



# Opteon™ XP40

Refrigerant

## Transport Properties of Opteon™ XP40 (R-449A) SI Units

### Physical Properties

Molecular Weight	87.2 g/mole
Boiling Point at One Atmosphere	-46.0 °C
Critical Temperature	81.5 °C
Critical Pressure	4447.0 kPa
Critical Density	465.44 kg/m <sup>3</sup>
Critical Volume	0.0021 m <sup>3</sup> /kg
Ozone Depletion Potential	0
Global Warming Potential (AR5)	1282
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
v	= 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™ XP40 (R-449A)  
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	
-40	1.2946	0.7893	1.1872	320.4	9.627	0.0024	0.0203	111.94	9.039	756.5	155.4	17.06
-39	1.2967	0.7931	1.1879	315.9	9.669	0.0024	0.0195	111.41	9.106	751.6	155.6	16.88
-38	1.2989	0.7970	1.1886	311.5	9.710	0.0024	0.0187	110.89	9.173	746.8	155.7	16.71
-37	1.3012	0.8009	1.1894	307.2	9.752	0.0023	0.0180	110.36	9.241	741.9	155.8	16.53
-36	1.3034	0.8049	1.1902	302.9	9.794	0.0023	0.0172	109.84	9.309	737.1	155.9	16.36
-35	1.3057	0.8089	1.1910	298.8	9.836	0.0023	0.0166	109.32	9.377	732.2	156.1	16.18
-34	1.3080	0.8129	1.1919	294.7	9.878	0.0022	0.0159	108.80	9.445	727.4	156.2	16.01
-33	1.3104	0.8169	1.1928	290.7	9.919	0.0022	0.0153	108.28	9.514	722.6	156.3	15.83
-32	1.3128	0.8211	1.1937	286.8	9.961	0.0022	0.0147	107.76	9.583	717.7	156.4	15.66
-31	1.3152	0.8252	1.1947	282.9	10.003	0.0022	0.0142	107.24	9.652	712.9	156.5	15.49
-30	1.3177	0.8294	1.1957	279.1	10.044	0.0021	0.0137	106.72	9.722	708.1	156.6	15.32
-29	1.3202	0.8336	1.1967	275.4	10.086	0.0021	0.0132	106.21	9.792	703.2	156.7	15.14
-28	1.3227	0.8379	1.1978	271.7	10.128	0.0021	0.0127	105.69	9.863	698.4	156.8	14.97
-27	1.3253	0.8422	1.1989	268.1	10.170	0.0021	0.0122	105.18	9.934	693.6	156.8	14.80
-26	1.3279	0.8466	1.2000	264.6	10.211	0.0021	0.0118	104.66	10.005	688.8	156.9	14.63
-25	1.3306	0.8510	1.2012	261.1	10.253	0.0020	0.0114	104.15	10.077	683.9	157.0	14.46
-24	1.3332	0.8554	1.2024	257.7	10.295	0.0020	0.0110	103.64	10.149	679.1	157.0	14.29
-23	1.3360	0.8599	1.2036	254.3	10.336	0.0020	0.0106	103.13	10.221	674.3	157.1	14.12
-22	1.3388	0.8644	1.2049	251.0	10.378	0.0020	0.0102	102.62	10.294	669.5	157.1	13.95
-21	1.3416	0.8690	1.2063	247.8	10.420	0.0020	0.0099	102.11	10.368	664.7	157.1	13.78
-20	1.3444	0.8737	1.2077	244.6	10.461	0.0019	0.0095	101.61	10.442	659.8	157.2	13.62
-19	1.3473	0.8783	1.2091	241.4	10.503	0.0019	0.0092	101.10	10.516	655.0	157.2	13.45
-18	1.3503	0.8831	1.2106	238.3	10.545	0.0019	0.0089	100.59	10.591	650.2	157.2	13.28
-17	1.3533	0.8878	1.2121	235.3	10.586	0.0019	0.0086	100.09	10.666	645.4	157.2	13.12
-16	1.3563	0.8927	1.2136	232.3	10.628	0.0019	0.0083	99.59	10.742	640.6	157.2	12.95
-15	1.3594	0.8976	1.2152	229.3	10.669	0.0018	0.0080	99.08	10.819	635.7	157.2	12.78
-14	1.3626	0.9025	1.2169	226.4	10.711	0.0018	0.0078	98.58	10.896	630.9	157.2	12.62
-13	1.3658	0.9075	1.2186	223.6	10.753	0.0018	0.0075	98.08	10.973	626.1	157.2	12.45
-12	1.3690	0.9126	1.2204	220.8	10.794	0.0018	0.0073	97.59	11.051	621.3	157.2	12.29
-11	1.3723	0.9177	1.2222	218.0	10.836	0.0018	0.0071	97.09	11.130	616.4	157.2	12.13
-10	1.3757	0.9229	1.2241	215.2	10.877	0.0017	0.0068	96.59	11.210	611.6	157.1	11.96
-9	1.3791	0.9281	1.2260	212.5	10.919	0.0017	0.0066	96.10	11.290	606.8	157.1	11.80
-8	1.3826	0.9334	1.2280	209.9	10.960	0.0017	0.0064	95.60	11.370	601.9	157.0	11.64
-7	1.3861	0.9388	1.2300	207.3	11.002	0.0017	0.0062	95.11	11.452	597.1	157.0	11.48
-6	1.3897	0.9442	1.2322	204.7	11.043	0.0017	0.0060	94.62	11.534	592.2	156.9	11.32
-5	1.3934	0.9497	1.2343	202.1	11.085	0.0017	0.0058	94.13	11.617	587.4	156.9	11.16
-4	1.3971	0.9553	1.2366	199.6	11.126	0.0016	0.0057	93.64	11.700	582.6	156.8	11.00
-3	1.4009	0.9610	1.2389	197.2	11.168	0.0016	0.0055	93.15	11.785	577.7	156.7	10.84
-2	1.4048	0.9667	1.2413	194.7	11.209	0.0016	0.0053	92.66	11.870	572.8	156.6	10.68
-1	1.4087	0.9725	1.2437	192.3	11.251	0.0016	0.0052	92.17	11.956	568.0	156.5	10.52
0	1.4127	0.9784	1.2463	189.9	11.292	0.0016	0.0050	91.69	12.043	563.1	156.4	10.36
1	1.4168	0.9843	1.2489	187.6	11.333	0.0016	0.0049	91.20	12.131	558.2	156.3	10.20
2	1.4210	0.9904	1.2516	185.3	11.375	0.0016	0.0047	90.72	12.220	553.4	156.2	10.05
3	1.4253	0.9965	1.2544	183.0	11.416	0.0015	0.0046	90.24	12.309	548.5	156.0	9.89
4	1.4296	1.0028	1.2573	180.7	11.457	0.0015	0.0045	89.75	12.400	543.6	155.9	9.73
5	1.4340	1.0091	1.2602	178.5	11.499	0.0015	0.0043	89.27	12.492	538.7	155.7	9.58
6	1.4386	1.0156	1.2633	176.3	11.540	0.0015	0.0042	88.80	12.585	533.8	155.6	9.42
7	1.4432	1.0221	1.2665	174.1	11.581	0.0015	0.0041	88.32	12.679	528.9	155.4	9.27
8	1.4479	1.0288	1.2697	172.0	11.623	0.0015	0.0040	87.84	12.775	524.0	155.3	9.12
9	1.4527	1.0356	1.2731	169.9	11.664	0.0015	0.0039	87.36	12.871	519.1	155.1	8.96
10	1.4576	1.0425	1.2766	167.8	11.705	0.0014	0.0038	86.89	12.969	514.2	154.9	8.81
11	1.4627	1.0495	1.2802	165.7	11.747	0.0014	0.0037	86.42	13.069	509.3	154.7	8.66
12	1.4678	1.0567	1.2840	163.7	11.789	0.0014	0.0036	85.94	13.169	504.3	154.5	8.51
