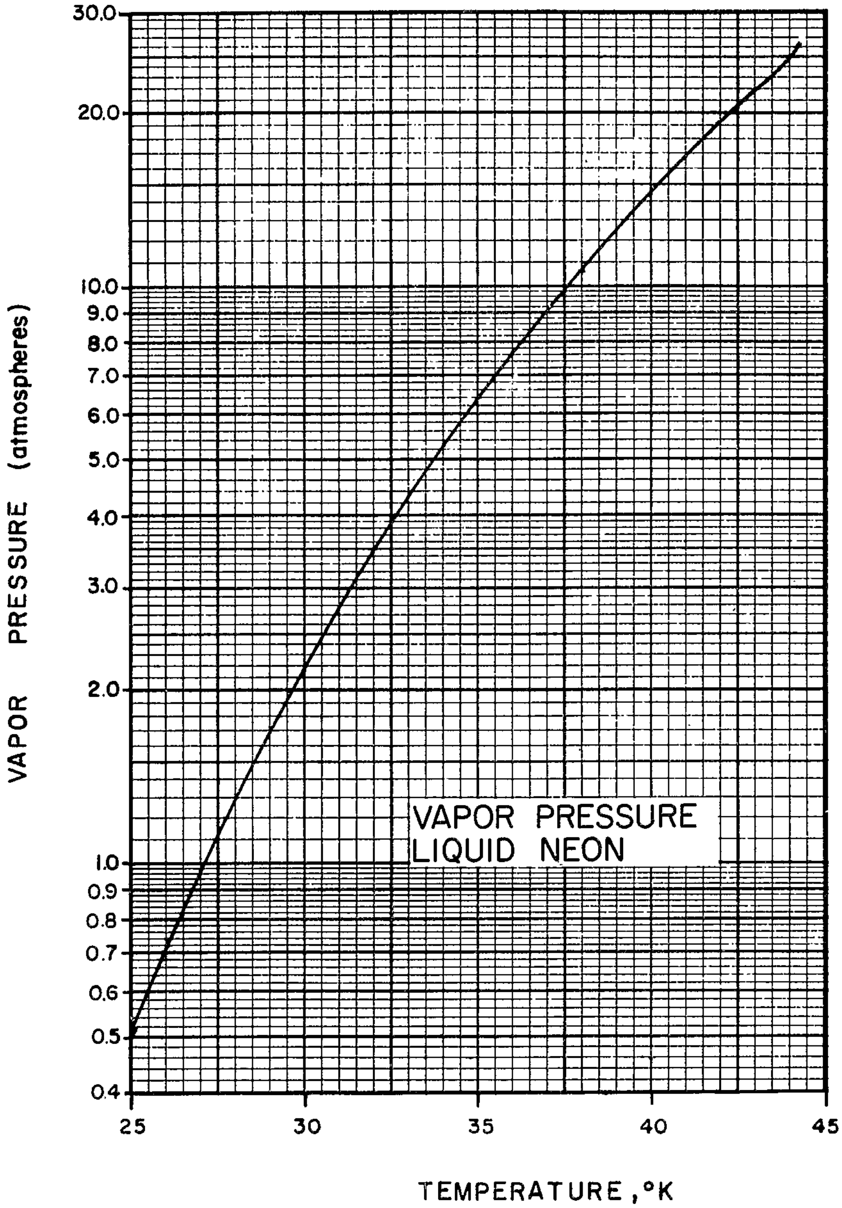
V. PROPERTIES OF NEON

CONTENTS

VAPOR PRESSURE LIQUID NEON

Source of Data: R.D. McCarty and R.B. Stewart, "Thermodynamic Properties of Neon from 25 to 300°K Between 0.1 and 200 Atmospheres", Cryogenics Division National Bureau of Standards

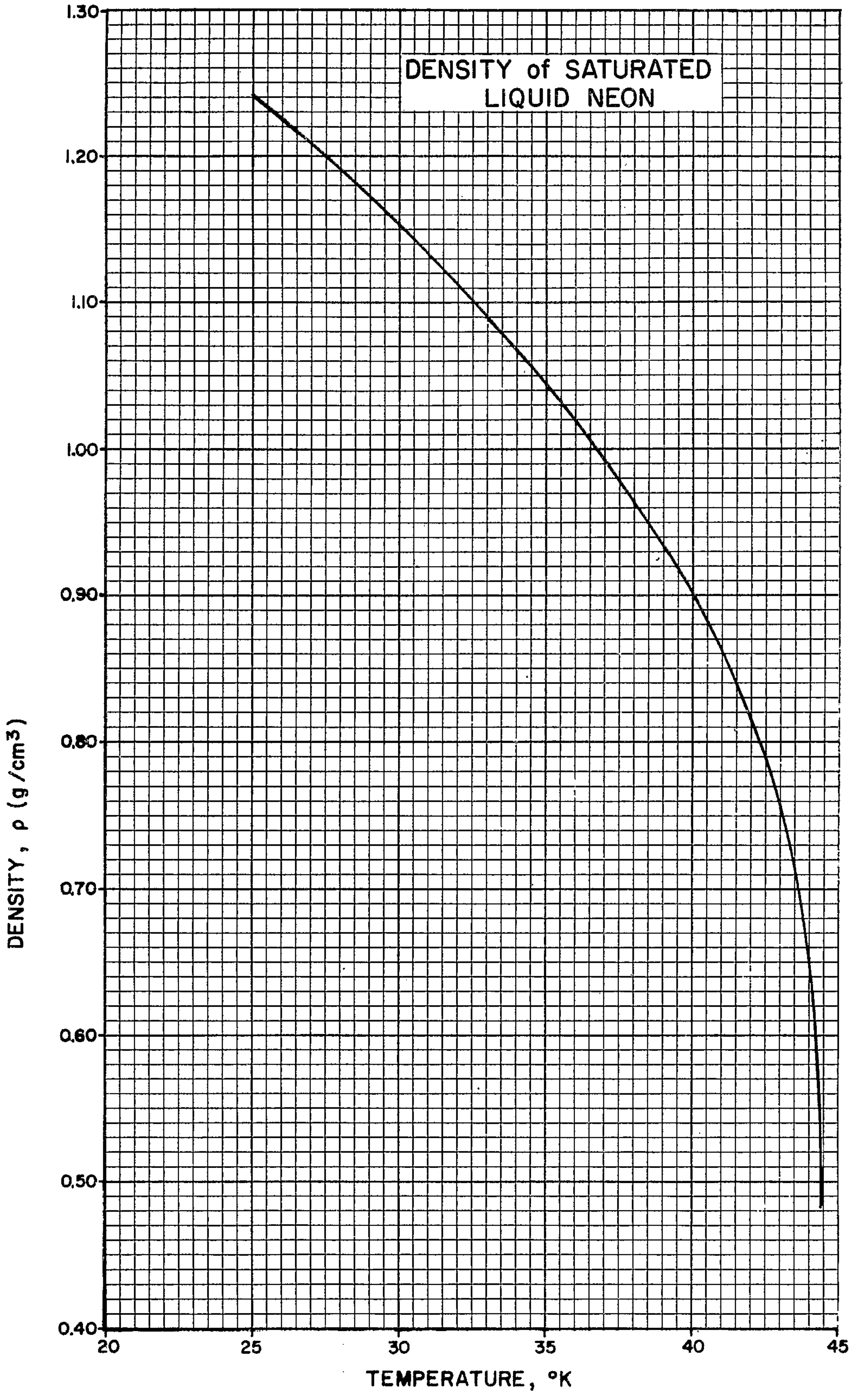
Temperature °K	Pressure (atm)
25	0.50366
26	0.70902
27	0.97255
28	1.3037
29	1.7124
30	2.2088
31	2.8031
32	3.5061
33	4.3286
34	5.2818
35	6.3773
36	7.6271
37	9.0439
38	10.641
39	12.432
40	14.434
41	16.661
42	19.133
43	21.867
44	24.887
44.4	26.19

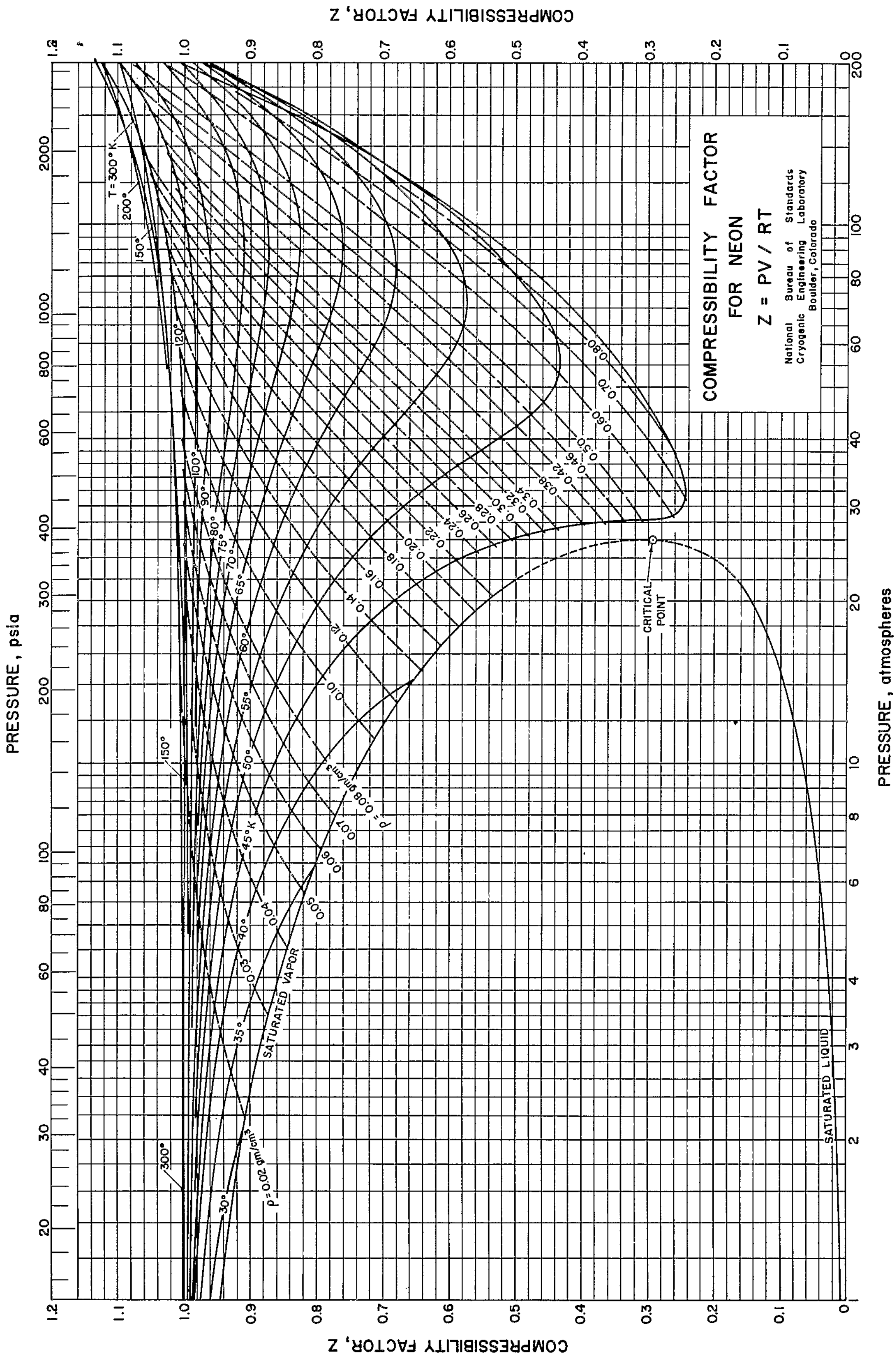

VAPOR PRESSURE (atmospheres)
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
25
30
35
40
45
TEMPERATURE, °K
VAPOR PRESSURE
LIQUID NEON

DENSITY OF SATURATED VAPOR AND LIQUID NEON

Source of Data: R.D. McCarty and R.B. Stewart, "Thermodynamic Properties of Neon from 25 to 300°K Between 0.1 and 200 Atmospheres", Cryogenics Division National Bureau of Standards

Temperature °K	Saturated Vapor ρ $(g/cm^3) \times 10^4$	Saturated Liquid ρ (g/cm^3)
25	51.019	1.24020
26	69.708	1.22370
27	93.109	1.20640
28	121.95	1.18850
29	157.02	1.17000
30	199.23	1.15080
31	249.58	1.13100
32	309.26	1.11030
33	379.65	1.08880
34	462.43	1.06640
35	559.61	1.04280
36	673.68	1.01800
37	807.73	0.99156
38	965.67	0.96319
39	1152.6	0.93235
40	1375.5	0.89822
41	1645.1	0.85944
42	1981.6	0.81338
43	2434.5	0.75363
44	3224.0	0.65096
44.4	4830.0	0.48300

