42	195.79	
255	207.70	207.49	207.09	206.69	206.29	205.90	205.51	204.74	203.98	202.15	200.42	198.78	197.23	
260	208.65	208.45	208.07	207.68	207.30	206.92	206.55	205.81	205.08	203.33	201.68	200.11	198.65	
265	209.60	209.41	209.04	208.67	208.30	207.94	207.58	206.87	206.17	204.50	202.92	201.43	200.04	
270	210.55	210.36	210.01	209.65	209.30	208.95	208.60	207.92	207.26	205.66	204.15	202.73	201.41	
275	211.49	211.31	210.97	210.63	210.29	209.95	209.62	208.97	208.33	206.80	205.36	204.02	202.76	
280	212.43	212.26	211.93	211.60	211.27	210.95	210.63	210.01	209.40	207.93	206.56	205.28	204.10	
285	213.36	213.19	212.88	212.56	212.25	211.94	211.64	211.04	210.45	209.06	207.75	206.53	205.41	
290	214.29	214.13	213.83	213.52	213.22	212.93	212.63	212.06	211.50	210.17	208.92	207.77	206.71	
295	215.21	215.06	214.77	214.48	214.19	213.91	213.63	213.08	212.54	211.27	210.08	208.99	207.98	

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