13	1.4731	1.0640	1.2879	161.6	11.831	0.0014	0.0035	85.47	13.272	499.4	154.3	8.36
14	1.4785	1.0715	1.2919	159.7	11.872	0.0014	0.0034	85.00	13.375	494.5	154.0	8.21
15	1.4840	1.0791	1.2960	157.7	11.916	0.0014	0.0033	84.53	13.481	489.5	153.8	8.06
16	1.4896	1.0869	1.3003	155.7	11.960	0.0014	0.0032	84.06	13.588	484.5	153.6	7.91
17	1.4954	1.0949	1.3047	153.8	12.003	0.0014	0.0031	83.59	13.696	479.6	153.3	7.76

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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	
	18	1.5013	1.1030	1.3094	151.9	12.047	0.0013	0.0030	83.13	13.807	474.6	153.1
19	1.5074	1.1114	1.3141	150.0	12.091	0.0013	0.0029	82.66	13.920	469.6	152.8	7.46
20	1.5137	1.1199	1.3191	148.1	12.135	0.0013	0.0029	82.20	14.034	464.6	152.5	7.32
21	1.5201	1.1287	1.3242	146.2	12.178	0.0013	0.0028	81.73	14.151	459.6	152.2	7.17
22	1.5266	1.1377	1.3295	144.4	12.222	0.0013	0.0027	81.27	14.270	454.6	151.9	7.03
23	1.5334	1.1469	1.3351	142.6	12.267	0.0013	0.0026	80.81	14.391	449.6	151.6	6.88
24	1.5403	1.1564	1.3408	140.8	12.311	0.0013	0.0026	80.35	14.515	444.6	151.3	6.74
25	1.5475	1.1662	1.3468	139.0	12.355	0.0013	0.0025	79.89	14.641	439.6	151.0	6.60
26	1.5548	1.1762	1.3530	137.2	12.406	0.0013	0.0024	79.43	14.770	434.5	150.6	6.45
27	1.5624	1.1866	1.3594	135.5	12.459	0.0012	0.0024	78.97	14.901	429.5	150.3	6.31
28	1.5702	1.1972	1.3661	133.8	12.513	0.0012	0.0023	78.51	15.036	424.4	149.9	6.17
29	1.5783	1.2082	1.3731	132.0	12.575	0.0012	0.0023	78.05	15.173	419.3	149.6	6.03
30	1.5866	1.2195	1.3803	130.3	12.639	0.0012	0.0022	77.60	15.313	414.3	149.2	5.89
31	1.5952	1.2312	1.3879	128.6	12.704	0.0012	0.0022	77.14	15.457	409.2	148.8	5.75
32	1.6041	1.2433	1.3958	127.0	12.770	0.0012	0.0021	76.69	15.604	404.1	148.4	5.61
33	1.6133	1.2558	1.4040	125.3	12.836	0.0012	0.0021	76.23	15.755	398.9	148.0	5.48
34	1.6228	1.2687	1.4126	123.6	12.904	0.0012	0.0020	75.78	15.910	393.8	147.6	5.34
35	1.6327	1.2821	1.4216	122.0	12.972	0.0012	0.0020	75.33	16.071	388.7	147.1	5.20
36	1.6430	1.2960	1.4310	120.4	13.042	0.0012	0.0019	74.88	16.236	383.5	146.7	5.07
37	1.6536	1.3104	1.4408	118.8	13.112	0.0011	0.0019	74.42	16.406	378.3	146.2	4.93
38	1.6647	1.3254	1.4510	117.2	13.185	0.0011	0.0018	73.97	16.582	373.1	145.7	4.80
39	1.6763	1.3410	1.4618	115.6	13.258	0.0011	0.0018	73.52	16.762	367.9	145.3	4.67
40	1.6883	1.3572	1.4730	114.0	13.333	0.0011	0.0017	73.08	16.949	362.7	144.8	4.54
41	1.7009	1.3741	1.4849	112.4	13.410	0.0011	0.0017	72.63	17.141	357.4	144.3	4.40
42	1.7141	1.3917	1.4973	110.9	13.489	0.0011	0.0017	72.18	17.340	352.2	143.7	4.27
43	1.7278	1.4101	1.5104	109.3	13.570	0.0011	0.0016	71.73	17.546	346.8	143.2	4.14
44	1.7423	1.4294	1.5241	107.8	13.653	0.0011	0.0016	71.28	17.759	341.5	142.6	4.02
45	1.7574	1.4495	1.5386	106.2	13.738	0.0011	0.0016	70.84	17.980	336.1	142.1	3.89
46	1.7734	1.4707	1.5540	104.7	13.825	0.0011	0.0015	70.39	18.209	330.7	141.5	3.76
47	1.7901	1.4929	1.5701	103.2	13.915	0.0010	0.0015	69.95	18.447	325.3	140.9	3.64
48	1.8078	1.5162	1.5873	101.7	14.008	0.0010	0.0014	69.50	18.694	319.8	140.3	3.51
49	1.8265	1.5408	1.6054	100.2	14.103	0.0010	0.0014	69.05	18.951	314.3	139.7	3.39
50	1.8463	1.5667	1.6247	98.6	14.202	0.0010	0.0014	68.61	19.218	308.7	139.0	3.26
51	1.8674	1.5941	1.6451	97.1	14.304	0.0010	0.0014	68.17	19.497	303.1	138.4	3.14
52	1.8897	1.6231	1.6670	95.6	14.409	0.0010	0.0013	67.72	19.788	297.5	137.7	3.02
53	1.9135	1.6540	1.6902	94.1	14.519	0.0010	0.0013	67.28	20.092	291.7	137.0	2.90
54	1.9390	1.6867	1.7151	92.7	14.632	0.0010	0.0013	66.83	20.410	286.0	136.3	2.78
55	1.9663	1.7217	1.7418	91.2	14.750	0.0010	0.0012	66.39	20.743	280.2	135.6	2.66
56	1.9956	1.7590	1.7705	89.7	14.872	0.0010	0.0012	65.95	21.092	274.3	134.9	2.55
57	2.0272	1.7990	1.8013	88.2	15.000	0.0010	0.0012	65.51	21.459	268.3	134.1	2.43
58	2.0615	1.8421	1.8347	86.7	15.133	0.0009	0.0012	65.07	21.845	262.3	133.3	2.32
59	2.0986	1.8885	1.8708	85.2	15.273	0.0009	0.0011	64.63	22.252	256.3	132.5	2.20
60	2.1392	1.9387	1.9100	83.7	15.419	0.0009	0.0011	64.19	22.682	250.1	131.7	2.09
61	2.1837	1.9933	1.9528	82.2	15.572	0.0009	0.0011	63.75	23.136	243.9	130.9	1.98
62	2.2326	2.0528	1.9997	80.6	15.733	0.0009	0.0011	63.31	23.618	237.6	130.0	1.87
63	2.2868	2.1180	2.0512	79.1	15.902	0.0009	0.0010	62.88	24.129	231.2	129.1	1.76
64	2.3473	2.1897	2.1081	77.6	16.082	0.0009	0.0010	62.45	24.674	224.8	128.2	1.66
65	2.4150	2.2692	2.1713	76.0	16.272	0.0009	0.0010	62.03	25.255	218.3	127.3	1.55
66	2.4917	2.3578	2.2419	74.4	16.474	0.0009	0.0010	61.61	25.878	211.7	126.3	1.45
67	2.5791	2.4571	2.3212	72.8	16.689	0.0009	0.0009	61.20	26.547	205.0	125.3	1.35
68	2.6797	2.5693	2.4111	71.2	16.919	0.0009	0.0009	60.80	27.269	198.2	124.3	1.25
69	2.7968	2.6973	2.5137	69.6	17.167	0.0009	0.0009	60.41	28.051	191.3	123.2	1.15
70	2.9350	2.8447	2.6320	67.9	17.434	0.0008	0.0009	60.04	28.902	184.3	122.1	1.05
71	3.1005	3.0165	2.7699	66.1	17.724	0.0008	0.0009	59.70	29.833	177.2	121.0	0.96
72	3.3023	3.2194	2.9328	64.4	18.042	0.0008	0.0008	59.39	30.860	170.0	119.9	0.86