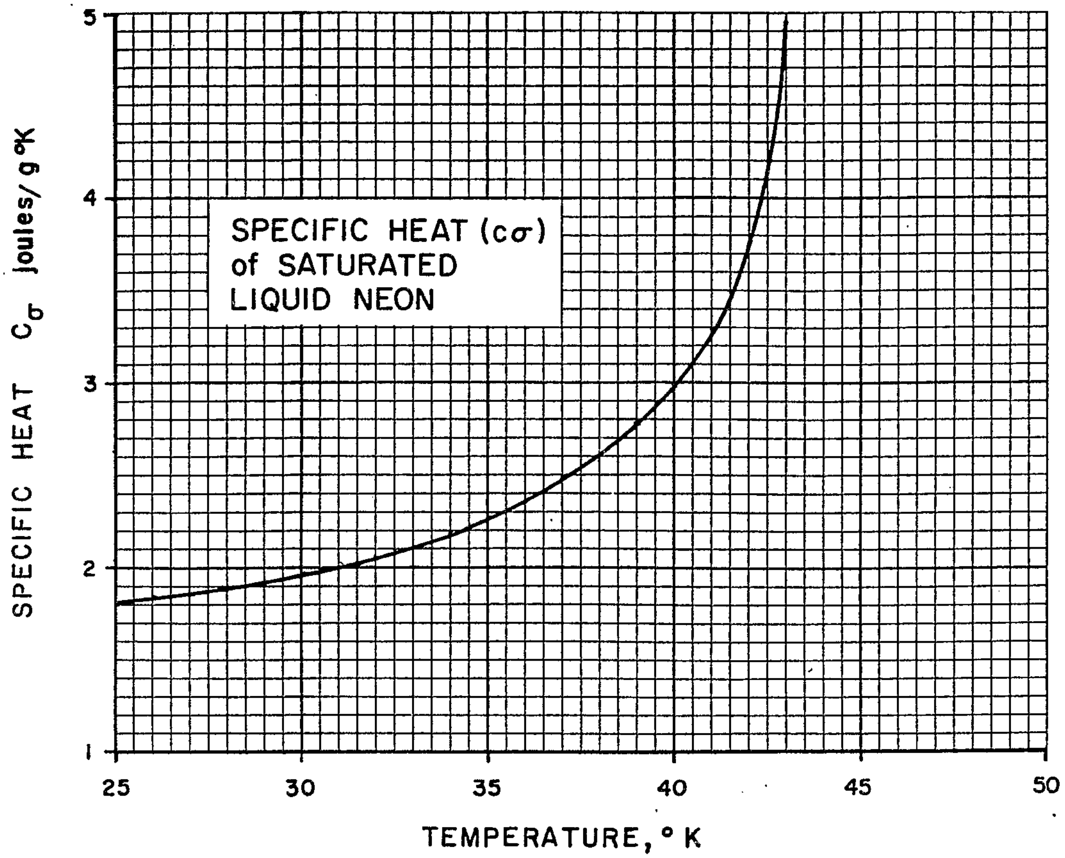

DENSITY of SATURATED LIQUID NEON
DENSITY, ρ (g/cm³)
TEMPERATURE, °K
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
20
25
30
35
40
45


COMPRESSIBILITY FACTOR FOR NEON
Z = PV / RT
National Bureau of Standards
Cryogenic Engineering Laboratory
Boulder, Colorado
COMPRESSIBILITY FACTOR, Z
PRESSURE, psia
PRESSURE, atmospheres
CRITICAL POINT
SATURATED VAPOR
SATURATED LIQUID
T = 300° K
ρ = 0.02 gm/cm³
ρ = 0.08 gm/cm³

SPECIFIC HEAT (C_σ) OF SATURATED LIQUID NEON

Source of Data: Gladun, C. "The Specific Heat at Constant Volume of Liquid Neon", Cryogenics, Vol. 6, 27-30 (1966)

Temperature °K	C_σ joules/g °K
25	1.80
26	1.82
27	1.85
28	1.88
29	1.92
30	1.96
31	2.01
32	2.06
33	2.12
34	2.19
35	2.27
36	2.36
37	2.47
38	2.58
39	2.77
40	2.97
41	3.27
42	3.77
43	4.96


SPECIFIC HEAT (cσ)
of SATURATED
LIQUID NEON
SPECIFIC HEAT Cσ joules/g °K
TEMPERATURE, ° K
1
2
3
4
5
25
30
35
40
45
50

SPECIFIC HEAT of GASEOUS NEON

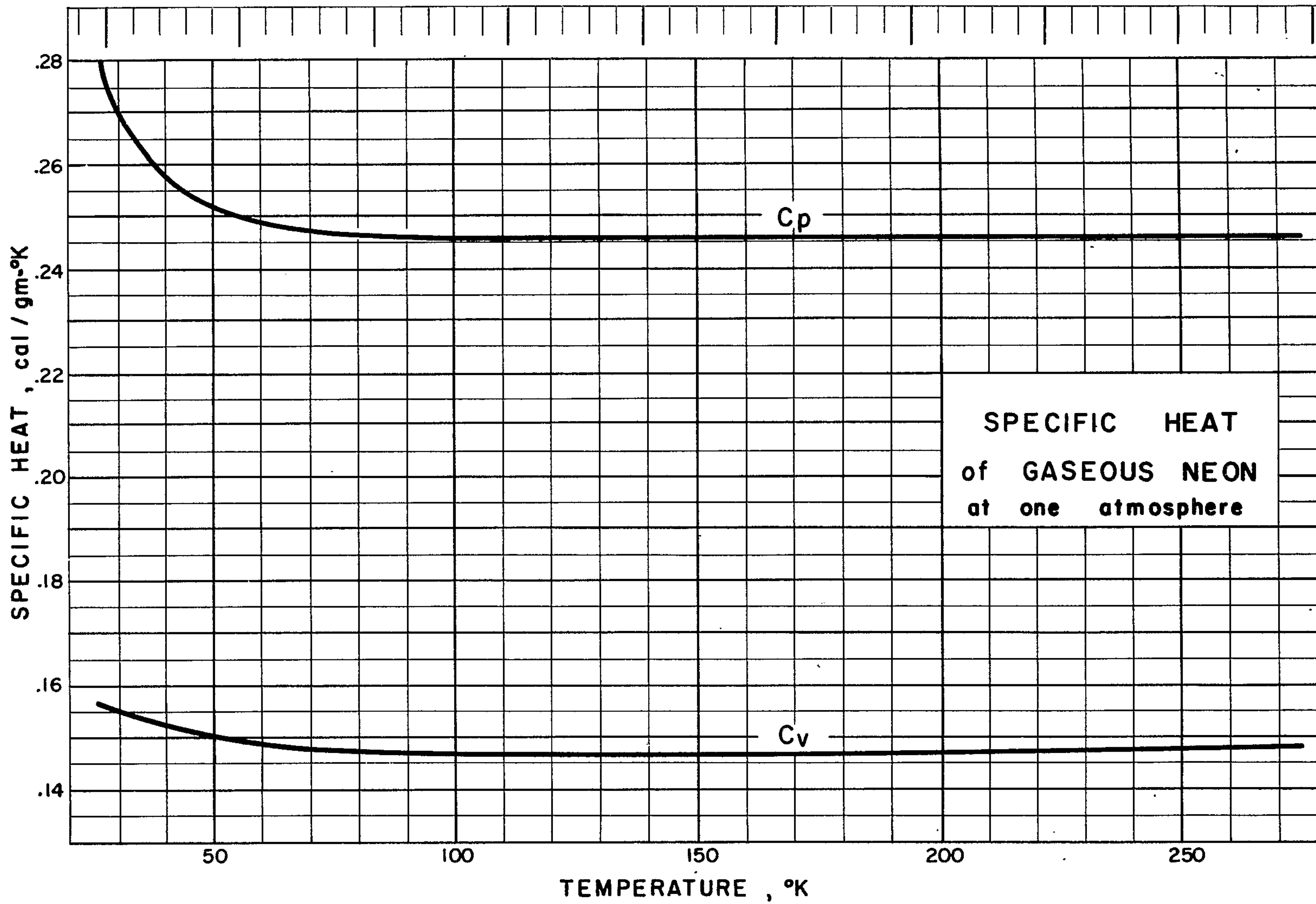
Source of Data: Keesom, W. H. and van Lammeren, J. A., Physica 1, 1161-70 (1934).

Comments: Holborn, L. and Otto, J., Z. Physik 33, 1-12 (1925) give a value of C_p/C_v at 0°C and 1 atm of 1.66. Michels, A. and Gibson, R. O., Ann. Physik (4), 87, 850-76 (1928) give a value of C_p/C_v at 0°C and 1 atm of 1.65. Ramsay, W., Proc. Roy. Soc. (London) 86, 100 (1912) gives a value of C_p/C_v at 19°C and 1 atm of 1.64.

Table of Selected Values

Temp. °K	Pressure Atm.	C_p		C_v		C_p/C_v
		cal/g-mole °K	cal/gm °K	cal/g-mole °K	cal/gm °K	
26.25	0.6	5.36	0.266	3.07	0.152	1.744
26.25	0.4	5.22	0.259	3.04	0.151	1.717
26.25	0.2	5.08	0.252	3.00	0.149	1.692
26.25	0.0	4.95	0.248	2.97	0.147	1.669
27.80	1.0	5.55	0.275	3.14	0.156	1.771
27.80	0.8	5.43	0.269	3.11	0.154	1.748
27.80	0.6	5.31	0.263	3.07	0.152	1.726
27.80	0.4	5.19	0.257	3.04	0.151	1.706
27.80	0.2	5.07	0.251	3.01	0.149	1.687
27.80	0.0	4.95	0.245	2.97	0.147	1.669
62.54	0.9784	5.01	0.248	2.99	0.148	1.677
74.11	0.8152	4.99	0.247	2.98	0.148	1.673
90.24	0.9581	4.97	0.246	2.97	0.147	1.674
170.0	0.9822	4.96	0.246	2.97	0.147	1.670
273.1	0.8797	4.96	0.246	2.98	0.148	1.668

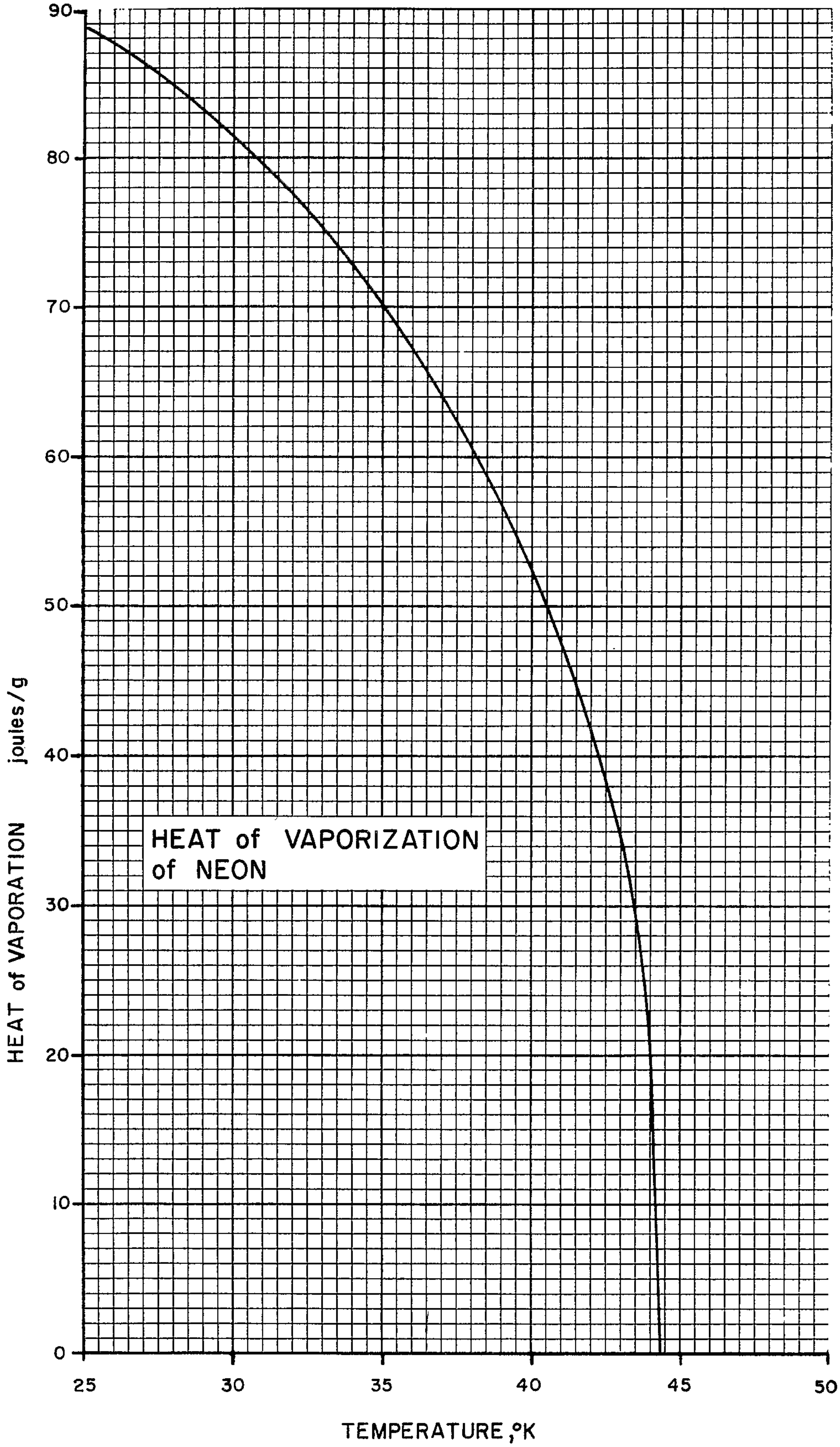
Taken from WADD TECH. REPORT 60-56


SPECIFIC HEAT
of GASEOUS NEON
at one atmosphere
Cp
Cv
SPECIFIC HEAT, cal / gm-°K
.14
.16
.18
.20
.22
.24
.26
.28
TEMPERATURE, °K
50
100
150
200
250

