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Standard Specification for Methane Thermophysical Property Tables¹

This standard is issued under the fixed designation D3956; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The thermophysical property tables for methane are for use in the calculation of the pressure-volume-temperature (PVT), thermodynamic, and transport properties of methane for process design and operations. ~~Tables Three tables~~ are provided for gaseous and liquid methane at temperatures between 90 K and 600K at pressures to 20 MPa. ~~One table provides properties at the conditions of 30 MPa.~~ Two tables provide properties for the liquid and vapor phases at liquid-vapor equilibrium (saturation properties). ~~The other third table~~ provides properties at selected T, p points for the equilibrium phase at those conditions. The tables were developed by the National Institute of Standards and Technology from a Standard Reference Database product REFPROP, version 7.0.9.0.

2. Applicability

2.1 These tables apply directly only to pure gaseous methane. However, it is expected that they may find substantial use in mathematical models and tables for the thermophysical properties of mixtures containing methane.

3. Tables

3.1 ~~Thermophysical Properties of Coexisting Gaseous and Liquid Methane, Methane Liquid at Liquid-Vapor Equilibrium~~, in SI units.

3.2 ~~Thermophysical Properties of Methane Vapor at Liquid-Vapor Equilibrium~~, in SI units.

3.3 ~~Thermophysical Properties of Methane Along Isobars~~, in SI units.

3.4 The tabulated properties are:

- ρ = molar density ($\text{mol}\cdot\text{L}^{-1}$)
- $\bar{\rho}$ = molar density ($\text{mol}\cdot\text{L}^{-1}$)
- \bar{H} = molar enthalpy ($\text{J}\cdot\text{mol}^{-1}$)
- S = molar entropy ($\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$)
- C_v = constant volume molar heat capacity ($\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$)
- C_p = constant pressure molar heat capacity ($\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$)
- c = speed of sound ($\text{m}\cdot\text{s}^{-1}$)
- μ = viscosity ($\mu\text{Pa}\cdot\text{s}$)
- k = thermal conductivity ($\text{mW}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$)

3.5 These tables were produced by equations from a computer package, “NIST Standard Reference Database 23; Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 7.0.9.0.” A wide selection of units (SI units, engineering units, chemical units) and additional properties are available with this program.²

4. Additional Information

4.1 Reference state properties are required to calculate certain of the thermodynamic properties (enthalpy, entropy, etc.) from an equation of state formulation. The reference state properties used to generate the tables in this specification are: enthalpy, H , and entropy, S , at 298.15 K and 0.101325 MPa ($H = 10018 \text{ J/mol}$ and $S = 186.266 \text{ J/(mol K)}$). The molar mass of methane is 16.043 g/mol.

¹ This specification is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.08 on Thermophysical Properties.

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² Available from Standard Reference Data, National Institute of Standards and Technology (NIST), 100 Bureau Drive, Stop 3460, Gaithersburg, MD 20899.

5. Keywords

5.1 methane gas tables; natural gas; thermodynamic properties of methane; transport properties of methane

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TABLE 1 Thermophysical Properties of Coexisting Gaseous and Liquid Methane