73	3.5538	3.4629	3.1284	62.5	18.392	0.0008	0.0008	59.13	32.002	162.7	118.7	0.77
74	3.8761	3.7612	3.3677	60.6	18.781	0.0008	0.0008	58.95	33.283	155.2	117.4	0.68
75	4.3034	4.1354	3.6674	58.6	19.220	0.0008	0.0008	58.86	34.742	147.6	116.1	0.60

**Opteon™ XP40 (R-449A)**  
**Saturation Properties - Transport Properties Table**

Temp °C	Heat Capacity, $c_p$ [kJ/kg-K]		$c_p/c_v$	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	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
76	4.8965	4.6197	4.0543	56.4	19.722	0.0008	0.0008	58.91	36.429	139.8	114.7	0.51
77	5.7719	5.2728	4.5744	54.1	20.308	0.0008	0.0008	59.17	38.426	131.9	113.3	0.43
78	7.1825	6.2054	5.3137	51.5	21.015	0.0008	0.0007	59.76	40.870	123.7	111.7	0.35
79	9.7718	7.6554	6.4559	48.6	21.908	0.0007	0.0007	60.43	44.017	115.4	110.0	0.28
80	15.5324	10.2587	8.4885	44.9	23.140	0.0007	0.0007	63.12	48.449	107.0	107.9	0.21

**Opteon™ XP40 (R-449A)**  
**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
	-53.4 °C	-39.9 °C	-24.9 °C	-14.9 °C	-7.1 °C	-0.8 °C	4.7 °C	13.8 °C	21.4 °C	36.1 °C	47.5 °C	56.8 °C	64.7 °C
	9.067	9.630	10.256	10.675	10.997	11.261	11.487	11.865	12.194	13.049	13.957	14.969	16.207
-50	9.209												
-45	9.418												
-40	9.627												
-35	9.836	9.836											
-30	10.044	10.044											
-25	10.253	10.253											
-20	10.461	10.461	10.461										
-15	10.669	10.669	10.669										
-10	10.877	10.877	10.877	10.877									
-5	11.085	11.085	11.085	11.085	11.085								
0	11.292	11.292	11.292	11.292	11.292	11.292							
5	11.499	11.499	11.499	11.499	11.499	11.499	11.499						
10	11.705	11.705	11.705	11.705	11.705	11.705	11.705						
15	11.911	11.911	11.911	11.911	11.911	11.911	11.911	11.914					
20	12.117	12.117	12.117	12.117	12.117	12.117	12.117	12.124					
25	12.322	12.322	12.322	12.322	12.322	12.322	12.325	12.333	12.345				
30	12.527	12.527	12.527	12.527	12.527	12.529	12.532	12.540	12.552				
35	12.731	12.731	12.731	12.731	12.733	12.735	12.738	12.746	12.767				
40	12.934	12.934	12.935	12.936	12.938	12.940	12.944	12.953	12.991	13.214			
45	13.138	13.138	13.139	13.140	13.142	13.145	13.148	13.170	13.217	13.427			
50	13.340	13.341	13.342	13.344	13.346	13.350	13.359	13.392	13.439	13.639	14.040		
55	13.543	13.543	13.545	13.547	13.553	13.563	13.575	13.610	13.658	13.851	14.214		
60	13.744	13.745	13.748	13.755	13.764	13.775	13.789	13.825	13.873	14.063	14.397	15.015	
65	13.946	13.948	13.954	13.962	13.972	13.985	14.000	14.038	14.087	14.273	14.586	15.123	16.194
70	14.147	14.150	14.158	14.167	14.179	14.193	14.209	14.249	14.299	14.483	14.779	15.259	16.105
75	14.348	14.352	14.361	14.372	14.385	14.400	14.417	14.458	14.510	14.691	14.974	15.412	16.125
80	14.548	14.552	14.563	14.575	14.589	14.605	14.623	14.666	14.719	14.899	15.170	15.576	16.200
85	14.747	14.752	14.764	14.777	14.792	14.810	14.829	14.873	14.926	15.105	15.367	15.747	16.307
90	14.945	14.951	14.964	14.978	14.995	15.013	15.033	15.078	15.132	15.310	15.565	15.924	16.434
95	15.143	15.149	15.163	15.179	15.196	15.215	15.236	15.282	15.337	15.515	15.762	16.104	16.575
100	15.340	15.347	15.362	15.378	15.396	15.416	15.437	15.485	15.541	15.718	15.960	16.287	16.727
105	15.536	15.544	15.560	15.577	15.596	15.616	15.638	15.687	15.744	15.920	16.157	16.471	16.886
110	15.732	15.740	15.757	15.775	15.795	15.816	15.838	15.888	15.945	16.121	16.354	16.657	17.050
115	15.927	15.936	15.953	15.972	15.992	16.014	16.037	16.088	16.146	16.322	16.550	16.844	17.218
120	16.121	16.130	16.149	16.168	16.189	16.212	16.235	16.287	16.345	16.521	16.746	17.031	17.390
125	16.315	16.325	16.343	16.364	16.385	16.408	16.432	16.485	16.544	16.719	16.942	17.219	17.564
130	16.508	16.518	16.537	16.558	16.580	16.604	16.629	16.682	16.741	16.917	17.136	17.407	17.740
135	16.701	16.711	16.731	16.752	16.775	16.799	16.824	16.878	16.938	17.113	17.330	17.595	17.917
140	16.892	16.903	16.923	16.945	16.969	16.993	17.018	17.073	17.134	17.309	17.523	17.783	18.095
145	17.083	17.094	17.115	17.138	17.161	17.186	17.212	17.268	17.328	17.503	17.716	17.971	18.275
150	17.274	17.285	17.306	17.329	17.353	17.379	17.405	17.461	17.522	17.697	17.908	18.158	18.454
155	17.463	17.475	17.497	17.520	17.545	17.570	17.597	17.654	17.715	17.890	18.099	18.345	18.634
160	17.653	17.664	17.687	17.710	17.735	17.761	17.788	17.845	17.907	18.082	18.289	18.532	18.815
165	17.841	17.853	17.876	17.900	17.925	17.951	17.979	18.036	18.098	18.273	18.479	18.718	18.995
170	18.029	18.041	18.064	18.089	18.114	18.141	18.168	18.226	18.289	18.463	18.668	18.904	19.176
175	18.216	18.228	18.252	18.277	18.303	18.329	18.357	18.416	18.478	18.653	18.856	19.089	19.356
180	18.402	18.415	18.439	18.464	18.490	18.517	18.545	18.604	18.667	18.842	19.043	19.274	19.536
185	18.588	18.601	18.625	18.651	18.677	18.705	18.733	18.792	18.855	19.030	19.230	19.458	19.716
190	18.773	18.786	18.811	18.837	18.863	18.891	18.919	18.979	19.042	19.217	19.416	19.642	19.896
195	18.958	18.971	18.996	19.022	19.049	19.077	19.105	19.165	19.229	19.403	19.601	19.825	20.075
200	19.142	19.155	19.180	19.207	19.234	19.262	19.291	19.351	19.414	19.589	19.786	20.007	20.254