HEAT OF VAPORIZATION OF NEON

Source of Data: R.D. McCarty and R.B. Stewart, "Thermodynamic Properties of Neon from 25 to 300°K Between 0.1 and 200 Atmospheres", Cryogenics Division National Bureau of Standards

Temperature °K	joules/ g
25	88.67
26	87.52
27	86.23
28	84.80
29	83.23
30	81.51
31	79.62
32	77.55
33	75.31
34	72.86
35	70.20
36	67.31
37	64.15
38	60.69
39	56.90
40	52.69
41	47.91
42	42.23
43	34.81
44	22.12
44.4	0



HEAT of VAPORIZATION
of NEON
HEAT of VAPORATION joules/g
90
80
70
60
50
40
30
20
10
0
25
30
35
40
45
50
TEMPERATURE,°K

NEON

Properties of Saturated Liquid and Vapor*

Temp K	Pressure atm	Volume (cm³/g) Sat Liquid	Volume (cm³/g) Sat Vapor	Enthalpy (j/g) Sat Liquid	Enthalpy (j/g) Sat Vapor	Entropy (j/g °K) Sat Liquid	Entropy (j/g °K) Sat Vapor
24.544[a]	.4273	.8016	227.9	.03	89.20	0	3.633
25	.5037	.8063	196.0	.90	89.57	.035	3.582
26	.7090	.8172	143.5	2.83	90.35	.110	3.476
27	.9726	.8289	107.4	4.83	91.06	.184	3.378
27.092[b]	1.000	.8300	104.7	5.02	91.12	.191	3.369
28	1.304	.8414	82.00	6.89	91.69	.258	3.287
29	1.712	.8547	63.69	9.00	92.23	.331	3.201
30	2.209	.8690	50.19	11.16	92.67	.403	3.120
31	2.803	.8842	40.07	13.38	93.00	.474	3.042
32	3.506	.9007	32.34	15.65	93.20	.544	2.968
33	4.329	.9184	26.34	17.96	93.27	.613	2.895
34	5.282	.9377	21.62	20.33	93.19	.681	2.824
35	6.377	.9590	17.87	22.74	92.94	.748	2.754
36	7.627	.9823	14.84	25.19	92.50	.814	2.683
37	9.044	1.009	12.38	27.70	91.85	.878	2.612
38	10.64	1.038	10.36	30.28	90.97	.943	2.540
39	12.43	1.073	8.676	32.93	89.83	1.007	2.466
40	14.43	1.113	7.270	35.69	88.38	1.071	2.388
41	16.66	1.164	6.079	38.67	86.58	1.138	2.307
42	19.13	1.229	5.046	42.05	84.28	1.212	2.218
43	21.87	1.327	4.108	46.32	81.13	1.304	2.114
44	24.89	1.536	3.102	53.39	75.51	1.457	1.960
44.4[c]	26.19	2.070	2.070				

* From published data, Advances in Thermophysical Properties at Extreme Temperatures and Pressures, American Society of Mechanical Engineers, New York (1965) pp 84-97.
[a] Triple point.
[b] Normal boiling point.
[c] Critical point.

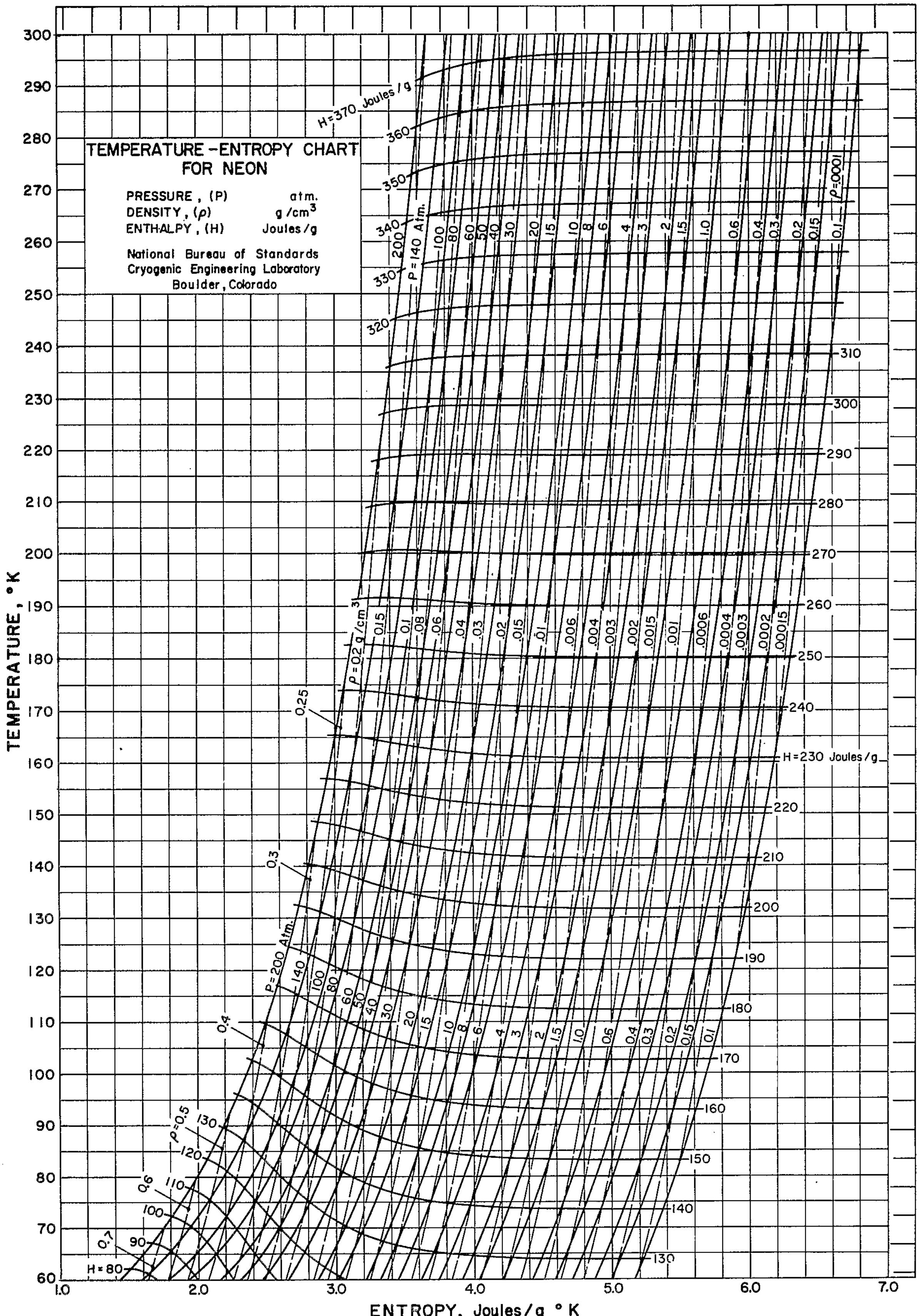
Properties of Liquid and Vapor*

Temp °K	P = 0.1 atm			P = 1 atm (Sat temp = 27.09°K)			P = 2 atm (Sat temp = 29.60°K)			P = 5 atm (Sat temp = 33.72°K)			P = 10 atm (Sat temp = 37.61°K)		
T	v cm³/g	h j/g	s j/g°K	v cm³/g	h j/g	s j/g°K	v cm³/g	h j/g	s j/g°K	v cm³/g	h j/g	s j/g°K	v cm³/g	h j/g	s j/g°K
(Sat Liq)				.8300	5.0	.191	.8632	10.3	.375	.9321	19.7	.662	1.026	29.3	.918
(Sat Vapor)				104.7	91.1	3.369	55.09	92.5	3.152	22.84	93.2	2.844	11 09	91.3	2.568
25	1011	90.1	4.259	.8061	.9	.034	.8056	1.0	.033	.8042	1.1	.030	.8019	1.4	.025
30	1216	95.2	4.447	117.3	94.2	3.479	56.02	93.0	3.167	.8669	11.3	.399	.8633	11.5	.391
40	1624	105.6	4.744	159.6	104.9	3.784	78.27	104.0	3.486	29.34	101.3	3.064	12.77	95.7	2.681
50	2031	115.9	4.974	201.3	115.4	4.019	99.61	114.8	3.725	38.61	112.9	3.324	18.26	109.7	2.994
60	2439	126.2	5.162	242.6	125.8	4.209	120.6	125.3	3.918	47.39	124.0	3.525	23.01	121.7	3.213
80	3253	146.8	5.459	324.7	146.6	4.508	162.0	146.3	4.219	64.39	145.4	3.834	31.88	144.0	3.535
90	3660	157.1	5.580	365.6	156.9	4.630	182.5	156.7	4.342	72.75	156.0	3.958	36.17	154.9	3.663
100	4067	167.4	5.689	406.4	167.3	4.739	203.1	167.1	4.451	81.06	166.5	4.069	40.41	165.6	3.776
110	4473	177.7	5.787	447.2	177.6	4.837	223.5	177.4	4.550	89.33	177.0	4.169	44.61	176.2	3.877
120	4880	188.0	5.876	488.0	187.9	4.927	244.0	187.8	4.640	97.58	187.4	4.260	48.79	186.8	3.969
140	5694	208.6	6.035	569.5	208.6	5.086	284.8	208.5	4.800	114.0	208.2	4.420	55.09	207.8	4.131
160	6507	229.2	6.173	651.0	229.2	5.224	325.6	229.1	4.938	130.4	229.0	4.558	65.35	228.7	4.270
180	7321	249.9	6.294	732.4	249.8	5.345	366.4	249.8	5.059	146.8	249.7	4.680	73.58	249.5	4.393
200	8134	270.5	6.402	813.8	270.4	5.454	407.1	270.4	5.168	163.1	270.3	4.789	81.79	270.2	4.502
220	8948	291.1	6.501	895.3	291.0	5.552	447.8	291.0	5.265	179.5	291.0	4.888	89.98	291.0	4.601
240	9761	311.7	6.590	976.7	311.7	5.642	488.6	311.7	5.356	195.8	311.7	4.978	98.15	311.7	4.691
260	10575	332.3	6.673	1058	332.3	5.724	529.3	332.3	5.438	212.1	332.3	5.060	106.3	332.4	4.774
280	11388	352.9	6.749	1139	352.9	5.800	570.0	352.9	5.515	228.4	353.0	5.137	114.5	353.0	4.850
300	12201	373.5	6.820	1221	373.5	5.871	610.7	373.5	5.586	244.7	373.6	5.208	122.7	373.7	4.922