<i>T</i> K	ρ MPa	ρ mol \cdot L $^{-1}$	<i>H</i> J \cdot mol $^{-1}$	<i>S</i> J \cdot mol $^{-1}\cdot$ K $^{-1}$	C_v J \cdot mol $^{-1}\cdot$ K $^{-1}$	C_p J \cdot mol $^{-1}\cdot$ K $^{-1}$	<i>c</i> m \cdot s $^{-1}$	μ Pa \cdot s	k mW \cdot m $^{-1}\cdot$ K $^{-1}$
90.70	0.011705	28.141	-15564	9899.5	34.78	54.03	1538.5	201.9	211.2
90.70	0.011705	0.015641	-6832.4	9995.8	25.24	33.85	249.13	3.609	8.792
92	0.013804	28.033	-15493	9900.3	34.64	54.10	1526.7	194.8	209.6
92	0.013804	0.018199	-6791.7	9994.9	25.27	33.92	250.76	3.658	8.949
94	0.017613	27.866	-15385	9901.5	34.44	54.23	1508.4	184.4	207.2
94	0.017613	0.022277	-6729.6	9993.5	25.32	34.02	253.2	3.732	9.192
96	0.022233	27.698	-15276	9902.6	34.26	54.37	1489.8	174.7	204.7
96	0.022233	0.028198	-6668.2	9992.3	25.37	34.14	255.57	3.808	9.438
98	0.027778	27.528	-15167	9903.7	34.08	54.52	1471.0	165.6	202.2
98	0.027778	0.034587	-6607.4	9991.1	25.43	34.28	257.87	3.883	9.687
100	0.034376	27.357	-15058	9904.8	33.91	54.68	1452.0	157.2	199.6
100	0.034376	0.042048	-6547.5	9989.9	25.49	34.42	260.09	3.960	9.939
102	0.042160	27.185	-14948	9905.9	33.74	54.85	1432.9	149.3	197.0
102	0.042160	0.050695	-6488.4	9988.9	25.55	34.58	262.24	4.036	10.19
104	0.051275	27.010	-14838	9907.0	33.58	55.04	1413.6	141.9	194.3
104	0.051275	0.060649	-6430.3	9987.8	25.62	34.76	264.31	4.114	10.46
106	0.061868	26.835	-14728	9908.0	33.42	55.23	1394.1	135.0	191.6
106	0.061868	0.072034	-6373.1	9986.9	25.69	34.95	266.29	4.192	10.72
108	0.074099	26.657	-14617	9909.1	33.27	55.44	1374.5	128.6	188.8
108	0.074099	0.08498	-6316.9	9985.9	25.76	35.16	268.20	4.270	10.99
110	0.08813	26.478	-14505	9910.1	33.12	55.67	1354.7	122.7	186.1
110	0.08813	0.099622	-6261.8	9985.0	25.84	35.38	270.01	4.349	11.26
112	0.10413	26.297	-14393	9911.1	32.97	55.88	1334.8	117.0	183.3
112	0.10413	0.1161	-6207.9	9984.2	25.92	35.62	271.75	4.429	11.54
114	0.12228	26.113	-14281	9912.1	32.82	56.13	1314.7	111.7	180.5
114	0.12228	0.13455	-6155.2	9983.4	26.01	35.88	273.39	4.510	11.82
116	0.14275	25.928	-14168	9913.1	32.68	56.38	1294.4	106.8	177.7
116	0.14275	0.15514	-6103.8	9982.6	26.10	36.16	274.94	4.591	12.11
118	0.16574	25.740	-14054	9914.0	32.54	56.65	1274.0	102.2	174.9
118	0.16574	0.17801	-6053.8	9981.8	26.20	36.46	276.4	4.674	12.41
120	0.19143	25.551	-13940	9915.0	32.40	56.94	1253.5	97.91	172.0
120	0.19143	0.20332	-6005.2	9981.1	26.30	36.79	277.76	4.757	12.71
122	0.22002	25.358	-13825	9915.9	32.26	57.25	1232.7	93.87	169.2
122	0.22002	0.23125	-5958.1	9980.4	26.40	37.14	279.03	4.841	13.02
124	0.2517	25.163	-13710	9916.8	32.13	57.57	1211.9	90.07	166.4
124	0.2517	0.26197	-5912.6	9979.7	26.50	37.51	280.21	4.926	13.33
126	0.28667	24.966	-13594	9917.8	32.00	57.92	1190.8	86.50	163.5
126	0.28667	0.29567	-5868.7	9979.1	26.62	37.92	281.28	5.012	13.66
128	0.32514	24.765	-13477	9918.7	31.88	58.29	1169.5	83.13	160.6
128	0.32514	0.33254	-5826.6	9978.4	26.73	38.36	282.25	5.100	13.99
130	0.36732	24.562	-13359	9919.6	31.76	58.68	1148.1	79.95	157.8
130	0.36732	0.37278	-5786.3	9977.8	26.85	38.84	283.13	5.188	14.33
132	0.41341	24.355	-13240	9920.5	31.64	59.11	1126.4	76.94	154.9
132	0.41341	0.41662	-5747.8	9977.2	26.98	39.35	283.90	5.278	14.69
134	0.46363	24.145	-13121	9921.3	31.52	59.57	1104.6	74.09	152.1
134	0.46363	0.46428	-5711.4	9976.6	27.11	39.91	284.57	5.370	15.05
136	0.51819	23.931	-13000	9922.2	31.41	60.06	1082.5	71.39	149.2
136	0.51819	0.51601	-5677.0	9976.1	27.25	40.51	285.13	5.464	15.42
138	0.57730	23.713	-12879	9923.1	31.308	60.59	1060.2	68.82	146.4
138	0.57730	0.57209	-5644.8	9975.5	27.397	41.17	285.58	5.559	15.81