205	19.325	19.338	19.364	19.390	19.418	19.446	19.475	19.536	19.599	19.773	19.969	20.189	20.433
210	19.508	19.521	19.547	19.574	19.601	19.630	19.659	19.720	19.784	19.957	20.153	20.370	20.611
215	19.690	19.703	19.729	19.756	19.784	19.813	19.842	19.903	19.967	20.141	20.335	20.551	20.789
220	19.871	19.885	19.911	19.938	19.966	19.995	20.025	20.086	20.150	20.323	20.517	20.731	20.966
225	20.052	20.066	20.092	20.120	20.148	20.177	20.207	20.268	20.332	20.505	20.698	20.910	21.143
230	20.233	20.246	20.273	20.301	20.329	20.358	20.388	20.449	20.513	20.687	20.878	21.089	21.320
235	20.412	20.426	20.453	20.481	20.509	20.538	20.568	20.630	20.694	20.867	21.058	21.268	21.496
240	20.591	20.605	20.632	20.660	20.689	20.718	20.748	20.810	20.874	21.047	21.237	21.445	21.672
245	20.770	20.784	20.811	20.839	20.868	20.897	20.927	20.989	21.054	21.226	21.416	21.622	21.847
250	20.948	20.962	20.989	21.017	21.046	21.076	21.106	21.168	21.233	21.405	21.594	21.799	22.021
255	21.125	21.139	21.167	21.195	21.224	21.254	21.284	21.346	21.411	21.583	21.771	21.975	22.196
260	21.302	21.316	21.344	21.372	21.401	21.431	21.461	21.524	21.588	21.760	21.948	22.151	22.369
265	21.478	21.493	21.520	21.549	21.578	21.608	21.638	21.701	21.765	21.937	22.124	22.325	22.542
270	21.654	21.668	21.696	21.725	21.754	21.784	21.814	21.877	21.942	22.113	22.299	22.500	22.715
275	21.829	21.844	21.872	21.900	21.930	21.960	21.990	22.053	22.117	22.289	22.474	22.674	22.887
280	22.004	22.018	22.046	22.075	22.105	22.135	22.165	22.228	22.292	22.464	22.648	22.847	23.059
285	22.178	22.192	22.221	22.250	22.279	22.309	22.340	22.402	22.467	22.638	22.822	23.020	23.231

**Opteon™ XP40 (R-449A)**  
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
	-53.4 °C	-39.9 °C	-24.9 °C	-14.9 °C	-7.1 °C	-0.8 °C	4.7 °C	13.8 °C	21.4 °C	36.1 °C	47.5 °C	56.8 °C	64.7 °C
	0.7414	0.7896	0.8513	0.8983	0.9381	0.9739	1.0073	1.0702	1.1319	1.2974	1.5033	1.7893	2.2418
-50	0.7424												
-45	0.7456												
-40	0.7500												
-35	0.7554	0.7878											
-30	0.7613	0.7887											
-25	0.7677	0.7913											
-20	0.7744	0.7951	0.8445										
-15	0.7814	0.7997	0.8415										
-10	0.7886	0.8049	0.8411	0.8876									
-5	0.7959	0.8106	0.8424	0.8814	0.9310								
0	0.8034	0.8167	0.8450	0.8785	0.9192	0.9707							
5	0.8110	0.8231	0.8484	0.8777	0.9121	0.9538	1.0058						
10	0.8187	0.8297	0.8525	0.8785	0.9082	0.9431	0.9848						
15	0.8265	0.8365	0.8572	0.8804	0.9065	0.9364	0.9711	1.0625					
20	0.8343	0.8435	0.8624	0.8833	0.9065	0.9325	0.9620	1.0365					
25	0.8422	0.8506	0.8679	0.8868	0.9076	0.9306	0.9563	1.0187	1.1039				
30	0.8501	0.8579	0.8737	0.8910	0.9097	0.9302	0.9528	1.0064	1.0761				
35	0.8580	0.8652	0.8798	0.8955	0.9126	0.9310	0.9512	0.9979	1.0565				
40	0.8660	0.8726	0.8860	0.9005	0.9161	0.9328	0.9508	0.9921	1.0424	1.2445			
45	0.8739	0.8801	0.8925	0.9058	0.9201	0.9353	0.9516	0.9883	1.0322	1.1961			
50	0.8819	0.8876	0.8991	0.9114	0.9245	0.9384	0.9532	0.9863	1.0249	1.1617	1.4368		
55	0.8898	0.8952	0.9059	0.9173	0.9293	0.9421	0.9556	0.9855	1.0198	1.1365	1.3447		
60	0.8978	0.9027	0.9127	0.9233	0.9344	0.9462	0.9586	0.9857	1.0166	1.1176	1.2830	1.6353	
65	0.9057	0.9103	0.9196	0.9295	0.9398	0.9506	0.9621	0.9869	1.0147	1.1034	1.2392	1.4880	2.1989
70	0.9136	0.9180	0.9266	0.9358	0.9454	0.9554	0.9660	0.9887	1.0140	1.0927	1.2070	1.3958	1.7990
75	0.9215	0.9256	0.9337	0.9423	0.9512	0.9605	0.9703	0.9912	1.0143	1.0847	1.1827	1.3328	1.6042
80	0.9293	0.9332	0.9408	0.9488	0.9571	0.9658	0.9749	0.9942	1.0154	1.0789	1.1642	1.2875	1.4873
85	0.9371	0.9408	0.9479	0.9554	0.9632	0.9714	0.9798	0.9977	1.0172	1.0748	1.1499	1.2537	1.4093
90	0.9449	0.9483	0.9551	0.9621	0.9695	0.9770	0.9849	1.0016	1.0196	1.0721	1.1389	1.2279	1.3538
95	0.9527	0.9559	0.9622	0.9689	0.9758	0.9829	0.9902	1.0057	1.0224	1.0705	1.1305	1.2080	1.3127
100	0.9604	0.9634	0.9694	0.9757	0.9821	0.9888	0.9957	1.0102	1.0257	1.0700	1.1241	1.1924	1.2814
105	0.9681	0.9709	0.9766	0.9825	0.9886	0.9949	1.0013	1.0149	1.0294	1.0702	1.1195	1.1802	1.2571
110	0.9757	0.9784	0.9838	0.9894	0.9951	1.0010	1.0071	1.0198	1.0333	1.0712	1.1162	1.1706	1.2380
115	0.9833	0.9859	0.9909	0.9962	1.0017	1.0072	1.0130	1.0249	1.0376	1.0728	1.1141	1.1632	1.2228
120	0.9908	0.9933	0.9981	1.0031	1.0082	1.0135	1.0189	1.0302	1.0421	1.0748	1.1129	1.1576	1.2108
125	0.9983	1.0006	1.0052	1.0100	1.0148	1.0198	1.0249	1.0356	1.0467	1.0774	1.1126	1.1534	1.2013
130	1.0057	1.0079	1.0123	1.0168	1.0214	1.0262	1.0310	1.0411	1.0516	1.0803	1.1130	1.1505	1.1939
135	1.0131	1.0152	1.0194	1.0237	1.0281	1.0326	1.0371	1.0466	1.0566	1.0835	1.1140	1.1485	1.1881
140	1.0204	1.0224	1.0264	1.0305	1.0347	1.0390	1.0433	1.0523	1.0617	1.0871	1.1155	1.1475	1.1837
145	1.0277	1.0296	1.0334	1.0373	1.0413	1.0454	1.0495	1.0580	1.0669	1.0908	1.1174	1.1472	1.1805
150	1.0349	1.0368	1.0404	1.0441	1.0479	1.0518	1.0557	1.0638	1.0723	1.0949	1.1198	1.1475	1.1783
155	1.0421	1.0438	1.0473	1.0509	1.0545	1.0582	1.0619	1.0697	1.0777	1.0990	1.1225	1.1484	1.1769