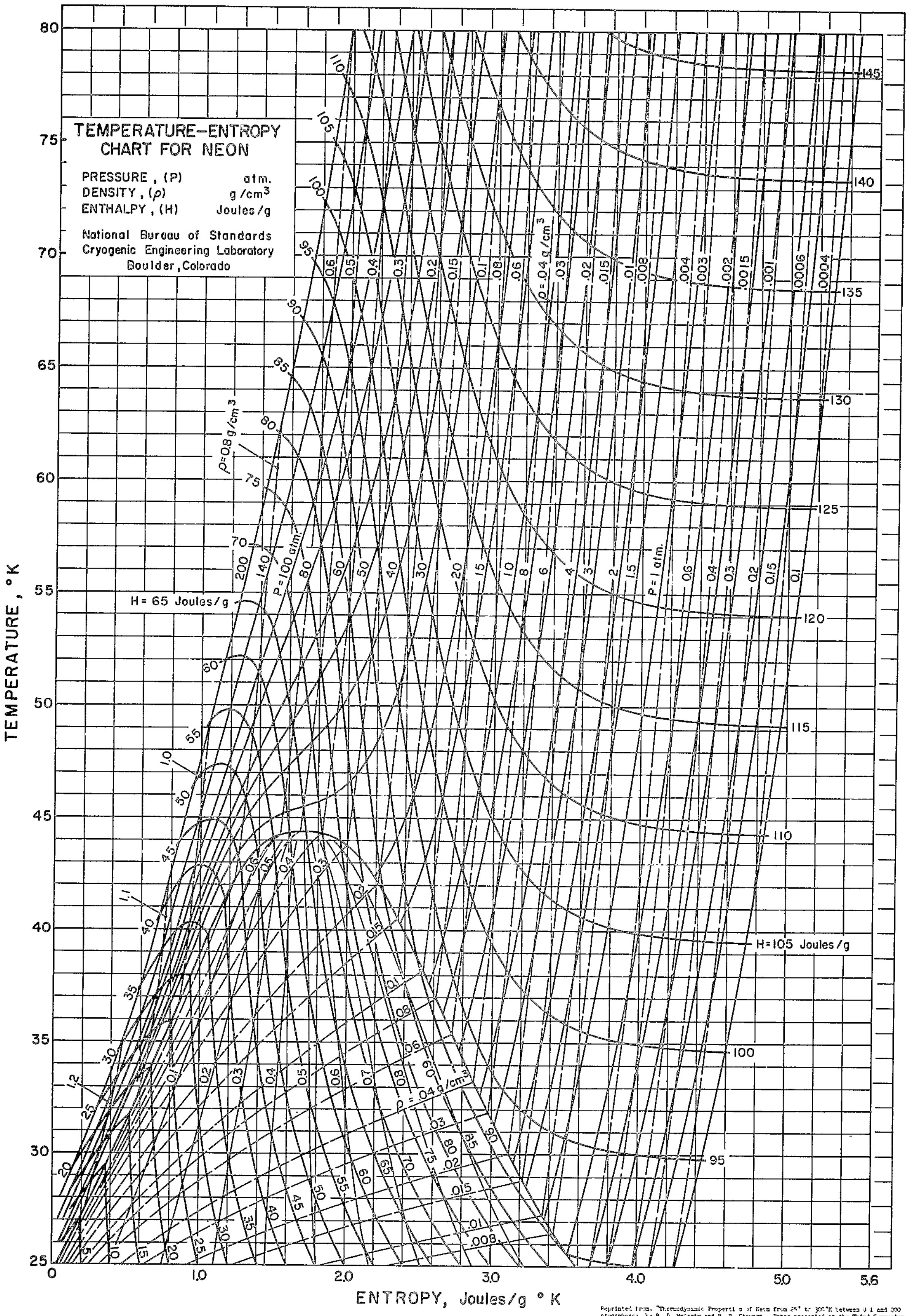
Temp °K	P = 20 atm (Sat temp = 42.33°K)			P = 40 atm			P = 60 atm			P = 80 atm			P = 100 atm		
(Sat Liq)	1.257	43.3	1.240												
(Sat Vapor)	4.732	83.4	2.186												
25	.7975	2.0	.014												
30	.8568	11.9	.377	.8450	12.9	.350	.8348	13.8	.325	.8258	14.8	.302	.8177	15.8	.280
40	1.089	35.2	1.043	1.032	34.4	.970	.9966	34.4	.918	.9705	34.7	.875	.9499	35.2	.839
50	8.060	102.5	2.607	2.602	79.8	1.959	1.501	63.0	1.548	1.238	58.3	1.396	1.194	56.5	1.311
60	10.87	117.0	2.873	4.856	107.4	2.470	2.872	96.6	2.165	2.057	88.0	1.940	1.697	82.8	1.791
80	15.66	141.4	3.224	7.623	136.4	2.891	4.987	131.9	2.679	3.693	127.6	2.518	2.945	123.7	2.386
90	17.91	152.7	3.358	8.833	148.8	3.037	5.847	145.3	2.837	4.375	142.1	2.639	3.509	139.2	2.568
100	20.11	163.8	3.475	9.997	160.7	3.162	6.660	157.9	2.970	5.010	155.3	2.828	4.033	153.1	2.715
110	22.27	174.8	3.579	11.13	172.2	3.271	7.444	169.9	3.084	5.616	167.8	2.947	4.530	166.1	2.838
120	24.41	185.6	3.673	12.24	183.4	3.369	8.208	181.5	3.186	6.204	179.9	3.052	5.010	178.4	2.946
140	28.64	206.9	3.838	14.42	205.5	3.539	9.696	204.2	3.360	7.342	203.1	3.231	5.936	202.1	3.129
160	32.82	228.1	3.979	16.56	227.1	3.684	11.15	226.3	3.508	8.450	225.6	3.381	6.832	225.0	3.281
180	36.98	249.1	4.103	18.68	248.5	3.800	12.58	248.0	3.636	9.537	247.6	3.511	7.711	247.3	3.413
200	41.12	270.0	4.213	20.78	269.7	3.922	14.00	269.5	3.749	10.61	269.3	3.625	8.577	269.2	3.528
220	45.24	290.9	4.313	22.86	290.8	4.022	15.40	290.8	3.850	11.6[illegible]	290.8	3.727	9.431	290.9	3.631
240	49.35	311.7	4.403	24.94	311.8	4.114	16.80	311.9	3.943	12.73	312.1	3.820	10.28	312.3	3.725
260	53.46	332.5	4.486	27.01	332.7	4.197	18.19	333.0	4.027	13.78	333.3	3.905	11.1[illegible]	333.7	3.810
280	57.56	353.2	4.563	29.08	353.6	4.275	19.58	354.0	4.105	14.82	354.5	3.983	11.97	354.9	3.889
300	61.65	374.0	4.635	31.14	374.5	4.347	20.96	375.0	4.177	15.87	375.5	4.056	12.81	376.1	3.962

* From published data, Advances in Thermophysical Properties at Extreme Temperatures and Pressures, American Society of Mechanical Engineers, New York (1965) pp 84-97.
Bold horizontal line indicates phase change (liquid above, vapor below the line).
Conversions for Units, to Equivalent in British System of Units:
- To convert temperature in degrees Kelvin (°K) to degress Rankine (°R), multiply (°K) by 1.8
- To convert pressure in atmospheres (atm) to (psia), multiply (atm) by 14.696
- To convert volume (v) in cubic centimeters per gram (cm³/g) to (cu ft/lb), multiply (cm³/g) by .016018
- To convert enthalpy (h) in joules per gram (j/g) to (Btu/lb), multiply (j/g) by .42993
- To convert entropy (s) in joules per gram °K (j/g°K) to (Btu/lb°R), multiply (j/g°K) by .23885

B- 62362



Reprinted from, "Thermodynamic Properties of Neon from 25° to 300°K between 0.1 and 200 atmospheres, by R. D. McCarty and R. B. Stewart. Paper presented at the Third Symposium on Thermophysical Properties, Purdue University, March 22-26, 1965, Lafayette, Indiana. Published in <u>Advances in Thermophysical Properties at Extreme Temperatures</u>, Serge Gratch, editor; published by American Society of Mechanical Engineers, New York, N. Y. (1965).



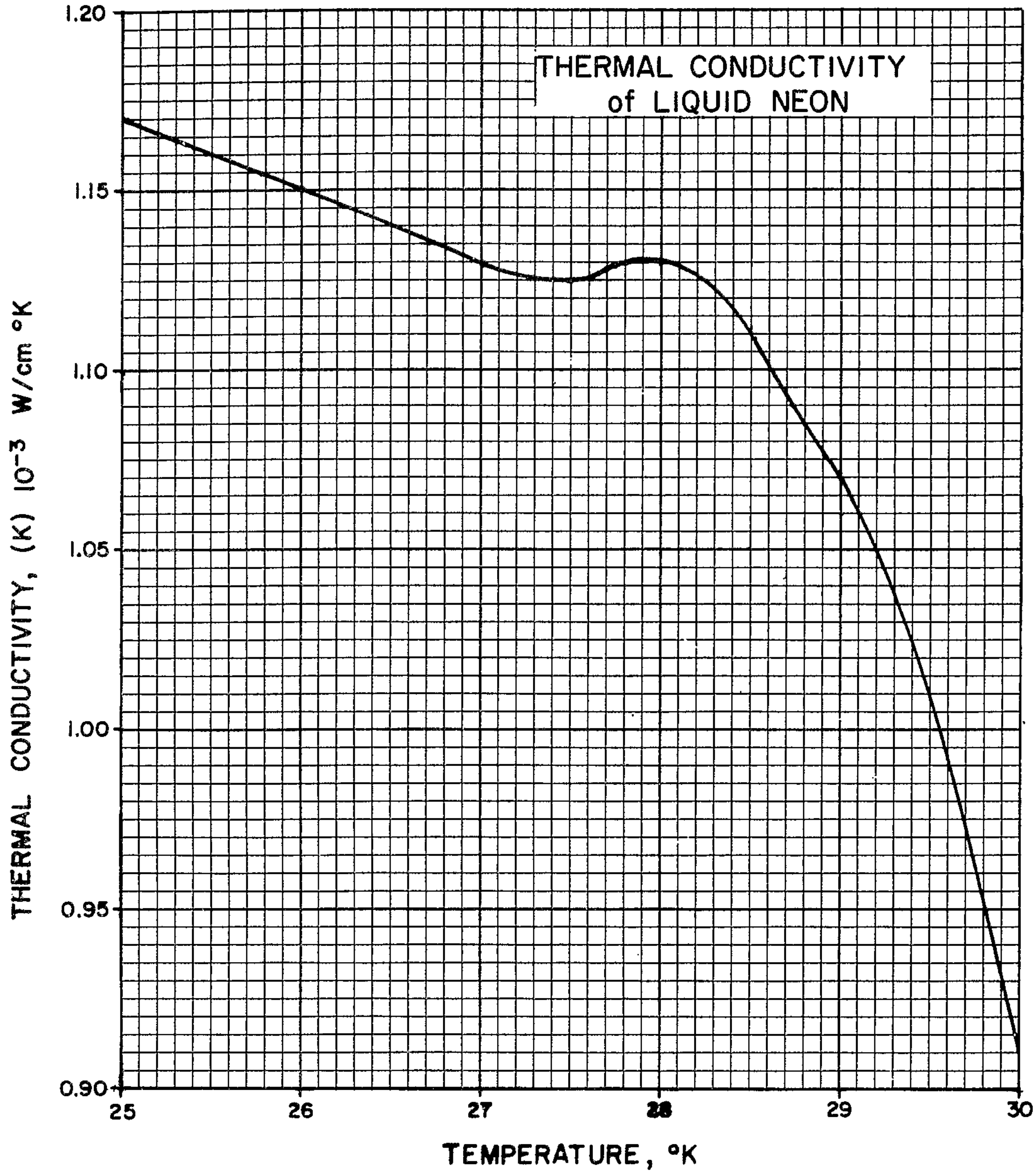
Reprinted from, "Thermodynamic Properties of Neon from 25° to 300°K between 0.1 and 200 atmospheres," by R. D. McCarty and R. B. Stewart. Paper presented at the Third Symposium on Thermophysical Properties, Purdue University, March 22-26, 1965, Lafayette, Indiana. Published in *Advances in Thermophysical Properties at Extreme Temperatures*, Serge Gratch, editor, published by American Society of Mechanical Engineers, New York, N. Y. (1965).

THERMAL CONDUCTIVITY OF LIQUID NEON

Source of Data: Lochtermann, E., "Thermal Conductivity of Liquid Neon", Cryogenics 3, 44-45 (1963)

Temperature ^{o}K	K 10^{-3} W/cm ^{o}K
25	1.17
26	1.15
27	1.13
27.5	1.125
28	1.13
28.5	1.11
29	1.07
30	0.91

Table constructed from data taken from smoothed curve in source.