TABLE 1 *Continued*

<i>T</i> K	<i>p</i> MPa	<i>H</i> mol ⁻¹	<i>H</i> J·mol ⁻¹	<i>S</i> J·mol ⁻¹ ·K ⁻¹	<i>C_v</i> J·mol ⁻¹ ·K ⁻¹	<i>C_p</i> J·mol ⁻¹ ·K ⁻¹	<i>c</i> m·s ⁻¹	<i>μ</i> Pa·s	<i>mW</i> m ⁻¹ ·K ⁻¹
140	0.64118	23.491	-12756	9923.9	31.206	61.17	1037.7	66.37	143.5
140	0.64118	0.63279	-5616.0	9975.0	27.549	41.88	286.93	5.656	16.24
142	0.71006	23.265	-12632	9924.8	31.109	61.80	1014.9	64.04	140.7
142	0.71006	0.69843	-5587.5	9974.4	27.709	42.67	286.16	5.756	16.62
144	0.78415	23.034	-12507	9925.7	31.018	62.48	991.81	61.81	137.8
144	0.78415	0.76935	-5562.6	9973.9	27.877	43.52	286.29	5.858	17.05
146	0.86368	22.798	-12381	9926.5	30.932	63.22	968.46	59.67	135.0
146	0.86368	0.84593	-5540.3	9973.4	28.054	44.47	286.30	5.962	17.50
148	0.94887	22.556	-12253	9927.3	30.852	64.04	944.81	57.62	132.1
148	0.94887	0.92857	-5520.9	9972.8	28.241	45.51	286.19	6.070	17.96
150	1.0400	22.309	-12123	9928.2	30.78	64.93	920.85	55.64	129.3
150	1.0400	1.0177	-5504.5	9972.3	28.439	46.66	285.97	6.181	18.45
152	1.1372	22.055	-11992	9929.0	30.714	65.92	896.54	53.74	126.4
152	1.1372	1.1140	-5491.3	9971.8	28.649	47.94	285.63	6.296	18.95
154	1.2408	21.794	-11859	9929.9	30.656	67.02	871.87	51.90	123.6
154	1.2408	1.2178	-5481.5	9971.3	28.872	49.36	285.16	6.415	19.49
156	1.3509	21.526	-11724	9930.7	30.608	68.24	846.82	50.12	120.8
156	1.3509	1.3299	-5475.3	9970.8	29.110	50.97	284.57	6.538	20.05
158	1.4680	21.249	-11587	9931.5	30.569	69.61	821.35	48.39	117.9
158	1.4680	1.4511	-5473.0	9970.2	29.363	52.78	283.86	6.667	20.65
160	1.5921	20.964	-11447	9932.4	30.541	71.16	795.43	46.71	115.0
160	1.5921	1.5821	-5475.0	9969.7	29.636	54.85	283.01	6.802	21.28
162	1.7235	20.668	-11305	9933.2	30.526	72.91	769.03	45.07	112.2
162	1.7235	1.7241	-5481.6	9969.2	29.928	57.22	282.03	6.943	21.96
164	1.8626	20.360	-11160	9934.1	30.525	74.92	742.10	43.46	109.3
164	1.8626	1.8782	-5493.1	9968.6	30.244	59.96	280.91	7.093	22.70
166	2.0096	20.040	-11011	9934.9	30.541	77.25	714.59	41.89	106.4
166	2.0096	2.0459	-5510.2	9968.1	30.588	63.16	279.65	7.252	23.49
168	2.1647	19.706	-10859	9935.8	30.576	79.98	686.42	40.33	103.5
168	2.1647	2.2289	-5533.5	9967.5	30.962	66.96	278.23	7.421	24.36
170	2.3283	19.355	-10702	9936.7	30.634	83.22	657.52	38.80	100.6
170	2.3283	2.4294	-5563.7	9966.9	31.374	71.53	276.66	7.604	25.34
172	2.5007	18.984	-10541	9937.6	30.721	87.13	627.77	37.27	97.63
172	2.5007	2.6500	-5601.7	9966.3	31.829	77.11	274.93	7.801	26.43
174	2.6822	18.591	-10374	9938.5	30.843	91.95	597.05	35.74	94.65
174	2.6822	2.8944	-5648.8	9965.6	32.337	84.09	273.02	8.018	27.69
176	2.8732	18.170	-10200	9939.4	31.011	98.06	565.18	34.20	91.65
176	2.8732	3.1671	-5706.6	9964.9	32.912	93.05	270.92	8.258	29.17
178	3.0740	17.716	-10017	9940.4	31.24	106.0	531.94	32.65	88.63
178	3.0740	3.4744	-5777.2	9964.2	33.57	105.0	268.60	8.528	30.97
180	3.2852	17.218	-9824.6	9941.4	31.554	117.0	497.01	31.05	85.60
180	3.2852	3.8257	-5863.9	9963.4	34.338	121.5	266.04	8.837	33.23
182	3.5071	16.664	-9618.3	9942.5	31.996	132.9	459.94	29.39	82.60
182	3.5071	4.2349	-5971.3	9962.5	35.257	146.0	263.17	9.201	36.23
184	3.7405	16.028	-9392.8	9943.6	32.641	158.5	420.00	27.62	79.73
184	3.7405	4.7255	-6107.3	9961.5	36.397	186.0	259.89	9.646	40.50
186	3.9860	15.267	-9137.8	9944.9	33.654	206.7	375.88	25.66	77.32
186	3.9860	5.3422	-6286.8	9960.2	37.893	262.0	255.97	10.22	47.31
188	4.2448	14.270	-8828.0	9946.5	35.503	332.7	324.57	23.34	76.72