160	1.0492	1.0509	1.0542	1.0576	1.0611	1.0646	1.0682	1.0755	1.0832	1.1034	1.1255	1.1497	1.1763
165	1.0562	1.0579	1.0610	1.0643	1.0676	1.0710	1.0744	1.0814	1.0887	1.1079	1.1288	1.1515	1.1763
170	1.0632	1.0648	1.0678	1.0710	1.0741	1.0774	1.0806	1.0873	1.0943	1.1125	1.1323	1.1537	1.1769
175	1.0702	1.0717	1.0746	1.0776	1.0806	1.0837	1.0869	1.0933	1.0999	1.1173	1.1360	1.1561	1.1779
180	1.0770	1.0785	1.0813	1.0842	1.0871	1.0901	1.0931	1.0992	1.1055	1.1221	1.1398	1.1589	1.1793
185	1.0839	1.0852	1.0879	1.0907	1.0935	1.0964	1.0993	1.1051	1.1112	1.1270	1.1439	1.1619	1.1812
190	1.0906	1.0920	1.0946	1.0972	1.0999	1.1027	1.1054	1.1111	1.1168	1.1319	1.1480	1.1651	1.1833
195	1.0973	1.0986	1.1011	1.1037	1.1063	1.1089	1.1116	1.1170	1.1225	1.1370	1.1523	1.1685	1.1857
200	1.1040	1.1052	1.1076	1.1101	1.1126	1.1151	1.1177	1.1229	1.1282	1.1420	1.1566	1.1721	1.1884
205	1.1106	1.1118	1.1141	1.1165	1.1189	1.1213	1.1238	1.1288	1.1339	1.1471	1.1611	1.1758	1.1913
210	1.1171	1.1183	1.1205	1.1228	1.1251	1.1275	1.1299	1.1347	1.1396	1.1523	1.1656	1.1797	1.1944
215	1.1236	1.1247	1.1269	1.1291	1.1313	1.1336	1.1359	1.1405	1.1452	1.1574	1.1702	1.1836	1.1977
220	1.1300	1.1311	1.1332	1.1353	1.1375	1.1397	1.1419	1.1463	1.1509	1.1626	1.1749	1.1877	1.2011
225	1.1364	1.1374	1.1394	1.1415	1.1436	1.1457	1.1478	1.1522	1.1565	1.1678	1.1796	1.1919	1.2046
230	1.1427	1.1437	1.1457	1.1477	1.1497	1.1517	1.1538	1.1579	1.1622	1.1730	1.1843	1.1961	1.2083
235	1.1489	1.1499	1.1518	1.1538	1.1557	1.1577	1.1597	1.1637	1.1678	1.1782	1.1891	1.2004	1.2121
240	1.1551	1.1561	1.1579	1.1598	1.1617	1.1636	1.1655	1.1694	1.1733	1.1834	1.1939	1.2047	1.2159
245	1.1613	1.1622	1.1640	1.1658	1.1676	1.1695	1.1713	1.1751	1.1789	1.1886	1.1987	1.2091	1.2199
250	1.1674	1.1683	1.1700	1.1717	1.1735	1.1753	1.1771	1.1807	1.1844	1.1938	1.2035	1.2136	1.2239
255	1.1734	1.1743	1.1759	1.1776	1.1794	1.1811	1.1828	1.1864	1.1899	1.1990	1.2084	1.2180	1.2279
260	1.1794	1.1802	1.1818	1.1835	1.1852	1.1869	1.1885	1.1920	1.1954	1.2042	1.2132	1.2225	1.2321
265	1.1853	1.1861	1.1877	1.1893	1.1909	1.1926	1.1942	1.1975	1.2008	1.2094	1.2181	1.2270	1.2362
270	1.1912	1.1920	1.1935	1.1951	1.1966	1.1982	1.1998	1.2030	1.2063	1.2145	1.2229	1.2316	1.2404
275	1.1970	1.1978	1.1993	1.2008	1.2023	1.2038	1.2054	1.2085	1.2116	1.2196	1.2278	1.2361	1.2447
280	1.2028	1.2035	1.2050	1.2064	1.2079	1.2094	1.2109	1.2139	1.2170	1.2247	1.2326	1.2407	1.2489
285	1.2085	1.2092	1.2106	1.2121	1.2135	1.2150	1.2164	1.2194	1.2223	1.2298	1.2375	1.2453	1.2532

Opteon™ XP40 (R-449A)  
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
	-53.4 °C	-39.9 °C	-24.9 °C	-14.9 °C	-7.1 °C	-0.8 °C	4.7 °C	13.8 °C	21.4 °C	36.1 °C	47.5 °C	56.8 °C	64.7 °C
	1.1804	1.1872	1.2013	1.2155	1.2298	1.2444	1.2594	1.2912	1.3261	1.4319	1.5778	1.7938	2.1495
-50	1.1769												
-45	1.1722												
-40	1.1680												
-35	1.1642	1.1809											
-30	1.1607	1.1754											
-25	1.1575	1.1705											
-20	1.1545	1.1661	1.1928										
-15	1.1516	1.1621	1.1855										
-10	1.1490	1.1584	1.1792	1.2051									
-5	1.1465	1.1550	1.1736	1.1961	1.2241								
0	1.1441	1.1519	1.1686	1.1885	1.2124	1.2419							
5	1.1418	1.1489	1.1640	1.1817	1.2026	1.2275	1.2583						
10	1.1397	1.1462	1.1599	1.1758	1.1941	1.2157	1.2414						
15	1.1376	1.1436	1.1561	1.1705	1.1868	1.2056	1.2276	1.2855					
20	1.1356	1.1412	1.1526	1.1656	1.1803	1.1969	1.2160	1.2645					
25	1.1338	1.1389	1.1494	1.1612	1.1744	1.1893	1.2060	1.2474	1.3047				
30	1.1320	1.1367	1.1464	1.1572	1.1692	1.1825	1.1974	1.2333	1.2809				
35	1.1302	1.1346	1.1436	1.1535	1.1644	1.1764	1.1897	1.2212	1.2616				
40	1.1286	1.1326	1.1410	1.1501	1.1601	1.1710	1.1829	1.2108	1.2456	1.3906			
45	1.1269	1.1307	1.1385	1.1469	1.1561	1.1660	1.1768	1.2017	1.2321	1.3502			
50	1.1254	1.1289	1.1361	1.1440	1.1524	1.1615	1.1713	1.1937	1.2205	1.3193	1.5258		
55	1.1239	1.1272	1.1339	1.1412	1.1490	1.1573	1.1663	1.1865	1.2104	1.2946	1.4514		
60	1.1225	1.1256	1.1318	1.1386	1.1458	1.1535	1.1617	1.1801	1.2015	1.2743	1.3989	1.6723	
65	1.1211	1.1240	1.1298	1.1361	1.1428	1.1500	1.1575	1.1743	1.1936	1.2574	1.3595	1.5531	2.1157
70	1.1197	1.1225	1.1280	1.1338	1.1401	1.1467	1.1537	1.1691	1.1866	1.2430	1.3287	1.4755	1.7966
75	1.1184	1.1210	1.1262	1.1317	1.1375	1.1436	1.1501	1.1643	1.1802	1.2305	1.3038	1.4202	1.6368
80	1.1171	1.1196	1.1244	1.1296	1.1350	1.1408	1.1468	1.1598	1.1744	1.2197	1.2832	1.3784	1.5376
85	1.1159	1.1182	1.1228	1.1276	1.1327	1.1381	1.1437	1.1558	1.1692	1.2101	1.2657	1.3456	1.4691
90	1.1147	1.1169	1.1212	1.1258	1.1306	1.1356	1.1408	1.1520	1.1644	1.2016	1.2508	1.3189	1.4183
95	1.1136	1.1156	1.1197	1.1240	1.1285	1.1332	1.1381	1.1485	1.1600	1.1939	1.2379	1.2968	1.3790
100	1.1124	1.1144	1.1183	1.1223	1.1266	1.1310	1.1355	1.1453	1.1559	1.1871	1.2266	1.2781	1.3475
105	1.1114	1.1132	1.1169	1.1207	1.1247	1.1288	1.1332	1.1423	1.1522	1.1808	1.2166	1.2621	1.3216
110	1.1103	1.1121	1.1155	1.1192	1.1229	1.1268	1.1309	1.1395	1.1487	1.1751	1.2077	1.2483	1.3000