THERMAL CONDUCTIVITY
of LIQUID NEON
THERMAL CONDUCTIVITY, (K) 10^{-3} W/cm °K
1.20
1.15
1.10
1.05
1.00
0.95
0.90
25
26
27
28
29
30
TEMPERATURE, °K

THERMAL CONDUCTIVITY of GASEOUS NEON
(at One Atmosphere)

Sources of Data:

Amdur, I., J. Chem. Phys. 16, 190-4 (1948)

Kannuluik, W. G. and Carman, E. H., Proc. Phys. Soc. (London) 65B, 701-9 (1952)

Srivastava, B. N. and Saxena, S. C., Proc. Phys. Soc. (London) 70B 369-78 (1957)

Thomas, L. B. and Golike, R. C., J. Chem. Phys. 22, 300-5 (1954)

Weber, S., Ann. Physik. 54, 325, 437, 481 (1917)

Weber, S., Proc. Roy. Acad. Sci. Amsterdam 21, 342 (1919(

Weber, S., Verslag Akad. Wetenschappen Amsterdam 26, 1338-53 (1918)

Comments:

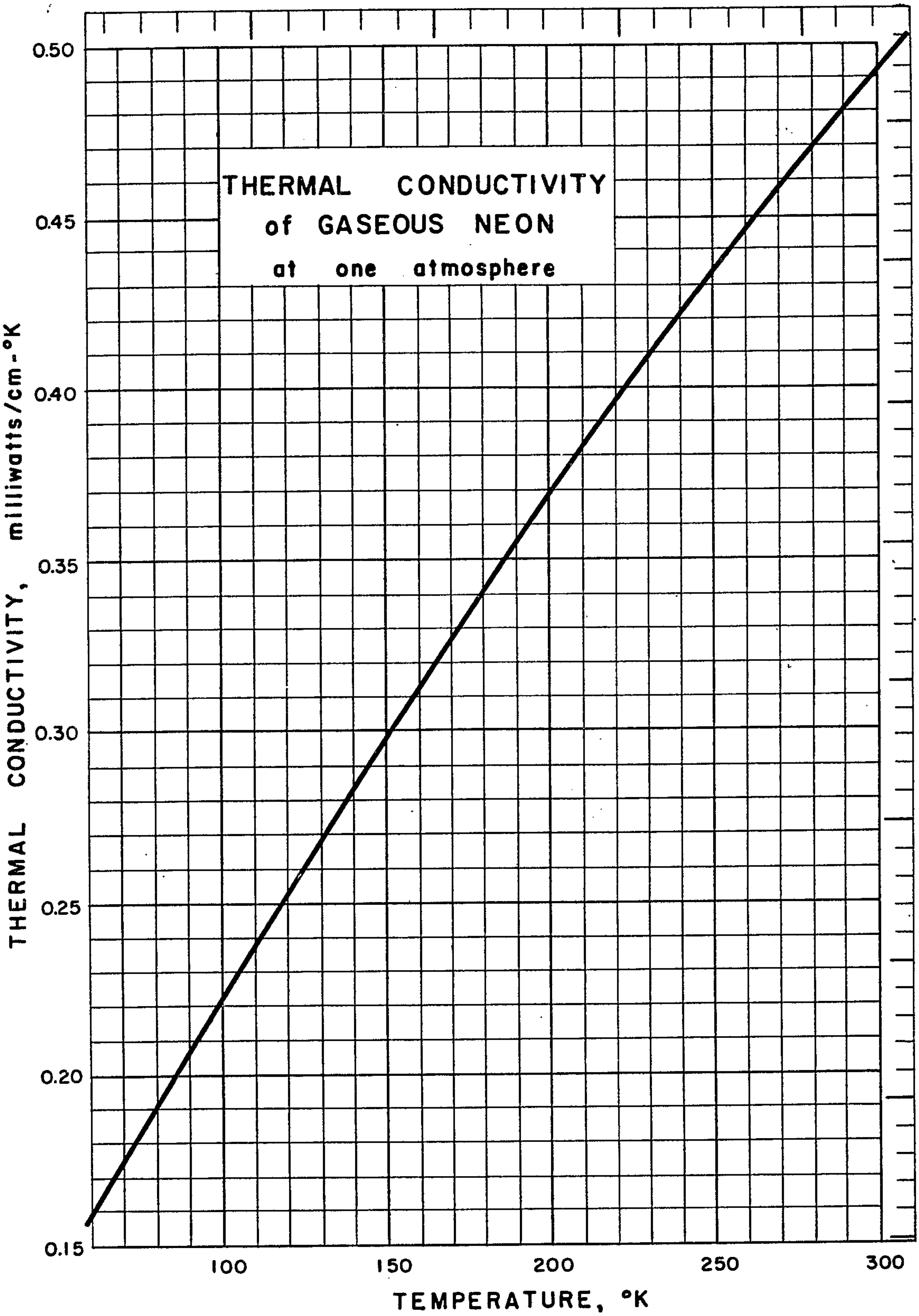
Conversions from 0°C to °K in the table below are based on a value of the ice point of 273.09°K used by the Leiden Laboratory in 1917 and 1918. The disagreement with the currently accepted value, 273.15°K is of no consequence because of the small temperature dependence of thermal conductivity and the relative uncertainty of the conductivity measurements.

Temperature		Thermal Cond.	Temperature		Thermal Cond.
°C	°K	cal/cm-sec-°K	°C	°K	cal/cm-sec-°K
-213.09	60	*3.79 x 10^{-5}	-100	173.09	+ 8.13 x 10^{-5}
-203.09	70	*4.17 "	- 93.09	180	* 7.32 "
-193.09	80	*4.53 "	- 78.5	194.59	8.76 "
-183.09	90	*4.86 "	- 78.5	194.59	* 8.85 "
-183.09	90	4.93 "	- 74.37	198.72	8.79 "
-182.97	90.12	4.89 "	- 73.09	200	8.82 "
-182.97	90.12	*5.00 "	- 73.09	200	7.78 "
-281.43	91.66	4.99 "	- 50	223.09	+ 9.67 "
-181.4	91.69	+4.99 "	0	273.09	+11.04 "
-173.09	100	*5.19 "	0	273.09	10.87 "
-153.09	120	*5.78 "	0	273.09	11.10 "
-150	123.09	6.31 "	0	273.09	*11.13 "
-133.09	140	*6.33 "	35.61	308.7	**11.99 "
-113.09	160	*6.84 "	36.91	310	‡12.016 "

* Calculated Values ‡ Interpolated Values ** ± .20%

+ Presented as K_T/K_0 where K_0 = 11.04 cal/cm-sec-°K at 0°C

Taken from WADD TECH. REPORT 60-56



THERMAL CONDUCTIVITY
of GASEOUS NEON
at one atmosphere
THERMAL CONDUCTIVITY, milliwatts/cm-°K
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
100
150
200
250
300
TEMPERATURE, °K

THERMAL CONDUCTIVITY of GASEOUS NEON

(at 274.79°K and 373.09°K)

Sources of Data:

Kannuluik, W. G. and Carman, E. H., Proc. Phys. Soc. (London) 65B, 701-9 (1952)

Kannuluik, W. G. and Martin, L. H., Proc. Roy. Soc. (London) A144, 496-513 (1934)

Weber, S., Ann. Physik. 82, 479-503 (1927)

Comments:

Values of the thermal conductivity at 273.09°K and 1 atmosphere are 10.91 x 10^{-5} g-cal/cm sec °K [Bannawitz, E., Ann. Physik. 48, 577-92 (1915)], 10.92 x 10^{-5} g-cal/cm sec °K [Curie, M. and Lepape, M., Compt. rend. 193, 842-3 (1931)], 11.10 x 10^{-5} g-cal/cm sec °K [Kannuluik, W. G. and Carman, E. G., Proc. Phys. Soc. (London) 65B, 701-9 (1952)], 11.12 x 10^{-5} g-cal/cm sec °K [Kannuluik, W. G. and Martin, L. H., Proc. Roy. Soc. (London) A144, 496-513 (1934)], and 10.87 x 10^{-5} g-cal/cm sec °K [Weber, S., Verslag Akad. Wetenschappen Amsterdam 26, 1338-53 (1918)].

A value of 11.04 x 10^{-5} g-cal/cm sec °K given by Weber is considered to be the best value at 273.09°K and 1 atmosphere.

Table of Selected Values

T = 274.79°K		T = 373.09°K*	
Press. cm/Hg	Thermal Cond. cal/cm-sec-°K	Press. cm/Hg	Thermal Cond. cal/cm-sec-°K
67.0	11.28 x 10^{-5}	75.07	13.58 x 10^{-5}
67.0	11.28 "	66.43	13.59 "
55.6	11.29 "	57.42	13.59 "
42.4	11.29 "	50.15	13.57 "
30.6	11.30 "	41.89	13.47 "
19.4	11.30 "	33.82	13.56 "
19.4	**11.31 "	25.56	13.58 "
		17.40	13.60 "

* mean gas temperature = 374.49°K
** mean gas temperature = 274.19°K

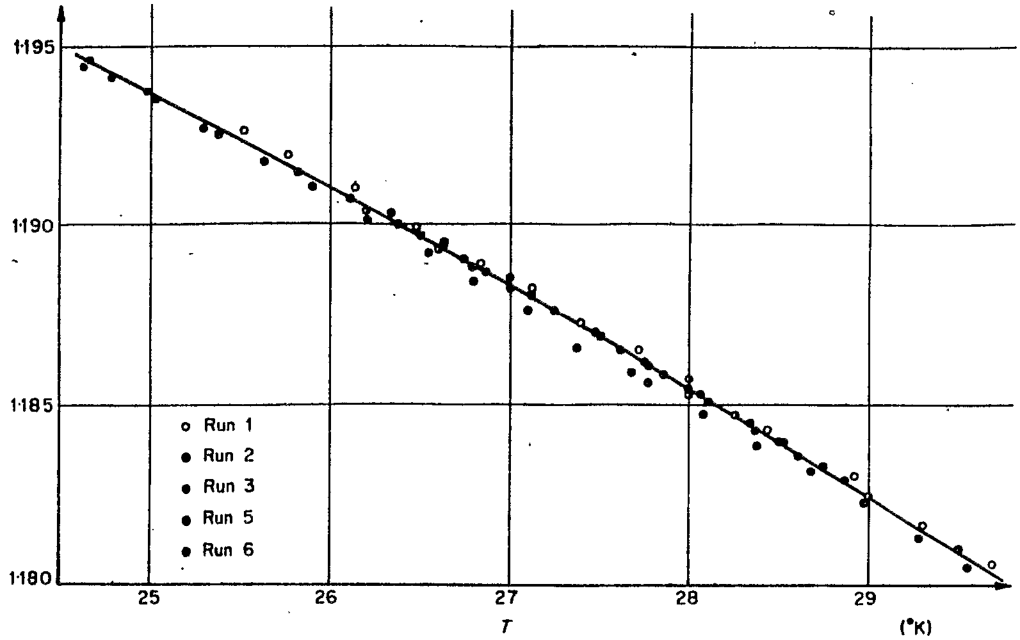
Taken from WADD TECH. REPORT 60-56

DIELECTRIC CONSTANT LIQUID NEON

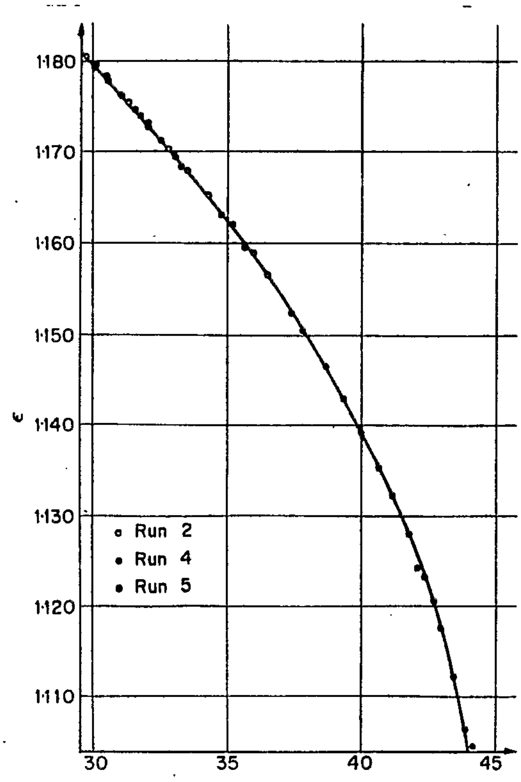
Source of Data: Bewilogua, I., et al., "Measurements on Liquid Neon", Cryogenics, Vol. 6, 21-24 (1966)

T rising		T falling	
T(°K)	ε	T(°K)	ε
26.50	1.1897	28.87	1.1828
26.75	1.1889	28.61	1.1836
27.00	1.1883	28.37	1.1843
27.25	1.1876	28.10	1.1850
27.50	1.1868	27.86	1.1858
27.75	1.1861	27.62	1.1865
28.00	1.1854	27.38	1.1872
28.25	1.1846	27.11	1.1880
28.50	1.1839	26.86	1.1887
28.75	1.1831	26.62	1.1893
29.00	1.1824	26.38	1.1900
		26.11	1.1907

DIELECTRIC CONSTANT OF LIQUID NEON



Dielectric constant of liquid neon (24·5—29·8° K)



Dielectric constant of liquid neon (29·8—44·2° K)

DIELECTRIC CONSTANT OF GASEOUS NEON

Sources of Data:

Bryan, A. B. (1929), The Dielectric Constants of Argon and Neon., Phys. Rev. 34, 615-17; C.A. 24, 1259 (1930).

Watson, H. E., Rao, G. G., and Ramaswamy, K. L. (1931), The Dielectric Coefficients of Gases. Part I. The Rare Gases and Hydrogen., Proc. Roy. Soc. (London) 132A, 569-85; C.A. 25, 5320 (1931).

Cuthbertson, C., and Cuthbertson, M. (1932), The Refraction and Dispersion of Neon and Helium., Proc. Roy. Soc. (London) 135A, 40; C.A. 26, 2093 (1932).

Hector, L. G., and Woernley, D. L. (1946), The Dielectric Constants of Eight Gases., Phys. Rev. 69, 101-5; C.A. 40, 2366 (1946).

Jelatis, J. G. (1948), Measurements of Dielectric Constant and Dipole Moment of Gases by the Beat-Frequency Method., J. Appl. Phys. 19, 419-25; C.A. 42, 6593 (1948).

Comments:

Using the heterodyne-beat method, Bryan found the value of the dielectric constant for neon at one atmosphere and 0°C to be 1.000148 after calibrating his instrument with air assuming its dielectric constant to be 1.000589. Using the same general method, Watson et al. reported values of 1.000134 and 1.0001346 for 0°C and 1 atmosphere, determined from measurements at 25 and -191°C respectively. They also report values for 25°C of 1.0001229 determined from measurements at 25°C and 1.0001233 determined from measurements at -191°C.

Cuthbertson and Cuthbertson report an index of refraction which through the Cauchy relation is equivalent to a dielectric constant of 1.000133 at 0°C and 1 atmosphere.

Hector and Woernley made a study of dielectric constants primarily to determine whether there was a marked difference between values obtained by static techniques and by high frequency techniques. They observed no such difference. Measurements of the dielectric constant of neon yielded the value of 1.0001274 ± 0.000005 at 0°C and 1 atmosphere.

Jelatis concluded that the wide discrepancies in the data of previous observers are due in part, at least, to the neglect of certain stray components in the circuits involved. He gives values of 1.0001337 and 1.0001341 resulting from six and five determinations respectively at STP (Probably 0°C and 1 atmosphere).

Reprinted from NBS Report 8252

SURFACE TENSION of SATURATED LIQUID NEON

Sources of Data:

Guggenheim, E. A., J. Chem. Phys. 13, 253-61 (1945)

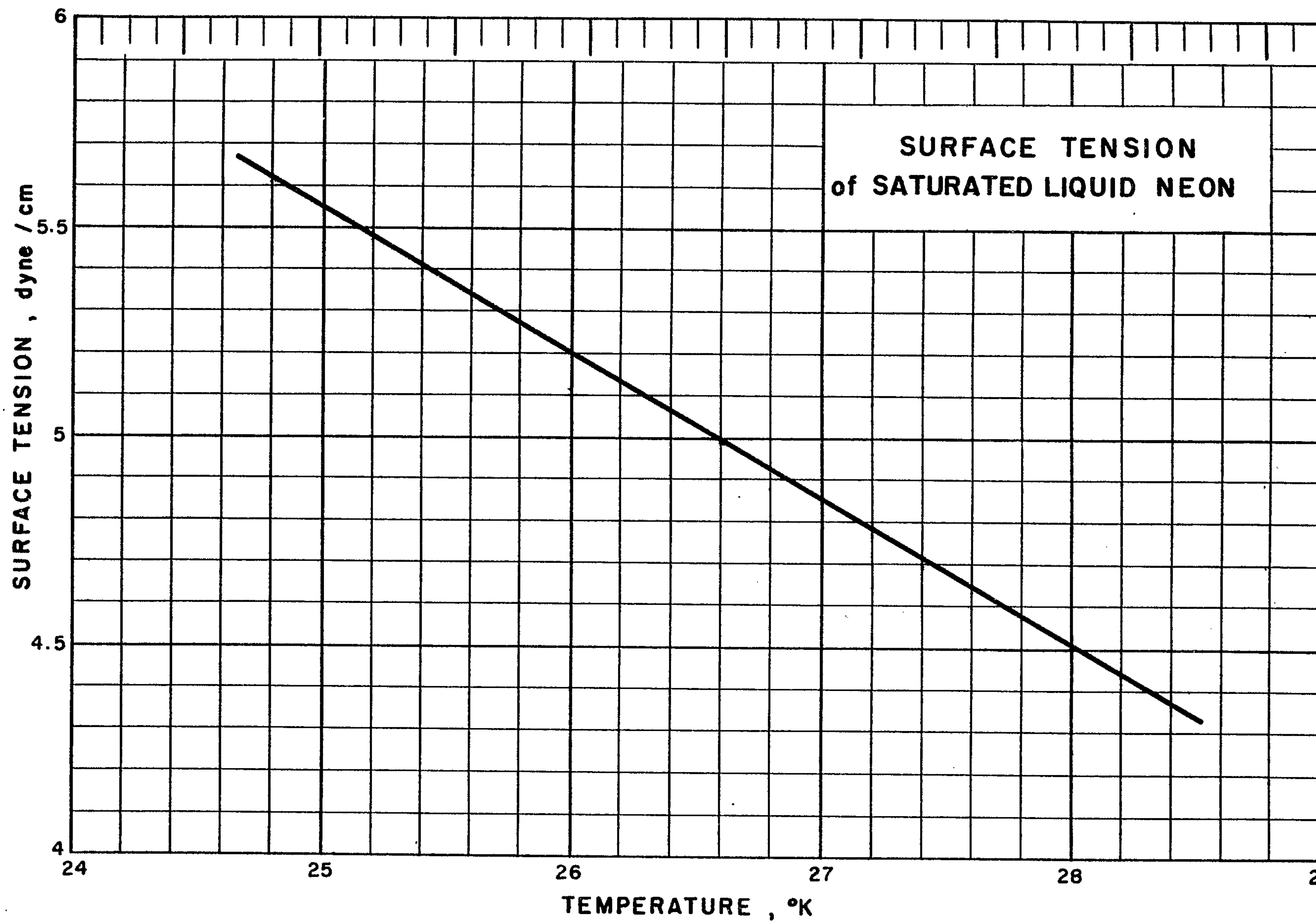
Van Urk, A. T., Keesom, W. H. and Nijhoff, G. P., Proc. Acad. Sci. Amsterdam 35, 482-4 (1926)

Table of Selected Values

Temperature °K	Surface Tension (γ), dyne/cm
24	5.90**
24.8	5.61*
25	5.50**
25.7	5.33*
26	5.15**
26.6	4.99*
27	4.80**
27.4	4.69*
28	4.45**
28.3	4.44*

* Experimental values
** Smoothed values

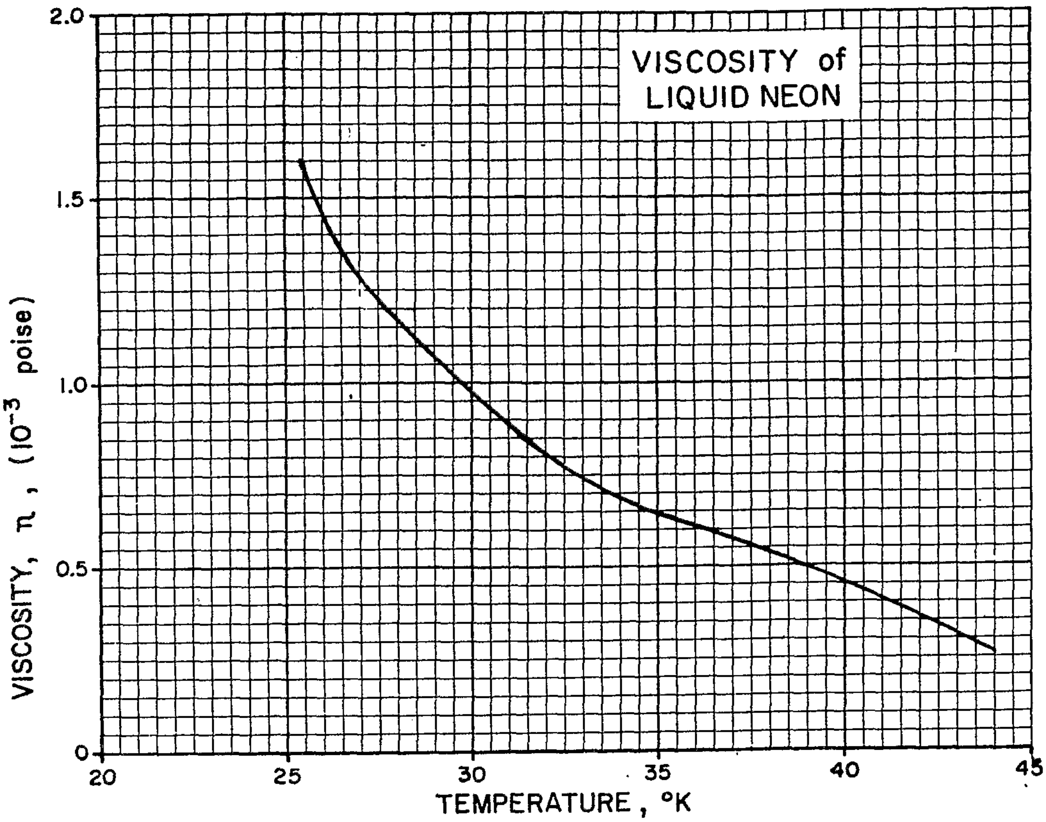
Taken from WADD TECH.REPORT 60-56


SURFACE TENSION
of SATURATED LIQUID NEON
SURFACE TENSION , dyne / cm
6
5.5
5
4.5
4
24
25
26
27
28
29
TEMPERATURE , °K

VISCOSITY OF LIQUID NEON

Source of Data: Forster, S., "Viscosity Measurements in Liquid Neon, Argon, and Nitrogen", Cryogenics, 3, 176-177, (1963)

Temperature °K	Viscosity η (10^{-3} poise)
25.09	1.60
27.10	1.24
27.70	1.21
28.10	1.15
28.83	1.08
31.40	0.86
34.50	0.67
38.90	0.50
44.13	0.27



VISCOSITY of LIQUID NEON
VISCOSITY, η, (10^{-3} poise)
2.0
1.5
1.0
0.5
0
20
25
30
35
40
45
TEMPERATURE, °K

VISCOSITY of GASEOUS NEON
(At one atmosphere pressure)

Source of Data: Edwards, R. S., Proc. Roy. Soc. (London), A119, 578-90 (1928); van Itterbeek, A. and van Paemel, O., Physica, 7, 265-72 (1940); Johnston, H. L. and Grilly, E. R., J. Phys. Chem., 46, 948-63 (1942); Rankine, A. O., Physik. Z., 11, 497-502 (1910); Rietveld, A. O., and van Itterbeek, A., Physica, 22, 785-90 (1956); Saulgeot, A. M., Compt. rend., 230, 922-3 (1950); Trautz, M. and Zink, R., Ann. Physik, 7, 427-52 (1930).

Comments: Two equations which may be used to calculate the viscosity of neon gas at one atmosphere are:

$$(1) \quad \frac{\mu}{\mu_o} = \left[\frac{T}{T_o}\right]^{0.77}$$

where μ_o is measured at T_o and the temperature is between -180 and 20 °C; and

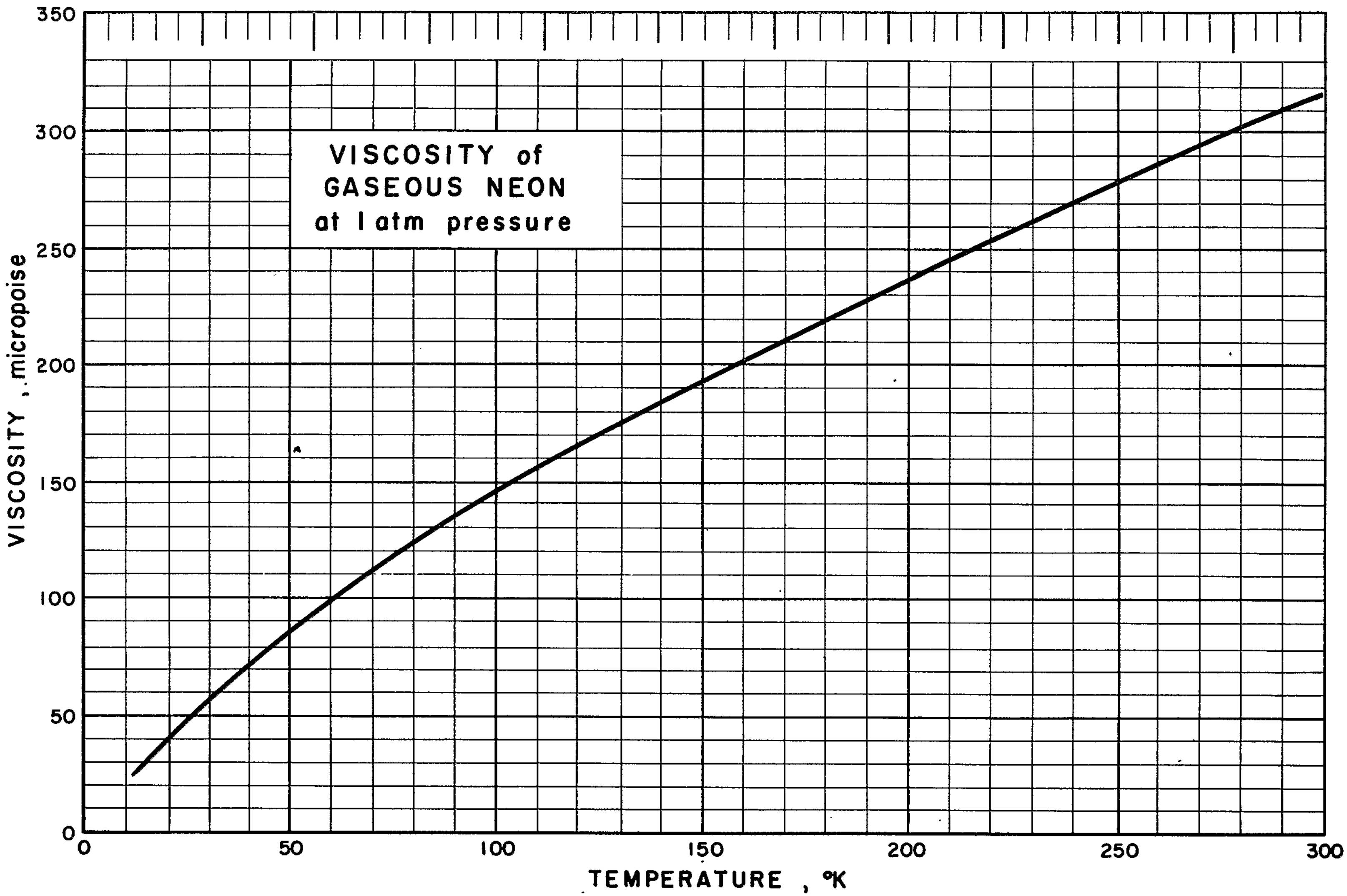
$$(2) \quad \mu \cong \frac{T^{0.6}}{1 + \frac{2.0}{T}}$$

where the temperature is between 20° and 800 °C.