115	1.1093	1.1109	1.1142	1.1177	1.1213	1.1249	1.1288	1.1368	1.1454	1.1700	1.1997	1.2361	1.2816
120	1.1083	1.1099	1.1130	1.1163	1.1196	1.1231	1.1267	1.1343	1.1424	1.1652	1.1924	1.2254	1.2657
125	1.1073	1.1088	1.1118	1.1149	1.1181	1.1214	1.1248	1.1319	1.1395	1.1608	1.1859	1.2158	1.2518
130	1.1064	1.1078	1.1106	1.1136	1.1166	1.1198	1.1230	1.1297	1.1369	1.1567	1.1799	1.2073	1.2397
135	1.1054	1.1068	1.1095	1.1123	1.1152	1.1182	1.1213	1.1276	1.1343	1.1529	1.1745	1.1995	1.2289
140	1.1045	1.1059	1.1084	1.1111	1.1139	1.1167	1.1196	1.1256	1.1320	1.1494	1.1694	1.1925	1.2192
145	1.1037	1.1049	1.1074	1.1100	1.1126	1.1153	1.1180	1.1237	1.1297	1.1461	1.1648	1.1861	1.2105
150	1.1028	1.1040	1.1064	1.1088	1.1113	1.1139	1.1165	1.1219	1.1276	1.1431	1.1605	1.1803	1.2027
155	1.1020	1.1031	1.1054	1.1077	1.1101	1.1126	1.1151	1.1202	1.1256	1.1402	1.1565	1.1749	1.1956
160	1.1012	1.1023	1.1045	1.1067	1.1090	1.1113	1.1137	1.1186	1.1237	1.1375	1.1528	1.1700	1.1891
165	1.1004	1.1015	1.1035	1.1057	1.1078	1.1101	1.1123	1.1170	1.1219	1.1349	1.1494	1.1654	1.1831
170	1.0996	1.1007	1.1026	1.1047	1.1068	1.1089	1.1111	1.1155	1.1201	1.1325	1.1461	1.1611	1.1777
175	1.0989	1.0999	1.1018	1.1037	1.1057	1.1078	1.1098	1.1141	1.1185	1.1302	1.1431	1.1572	1.1726
180	1.0982	1.0991	1.1009	1.1028	1.1047	1.1067	1.1087	1.1127	1.1169	1.1281	1.1403	1.1535	1.1679
185	1.0974	1.0983	1.1001	1.1019	1.1038	1.1056	1.1075	1.1114	1.1154	1.1261	1.1376	1.1501	1.1636
190	1.0968	1.0976	1.0993	1.1010	1.1028	1.1046	1.1064	1.1101	1.1140	1.1241	1.1350	1.1468	1.1596
195	1.0961	1.0969	1.0985	1.1002	1.1019	1.1036	1.1054	1.1089	1.1126	1.1223	1.1326	1.1438	1.1558
200	1.0954	1.0962	1.0978	1.0994	1.1010	1.1027	1.1043	1.1078	1.1113	1.1205	1.1304	1.1410	1.1523
205	1.0948	1.0955	1.0970	1.0986	1.1002	1.1017	1.1034	1.1066	1.1100	1.1188	1.1282	1.1383	1.1489
210	1.0941	1.0949	1.0963	1.0978	1.0993	1.1009	1.1024	1.1056	1.1088	1.1172	1.1262	1.1357	1.1458
215	1.0935	1.0942	1.0956	1.0971	1.0985	1.1000	1.1015	1.1045	1.1076	1.1157	1.1243	1.1333	1.1429
220	1.0929	1.0936	1.0950	1.0963	1.0977	1.0992	1.1006	1.1035	1.1065	1.1142	1.1224	1.1310	1.1401
225	1.0923	1.0930	1.0943	1.0956	1.0970	1.0983	1.0997	1.1025	1.1054	1.1128	1.1206	1.1289	1.1375
230	1.0917	1.0924	1.0937	1.0949	1.0962	1.0976	1.0989	1.1016	1.1043	1.1115	1.1190	1.1268	1.1351
235	1.0912	1.0918	1.0930	1.0943	1.0955	1.0968	1.0981	1.1007	1.1033	1.1102	1.1174	1.1249	1.1327
240	1.0906	1.0912	1.0924	1.0936	1.0948	1.0961	1.0973	1.0998	1.1023	1.1089	1.1158	1.1230	1.1305
245	1.0901	1.0907	1.0918	1.0930	1.0941	1.0953	1.0965	1.0989	1.1014	1.1077	1.1144	1.1212	1.1284
250	1.0896	1.0901	1.0912	1.0923	1.0935	1.0946	1.0958	1.0981	1.1005	1.1066	1.1129	1.1195	1.1264
255	1.0890	1.0896	1.0907	1.0917	1.0928	1.0939	1.0951	1.0973	1.0996	1.1055	1.1116	1.1179	1.1245
260	1.0885	1.0891	1.0901	1.0911	1.0922	1.0933	1.0944	1.0965	1.0987	1.1044	1.1103	1.1164	1.1226
265	1.0880	1.0885	1.0895	1.0906	1.0916	1.0926	1.0937	1.0958	1.0979	1.1034	1.1090	1.1149	1.1209
270	1.0875	1.0880	1.0890	1.0900	1.0910	1.0920	1.0930	1.0950	1.0971	1.1024	1.1078	1.1134	1.1192
275	1.0871	1.0876	1.0885	1.0895	1.0904	1.0914	1.0924	1.0943	1.0963	1.1014	1.1067	1.1121	1.1176
280	1.0866	1.0871	1.0880	1.0889	1.0898	1.0908	1.0917	1.0936	1.0956	1.1005	1.1056	1.1108	1.1161
285	1.0861	1.0866	1.0875	1.0884	1.0893	1.0902	1.0911	1.0930	1.0948	1.0996	1.1045	1.1095	1.1146

Opteon™ XP40 (R-449A)  
 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
	-53.4 °C	-39.9 °C	-24.9 °C	-14.9 °C	-7.1 °C	-0.8 °C	4.7 °C	13.8 °C	21.4 °C	36.1 °C	47.5 °C	56.8 °C	64.7 °C
	8.173	9.045	10.082	10.829	11.441	11.977	12.465	13.357	14.193	16.253	18.558	21.371	25.058
-50	8.382												
-45	8.696												
-40	9.014												
-35	9.337	9.361											
-30	9.665	9.687											
-25	9.998	10.019											
-20	10.335	10.355	10.408										
-15	10.678	10.696	10.746										
-10	11.025	11.043	11.088	11.156									
-5	11.377	11.394	11.436	11.498	11.583								
0	11.734	11.750	11.790	11.846	11.923	12.027							
5	12.096	12.111	12.148	12.200	12.270	12.362	12.484						
10	12.463	12.477	12.512	12.560	12.624	12.707	12.814						
15	12.834	12.847	12.881	12.926	12.984	13.060	13.155	13.429					
20	13.210	13.223	13.254	13.296	13.351	13.419	13.505	13.745					
25	13.591	13.603	13.633	13.673	13.723	13.786	13.864	14.077	14.397				
30	13.977	13.989	14.017	14.054	14.101	14.159	14.230	14.422	14.700				
35	14.367	14.379	14.405	14.440	14.484	14.538	14.604	14.777	15.023				
40	14.763	14.773	14.799	14.832	14.873	14.923	14.984	15.142	15.361	16.371			
45	15.163	15.173	15.197	15.229	15.267	15.314	15.370	15.515	15.713	16.582			
50	15.568	15.578	15.601	15.630	15.667	15.711	15.763	15.897	16.078	16.840	18.484		
55	15.978	15.987	16.009	16.037	16.072	16.113	16.163	16.288	16.455	17.132	18.476		
60	16.392	16.401	16.423	16.450	16.483	16.523	16.569	16.686	16.841	17.449	18.585	20.932	
65	16.812	16.821	16.842	16.868	16.900	16.938	16.982	17.092	17.236	17.788	18.769	20.603	24.904
70	17.236	17.245	17.266	17.292	17.323	17.359	17.401	17.505	17.640	18.144	19.006	20.507	23.442