Table of Values

Temp. °K	Viscosity Centipoises	Temp. °K	Viscosity Centipoises	Temp. °K	Viscosity Centipoises
16.49	3.059 x 10^{-3}	100.0	14.345 x 10^{-3}	230.0	26.265 x 10^{-3}
17.76	3.218 "	110.0	15.425 "	240.0	27.080 "
19.04	3.396 "	120.0	16.460 "	250.0	27.880 "
20.42	3.593 "	130.0	17.450 "	260.0	28.665 "
58.60	9.48 x 10^{-3}	140.0	18.405 x 10^{-3}	270.0	29.435 x 10^{-3}
64.25	10.43 "	150.0	19.340 "	273.1	29.675 "
68.52	10.90 "	160.0	20.255 "	280.0	30.205 "
72.11	11.40 "	170.0	21.155 "	283.2	31.5 "
72.3	11.72 x 10^{-3}	180.0	22.040 x 10^{-3}	288.1	30.76 x 10^{-3}
77.37	12.08 "	190.0	22.910 "	290.0	30.965 "
80.0	11.980 "	193.4	23.52 "	291.1	31.29 "
83.45	12.89 "	194.7	23.67 "	291.1	31.40 "
90.0	13.200 x 10^{-3}	200.0	23.755 x 10^{-3}	292.6	31.32 x 10^{-3}
90.08	13.44 "	210.0	24.600 "	293.1	31.210 "
90.20	13.47 "	220.0	25.435 "	296.1	31.435 "
90.3	13.52 "	229.0	26.7 "	298.1	31.580 "
				300.0	31.725 "

Taken from WADD TECH.REPORT 60-56


VISCOSITY of
GASEOUS NEON
at 1 atm pressure
VISCOSITY , micropoise
TEMPERATURE , °K
0
50
100
150
200
250
300
350

VISCOSITY of GASEOUS NEON at LOW PRESSURES

(From 20° to 80°K)

Source of Data: Coremans, J. M. J., Van Itterbeek, A., Beenakker, J. J. M., Knapp, H. F. P. and Zandbergen, P., Physica 24, 557 (1958).

Other References: Van Itterbeek, A. and Van Paemel, O., Physica 7, 265 (1940). (See data sheet 10.003, Viscosity of Gaseous Neon at One Atmosphere Pressure, 20° to 300°K.)

Comments: The viscosity of gaseous Neon measured at a constant pressure, 3 cm of Hg, varies in a nearly linear manner between 20° and 80°K according to the equation

$$\eta = 1.55\ T + 2.4$$

Below 20°K the above equation is no longer valid. The reduced viscosity of gaseous Neon derived from quantum mechanical consideration is valid to a first approximation over a narrow temperature range and is represented by plotting

$$\frac{\eta^*}{\sqrt{T^*}} \text{ vs } T^* \qquad \eta^* = \text{reduced viscosity},\quad T^* = \text{reduced temperature}$$

At the pressure used, 3 cm Hg, the viscosity of gaseous Neon is essentially constant for a given temperature. However, below a pressure of 1.0 cm Hg, the viscosity of gaseous Neon varies markedly at a given temperature.

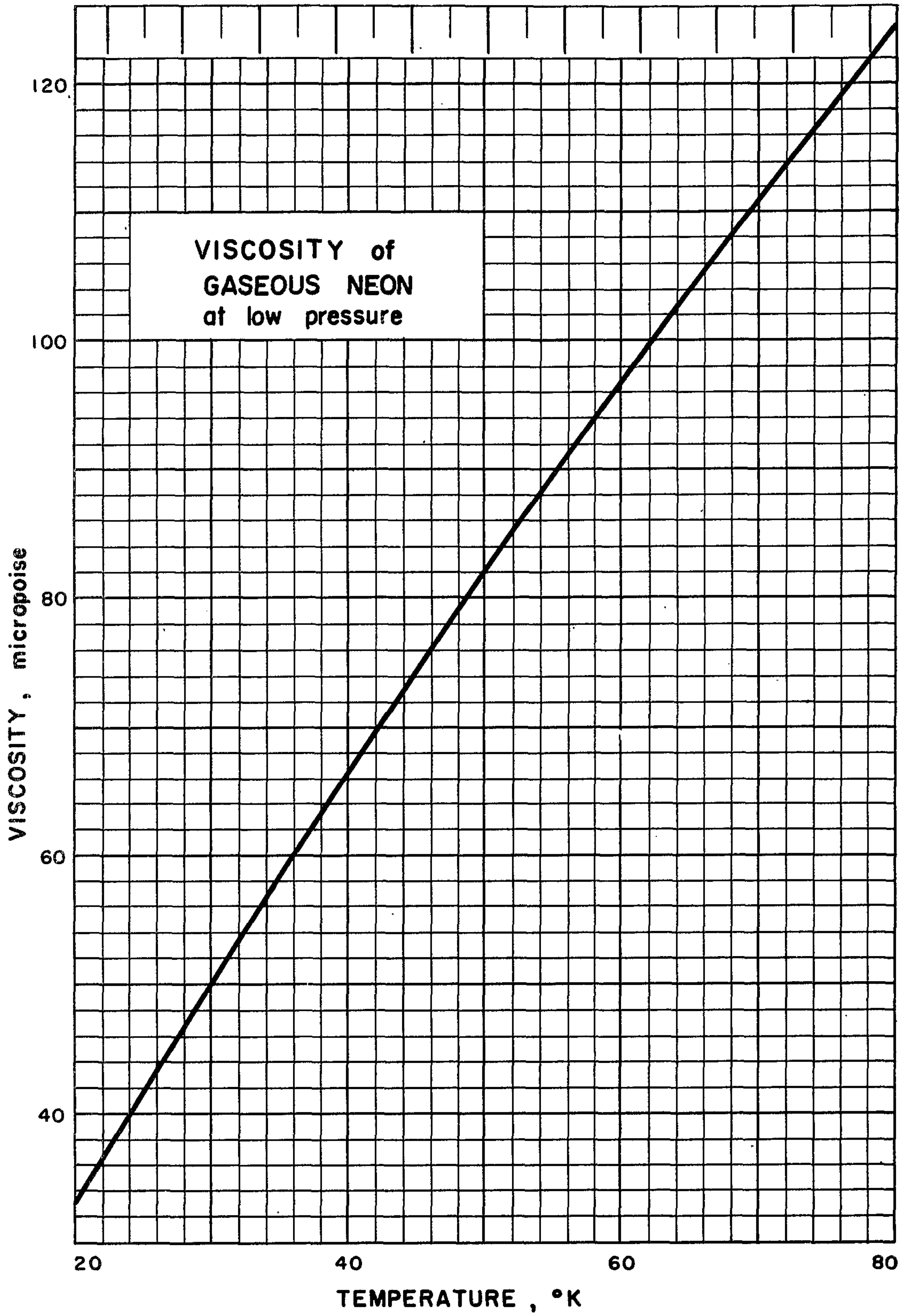
The data plotted are the smoothed values from the table of selected data and identified by an asterisk.

Table of Selected Values

Temp. °K	Viscosity micropoise	Temp. °K	Viscosity micropoise
20.00	33.0*	50.00	81.8*
20.43	33.6	52.11	85.4
20.47	33.9	59.98	96.4
25.19	42.1	60.00	96.6*
26.31	43.0	60.71	97.4
29.84	50.3	61.64	98.9
30.00	50.0*	68.15	108.0
31.80	52.5	70.00	110.8*
39.52	64.9	70.18	111.2
40.00	66.3*	71.20	112.4
40.28	67.0	73.28	115.1
46.50	76.6	77.77	121.1
49.97	80.4	80.00	124.5*

* Smoothed Values

Taken from WADD TECH.REPORT 60-56



VISCOSITY of GASEOUS NEON at low pressure
120
100
80
60
40
VISCOSITY, micropoise
20
40
60
80
TEMPERATURE, °K

VISCOSITY of GASEOUS NEON

(Below 1 atmosphere at 20.42°K and 90.08°K)

Source of Data:

Van Itterbeek, A. and Van Paemel, C., Physica, 7, 273-83 (1940).

Table of Selected Values

T = 20.42°K			T = 90.08°K		
Observed Pressure mm Hg	Corrected Pressure mm Hg	Viscosity Centipoise	Observed Pressure mm Hg	Corrected Pressure mm Hg	Viscosity Centipoise
300.0		3.593×10^{-3}	300.0		13.44×10^{-3}
3.71		3.593 "	37.8		13.429 "
0.696		3.441 "	9.51		13.406 "
0.217	0.216	3.339 "	2.186		13.034 "
0.0970	0.0944	3.165 "	1.149		12.677 "
0.0465	0.0442	2.846 "	0.600		12.095 "
0.0246	0.0220	2.441 "	0.312		11.054 "
0.01107	0.00887	1.656 "	0.1528	0.1513	9.389 "
0.00498	0.00339	0.925 "	0.0772	0.0754	6.965 "
0.00218	0.00120	0.398 "	0.0352	0.0329	4.419 "
			0.0222	0.0200	3.139 "
			0.01083	0.00903	1.588 "
			0.00521	0.00395	0.775 "

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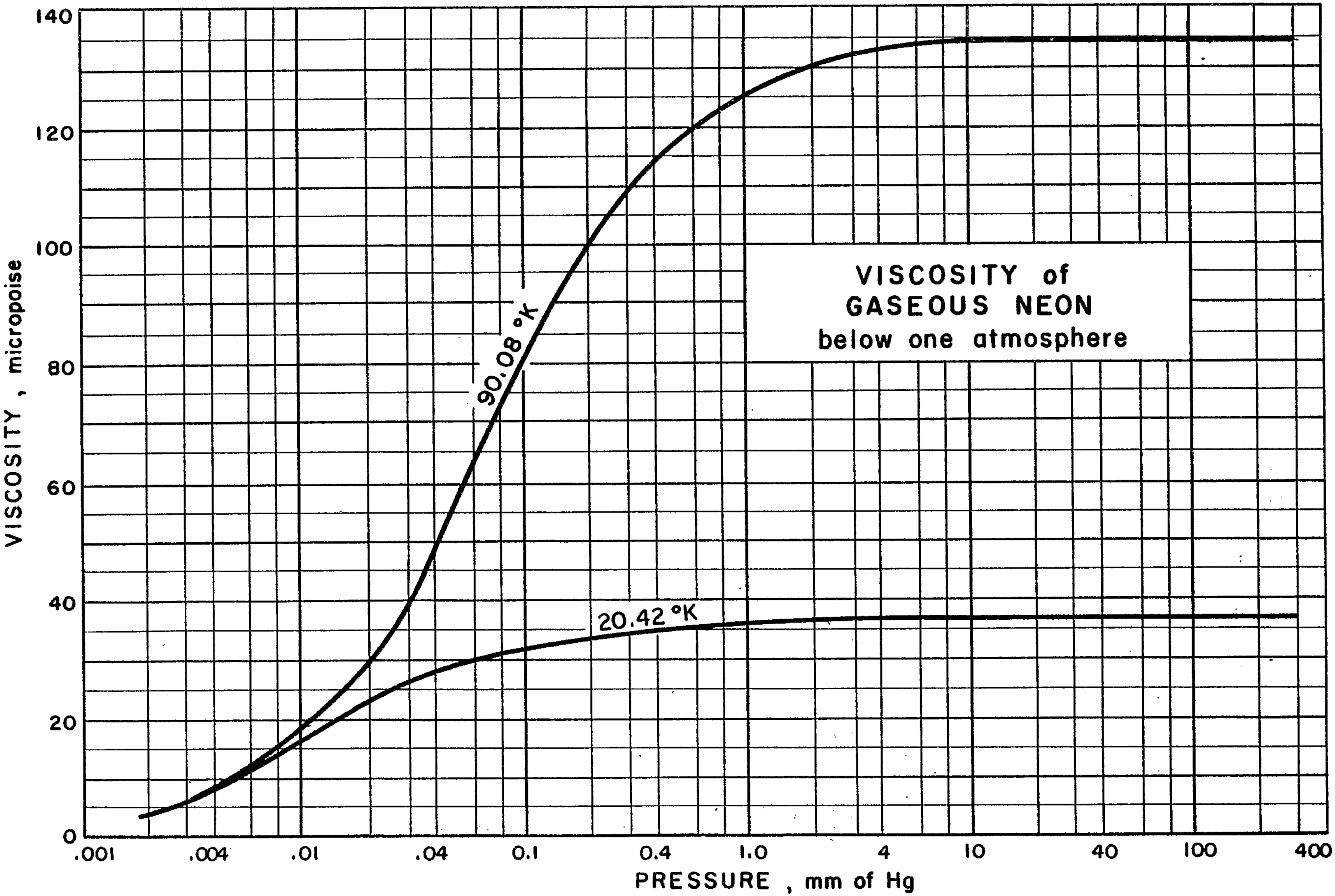

VISCOSITY of
GASEOUS NEON
below one atmosphere
90.08 °K
20.42 °K
VISCOSITY , micropoise
PRESSURE , mm of Hg
140
120
100
80
60
40
20
0
.001
.004
.01
.04
0.1
0.4
1.0
4
10
40
100
400

V-J-2.6

VELOCITY of SOUND in GASEOUS NEON

Source of Data:

Keesom, W. H. and Van Lammeren, J. A.; Physica 1, 1161 (1934)

Other References:

Grennspan, M. J.; Acoust. Soc. Am. 28, 644 (1956)

Keesom, W. H. and Van Itterbeek, A.; Proc. Acad. Sci. Amsterdam 33, 440 (1930); Communs. Phys. Lab. Univ. Leiden No. 209a (1930)

Skudrzyk, E.; Acta Phys. Austriaca 2, 148 (1949)

Van Itterbeek, A. and Mariens, P.; Physica 7, 125 (1940)

Van Itterbeek, A. and Thys, L.; Physica 5, 889 (1938)

Comments:

The values of the velocity of sound in gaseous neon are given here as functions of pressure and temperature for temperatures from 26.25°K to 273.1°K at various pressures between 0 and 0.9825 atmospheres. The 26.25°K isotherm on the plot of the velocity of sound versus pressure has been terminated at the point of saturation. All the data tabulated below are from Keesom and Van Lammeren listed above under "Sources of Data".

The values of velocity of sound by Keesom and Van Lammeren are the average values from measurements at several frequencies in the audible sound range. The error caused by the resonator (heat conduction and viscosity) in the experimental apparatus was corrected by means of the Kirchhoff-Helmholtz formula as reported by Keesom and Van Itterbeek. No estimate is made of the accuracy of the measurements or the purity of the neon gas used.

The values of the velocity of sound at 0 pressure were calculated for the ideal gas, i.e., $c = \sqrt{RT\gamma}$ where c is the velocity of sound, R is the gas constant, T is the temperature and γ is the specific heat ratio. The 26.25°K isotherm has been terminated at the saturated vapor pressure.

The units of the velocity of sound in neon gas used in the tabulations below and on the graphs are: temperature in degrees Kelvin (0°C = 273.16°K), pressure in atmospheres (g = 890.665) and the velocity of sound in meters per second.

(Continued on following page)

Comments: (cont.)

Velocity of Sound in Gaseous Neon
as a Function of Temperature

Keesom and Van Lammeren		
Temp. °K	Pressure atm.	Velocity m/sec
273.1	0.8626	433.4
170.0	0.9822	342.2
90.24	0.9581	249.3
74.11	0.8152	225.7
62.54	0.9784	207.1

Velocity of Sound in Gaseous Neon
as a Function of Pressure

Keesom and Van Lammeren			
Pressure atm.	Velocity m/sec	Pressure atm.	Velocity m/sec
27.80°K		26.25°K	
0.9825	134.9	0.6760	131.9
0.8053	135.6	0.5063	132.6
0.6024	136.3	0.4113	133.0
0.4514	136.8	0.2763	133.5
0.2859	137.3		
0.1376	138.1		

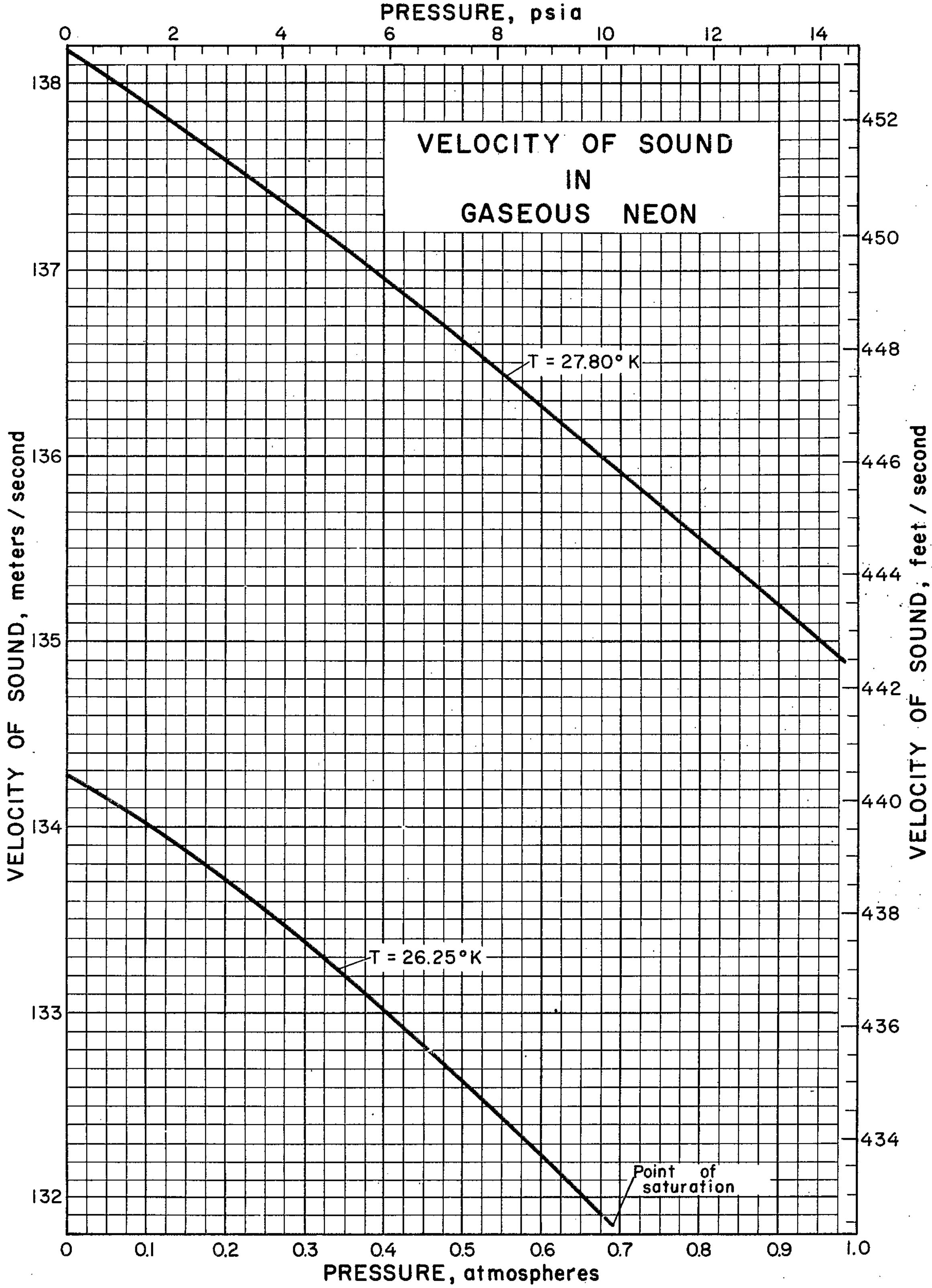
Van Itterbeek and Thys made measurements of the velocity of sound in neon gas using a sound wave with a frequency of 304.4 kilocycles per second; whereas Keesom and Van Lammeren had used audible sound. From these measurements they calculated the value of the velocity of sound at 0°C and 1 atmosphere pressure in neon gas as 434.9 m/sec, differing slightly from the value of 433.4 m/sec reported by Keesom and Van Lammeren. Van Itterbeek and Thys conclude that their own neon contained a small amount of hydrogen.

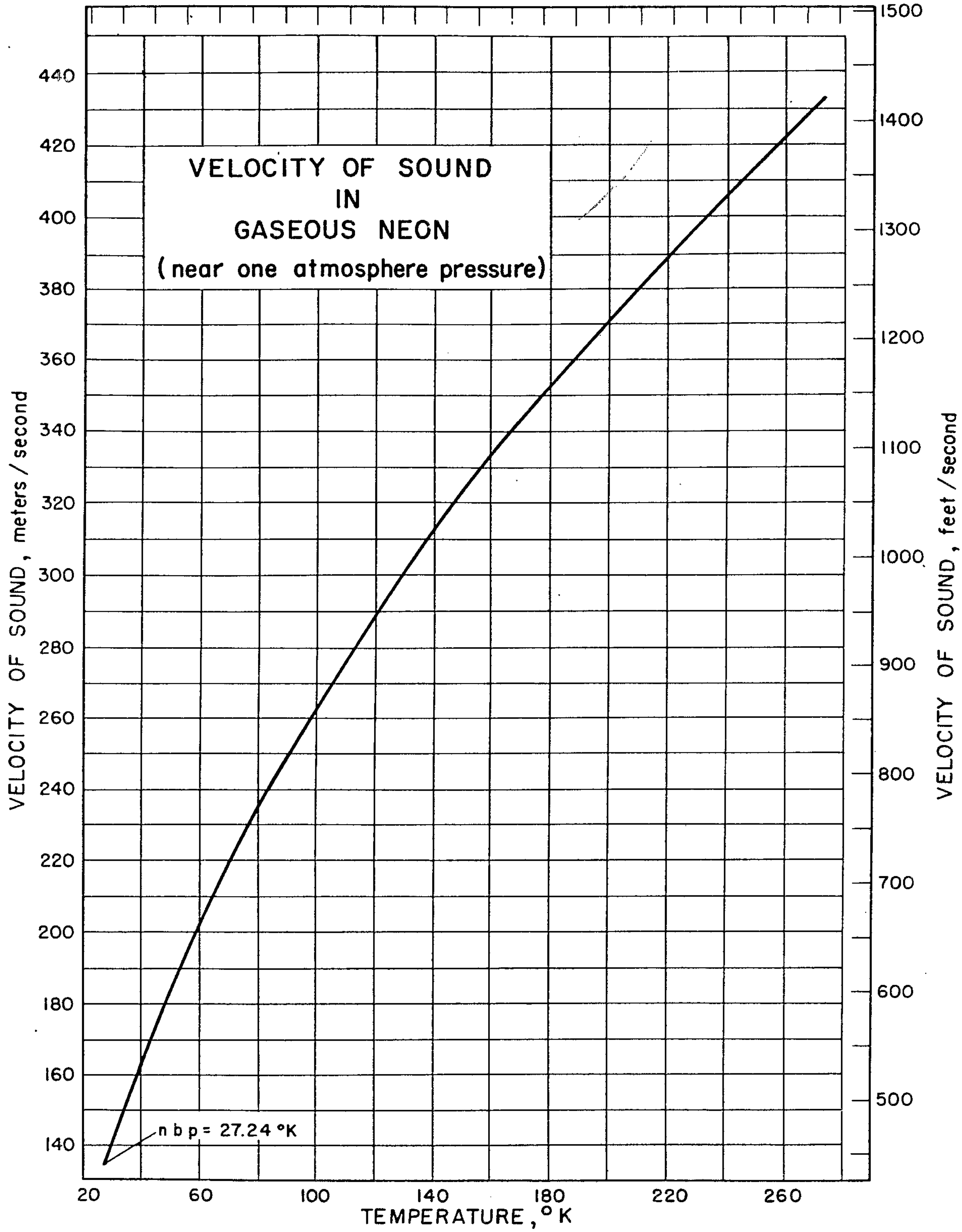
Van Itterbeek and Mariens made measurements on carbon dioxide to which small amounts (0.28%) of neon had been added to study the effect of this impurity.

Skudrzyk derived relations of absorption and velocity of sound and compared them with the classical hypothesis of Stokes. The specific behavior of helium and neon was also explained.

Greenspan measured the speed and attenuation of sound at 11 megacycles in helium, neon, argon, krypton, and xenon at various pressures between atmospheric and a few mm Hg, and compared the results with existing theories.

Taken from WADD TECH. REPORT 60-56


PRESSURE, psia
0 2 4 6 8 10 12 14
VELOCITY OF SOUND
IN
GASEOUS NEON
T = 27.80° K
T = 26.25° K
Point of saturation
VELOCITY OF SOUND, meters / second
138 137 136 135 134 133 132
VELOCITY OF SOUND, feet / second
452 450 448 446 444 442 440 438 436 434
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
PRESSURE, atmospheres


VELOCITY OF SOUND
IN
GASEOUS NEON
(near one atmosphere pressure)
VELOCITY OF SOUND, meters / second
VELOCITY OF SOUND, feet / second
TEMPERATURE, °K
n b p = 27.24 °K
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
1500
1400
1300
1200
1100
1000
900
800
700
600
500
20
60
100
140
180
220
260