75	17.665	17.675	17.696	17.721	17.751	17.786	17.826	17.925	18.051	18.516	19.282	20.550	22.777
80	18.100	18.109	18.130	18.155	18.185	18.219	18.258	18.352	18.470	18.900	19.590	20.683	22.472
85	18.539	18.549	18.570	18.595	18.624	18.657	18.694	18.784	18.897	19.297	19.922	20.881	22.370
90	18.982	18.993	19.014	19.039	19.068	19.100	19.137	19.223	19.330	19.704	20.275	21.126	22.397
95	19.431	19.441	19.464	19.489	19.517	19.549	19.585	19.668	19.770	20.121	20.646	21.410	22.514
100	19.884	19.895	19.918	19.943	19.972	20.003	20.038	20.119	20.216	20.547	21.032	21.724	22.697
105	20.342	20.354	20.377	20.403	20.431	20.462	20.497	20.575	20.669	20.981	21.432	22.063	22.930
110	20.805	20.817	20.841	20.867	20.896	20.927	20.960	21.037	21.127	21.424	21.845	22.423	23.204
115	21.273	21.285	21.310	21.336	21.365	21.396	21.429	21.504	21.592	21.875	22.269	22.802	23.510
120	21.745	21.758	21.783	21.810	21.839	21.870	21.903	21.977	22.062	22.333	22.703	23.197	23.844
125	22.222	22.236	22.262	22.289	22.318	22.349	22.382	22.455	22.538	22.798	23.148	23.607	24.200
130	22.704	22.718	22.745	22.773	22.802	22.833	22.866	22.939	23.020	23.270	23.601	24.031	24.578
135	23.191	23.205	23.233	23.262	23.291	23.322	23.355	23.427	23.507	23.749	24.063	24.466	24.973
140	23.682	23.697	23.725	23.755	23.785	23.817	23.849	23.920	23.999	24.234	24.534	24.913	25.384
145	24.179	24.193	24.223	24.253	24.284	24.316	24.349	24.419	24.497	24.725	25.012	25.370	25.810
150	24.679	24.695	24.725	24.756	24.787	24.820	24.853	24.923	25.000	25.222	25.498	25.837	26.250
155	25.185	25.201	25.231	25.263	25.296	25.329	25.363	25.432	25.508	25.725	25.991	26.313	26.701
160	25.696	25.712	25.743	25.775	25.808	25.842	25.876	25.947	26.021	26.235	26.491	26.798	27.164
165	26.211	26.227	26.259	26.292	26.326	26.360	26.395	26.467	26.541	26.749	26.998	27.291	27.638
170	26.731	26.747	26.780	26.814	26.848	26.883	26.918	26.991	27.066	27.270	27.511	27.793	28.122
175	27.255	27.273	27.306	27.340	27.375	27.411	27.446	27.520	27.595	27.796	28.031	28.302	28.615
180	27.785	27.802	27.836	27.871	27.907	27.943	27.979	28.053	28.129	28.329	28.557	28.819	29.118
185	28.319	28.337	28.372	28.407	28.443	28.480	28.517	28.591	28.668	28.868	29.089	29.342	29.629
190	28.858	28.876	28.912	28.948	28.984	29.021	29.059	29.134	29.212	29.413	29.628	29.873	30.148
195	29.401	29.420	29.456	29.493	29.530	29.568	29.605	29.682	29.760	29.962	30.175	30.411	30.676
200	29.950	29.969	30.006	30.043	30.081	30.119	30.157	30.234	30.313	30.516	30.728	30.955	31.211
205	30.503	30.522	30.560	30.598	30.636	30.675	30.713	30.792	30.871	31.075	31.287	31.509	31.754
210	31.061	31.081	31.119	31.157	31.196	31.235	31.274	31.353	31.433	31.638	31.850	32.071	32.304
215	31.624	31.644	31.682	31.721	31.761	31.800	31.840	31.920	32.001	32.206	32.418	32.638	32.865
220	32.191	32.211	32.250	32.290	32.330	32.370	32.410	32.491	32.572	32.779	32.991	33.210	33.435
225	32.763	32.784	32.823	32.864	32.904	32.945	32.985	33.067	33.149	33.357	33.569	33.787	34.010
230	33.340	33.361	33.401	33.442	33.483	33.524	33.565	33.647	33.730	33.939	34.152	34.369	34.591
235	33.922	33.943	33.984	34.025	34.067	34.108	34.149	34.233	34.316	34.526	34.739	34.955	35.176
240	34.508	34.530	34.571	34.613	34.655	34.697	34.739	34.823	34.907	35.118	35.331	35.547	35.766
245	35.099	35.121	35.163	35.205	35.248	35.290	35.332	35.417	35.502	35.714	35.928	36.143	36.361
250	35.695	35.717	35.760	35.803	35.845	35.888	35.931	36.017	36.102	36.316	36.529	36.744	36.961
255	36.296	36.318	36.361	36.405	36.448	36.491	36.534	36.621	36.707	36.921	37.135	37.350	37.565
260	36.902	36.924	36.967	37.011	37.055	37.099	37.142	37.229	37.316	37.531	37.745	37.959	38.172
265	37.512	37.535	37.578	37.623	37.667	37.711	37.755	37.842	37.929	38.145	38.359	38.571	38.782
270	38.127	38.150	38.194	38.239	38.283	38.328	38.372	38.461	38.548	38.766	38.981	39.194	39.406
275	38.746	38.770	38.814	38.860	38.905	38.950	38.994	39.084	39.172	39.392	39.608	39.822	40.034
280	39.371	39.394	39.440	39.485	39.531	39.576	39.621	39.711	39.801	40.022	40.239	40.454	40.667
285	40.000	40.024	40.070	40.116	40.162	40.207	40.253	40.344	40.434	40.657	40.875	41.091	41.304



Opteon™ XP40 (R-449A)  
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
	-53.4 °C	-39.9 °C	-24.9 °C	-14.9 °C	-7.1 °C	-0.8 °C	4.7 °C	13.8 °C	21.4 °C	36.1 °C	47.5 °C	56.8 °C	64.7 °C
	153.06	155.43	156.96	157.24	157.00	156.48	155.79	154.08	152.12	146.63	140.64	134.27	127.57
-50	154.30												
-45	156.08												
-40	157.82												
-35	159.53	157.29											
-30	161.21	159.13											
-25	162.86	160.92											
-20	164.48	162.67	158.98										
-15	166.07	164.37	160.94										
-10	167.64	166.05	162.85	159.37									
-5	169.19	167.69	164.69	161.47	158.01								
0	170.73	169.31	166.49	163.48	160.29	156.86							
5	172.24	170.90	168.25	165.43	162.46	159.31	155.94						
10	173.73	172.47	169.97	167.32	164.55	161.64	158.55						
15	175.20	174.01	171.65	169.16	166.57	163.86	161.01	154.78					
20	176.66	175.53	173.30	170.95	168.52	165.99	163.34	157.64					
25	178.11	177.03	174.91	172.70	170.41	168.04	165.58	160.32	154.49				
30	179.54	178.51	176.50	174.41	172.26	170.03	167.72	162.84	157.52				
35	180.95	179.98	178.07	176.09	174.05	171.95	169.79	165.25	160.34				
40	182.35	181.42	179.61	177.73	175.80	173.83	171.79	167.54	163.00	149.81			
45	183.74	182.85	181.13	179.34	177.52	175.65	173.73	169.75	165.52	153.52			
50	185.11	184.27	182.63	180.93	179.20	177.43	175.62	171.87	167.92	156.92	143.28		
55	186.47	185.67	184.10	182.49	180.84	179.17	177.45	173.92	170.22	160.06	147.93		
60	187.82	187.06	185.56	184.02	182.46	180.87	179.25	175.91	172.44	163.01	152.07	138.44	
65	189.16	188.43	187.00	185.53	184.05	182.53	181.00	177.84	174.57	165.78	155.81	143.95	128.16
70	190.49	189.79	188.42	187.03	185.61	184.17	182.71	179.72	176.64	168.42	159.26	148.72	135.79
75	191.81	191.13	189.83	188.50	187.14	185.77	184.39	181.55	178.64	170.93	162.47	152.97	141.87
80	193.11	192.47	191.22	189.95	188.66	187.35	186.03	183.34	180.58	173.33	165.48	156.83	147.06
85	194.41	193.79	192.60	191.38	190.15	188.90	187.64	185.09	182.47	175.64	168.32	160.38	151.63
90	195.70	195.11	193.96	192.80	191.62	190.43	189.23	186.80	184.31	177.86	171.02	163.69	155.76
95	196.97	196.41	195.31	194.20	193.07	191.94	190.79	188.47	186.11	180.01	173.59	166.79	159.55
100	198.24	197.70	196.65	195.58	194.50	193.42	192.33	190.12	187.87	182.09	176.06	169.72	163.06
105	199.50	198.98	197.97	196.95	195.92	194.88	193.84	191.73	189.59	184.11	178.42	172.51	166.34
110	200.75	200.25	199.29	198.31	197.32	196.33	195.33	193.31	191.28	186.07	180.70	175.16	169.43
115	201.99	201.51	200.59	199.65	198.70	197.75	196.80	194.87	192.93	187.98	182.91	177.70	172.35
120	203.22	202.76	201.88	200.98	200.07	199.16	198.25	196.41	194.55	189.85	185.04	180.13	175.14
125	204.45	204.01	203.16	202.29	201.42	200.55	199.68	197.92	196.15	191.67	187.11	182.48	177.79
130	205.67	205.24	204.43	203.60	202.76	201.93	201.09	199.41	197.71	193.44	189.12	184.75	180.34
135	206.88	206.47	205.68	204.89	204.09	203.29	202.49	200.87	199.26	195.18	191.08	186.94	182.79
140	208.08	207.69	206.93	206.17	205.40	204.63	203.86	202.32	200.78	196.89	192.98	189.06	185.15
145	209.27	208.90	208.17	207.44	206.70	205.97	205.23	203.75	202.27	198.56	194.84	191.12	187.43
150	210.46	210.10	209.40	208.70	207.99	207.29	206.58	205.16	203.75	200.20	196.66	193.13	189.63
155	211.64	211.29	210.63	209.95	209.27	208.59	207.91	206.56	205.20	201.81	198.44	195.08	191.77
160	212.82	212.48	211.84	211.19	210.54	209.89	209.24	207.94	206.64	203.40	200.18	196.99	193.85
165	213.98	213.66	213.04	212.42	211.79	211.17	210.54	209.30	208.05	204.96	201.88	198.85	195.87
170	215.14	214.83	214.24	213.64	213.04	212.44	211.84	210.65	209.45	206.49	203.56	200.67	197.84
175	216.30	216.00	215.43	214.85	214.28	213.70	213.12	211.98	210.84	208.00	205.20	202.45	199.76
180	217.44	217.16	216.61	216.06	215.50	214.95	214.40	213.30	212.20	209.49	206.81	204.19	201.63
185	218.58	218.31	217.78	217.25	216.72	216.19	215.66	214.60	213.55	210.96	208.40	205.90	203.47
190	219.72	219.46	218.95	218.44	217.93	217.42	216.91	215.90	214.89	212.40	209.96	207.58	205.26
195	220.85	220.59	220.11	219.62	219.13	218.64	218.15	217.18	216.21	213.83	211.50	209.22	207.02
200	221.97	221.73	221.26	220.79	220.32	219.85	219.38	218.45	217.52	215.24	213.01	210.84	208.74
205	223.09	222.85	222.40	221.95	221.50	221.05	220.60	219.70	218.82	216.63	214.50	212.43	210.43
210	224.20	223.97	223.54	223.11	222.67	222.24	221.81	220.95	220.10	218.01	215.97	214.00	212.09
215	225.30	225.09	224.67	224.26	223.84	223.42	223.01	222.19	221.37	219.37	217.42	215.54	213.72
220	226.40	226.20	225.80	225.40	225.00	224.60	224.20	223.41	222.63	220.72	218.85	217.05	215.33
225	227.50	227.30	226.92	226.53	226.15	225.77	225.39	224.63	223.88	222.05	220.27	218.55	216.90
230	228.59	228.40	228.03	227.66	227.29	226.93	226.56	225.84	225.12	223.36	221.66	220.02	218.45
235	229.67	229.49	229.14	228.78	228.43	228.08	227.73	227.03	226.35	224.66	223.04	221.48	219.98
240	230.75	230.58	230.24	229.90	229.56	229.22	228.89	228.22	227.56	225.95	224.40	222.91	221.49
245	231.83	231.66	231.33	231.01	230.68	230.36	230.04	229.40	228.77	227.23	225.75	224.33	222.97
250	232.89	232.73	232.42	232.11	231.80	231.49	231.18	230.57	229.97	228.50	227.08	225.72	224.43
255	233.96	233.80	233.50	233.20	232.91	232.61	232.31	231.73	231.15	229.75	228.40	227.10	225.88
260	235.02	234.87	234.58	234.30	234.01	233.73	233.44	232.88	232.33	230.99	229.70	228.47	227.30
265	236.07	235.93	235.66	235.38	235.11	234.83	234.56	234.03	233.50	232.22	230.99	229.82	228.71
270	237.12	236.98	236.72	236.46	236.20	235.94	235.68	235.17	234.66	233.44	232.27	231.15	230.10
275	238.17	238.03	237.78	237.53	237.28	237.03	236.79	236.30	235.82	234.65	233.53	232.47	231.47
280	239.21	239.08	238.84	238.60	238.36	238.12	237.89	237.42	236.96	235.85	234.79	233.78	232.83
285	240.24	240.12	239.89	239.66	239.43	239.21	238.98	238.54	238.10	237.04	236.03	235.07	234.17

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