TABLE 1 *Continued*

<i>T</i> K	<i>p</i> MPa	<i>H</i> mol·L ⁻¹	<i>H</i> J·mol ⁻¹	<i>S</i> J·mol ⁻¹ ·K ⁻¹	<i>C_v</i> J·mol ⁻¹ ·K ⁻¹	<i>C_p</i> J·mol ⁻¹ ·K ⁻¹	<i>c</i> m·s ⁻¹	<i>μ</i> Pa·s	<i>k</i> mW·m ⁻¹ ·K ⁻¹
188	4.2448	6.1945	-6545.2	9958.6	40.109	461.6	250.72	11.06	60.74
190	4.5186	12.515	-8343.5	9948.9	41.746	450.8	250.31	10.78	95.22
190	4.5186	7.8027	-7047.8	9955.7	45.796	225.0	238.55	12.80	117.4

TABLE 1 Thermophysical Properties of Methane Liquid at Liquid-Vapor Equilibrium

<i>T</i> K	<i>p</i> MPa	<i>H</i> mol·L ⁻¹	<i>H</i> J·mol ⁻¹	<i>S</i> J·mol ⁻¹ ·K ⁻¹	<i>C_v</i> J·mol ⁻¹ ·K ⁻¹	<i>C_p</i> J·mol ⁻¹ ·K ⁻¹	<i>c</i> m·s ⁻¹	<i>μ</i> Pa·s	<i>k</i> mW·m ⁻¹ ·K ⁻¹
90.7	0.011705	28.141	84267	67.794	34.775	54.029	1538.5	193.53	211.18
92	0.013801	28.033	84338	68.563	34.641	54.102	1526.7	186.13	209.64
94	0.017613	27.866	84446	69.728	34.445	54.226	1508.4	175.87	207.20
96	0.022233	27.698	84555	70.870	34.258	54.366	1489.8	166.73	204.71
98	0.027778	27.528	84664	71.992	34.08	54.517	1471.0	158.48	202.16
100	0.034376	27.357	84773	73.095	33.908	54.681	1452.0	150.97	199.56
102	0.04216	27.185	84883	74.178	33.741	54.854	1432.9	144.06	196.92
104	0.051275	27.010	84993	75.244	33.579	55.039	1413.6	137.66	194.24
106	0.061868	26.835	85103	76.293	33.421	55.234	1394.1	131.71	191.53
108	0.074099	26.657	85214	77.326	33.266	55.439	1374.5	126.14	188.79
110	0.08813	26.478	85326	78.343	33.115	55.656	1354.7	120.90	186.02
112	0.10413	26.297	85438	79.346	32.966	55.885	1334.8	115.97	183.24
114	0.12228	26.113	85550	80.335	32.82	56.127	1314.7	111.30	180.44
116	0.14275	25.928	85663	81.310	32.677	56.383	1294.4	106.88	177.62
118	0.16574	25.740	85777	82.273	32.537	56.653	1274.0	102.68	174.79
120	0.19143	25.551	85891	83.224	32.4	56.941	1253.5	98.680	171.95
122	0.22002	25.358	86006	84.164	32.265	57.246	1232.7	94.874	169.11
124	0.2517	25.163	86121	85.092	32.133	57.571	1211.9	91.243	166.26
126	0.28667	24.966	86237	86.010	32.005	57.917	1190.8	87.777	163.41
128	0.32514	24.765	86354	86.919	31.879	58.288	1169.5	84.465	160.55
130	0.36732	24.562	86472	87.819	31.757	58.684	1148.1	81.298	157.69
132	0.41341	24.355	86591	88.710	31.639	59.110	1126.4	78.267	154.83
134	0.46363	24.145	86710	89.593	31.525	59.567	1104.6	75.363	151.98
136	0.51819	23.931	86831	90.468	31.414	60.060	1082.5	72.581	149.12
138	0.57730	23.713	86952	91.337	31.308	60.593	1060.2	69.913	146.27
140	0.64118	23.491	87075	92.200	31.206	61.169	1037.7	67.354	143.41
142	0.71006	23.265	87199	93.057	31.109	61.795	1014.9	64.896	140.56
144	0.78415	23.034	87324	93.910	31.018	62.477	991.81	62.536	137.71
146	0.86368	22.798	87450	94.758	30.932	63.221	968.46	60.267	134.87
148	0.94887	22.556	87578	95.603	30.852	64.036	944.81	58.085	132.02
150	1.0400	22.309	87707	96.444	30.78	64.932	920.85	55.984	129.18
152	1.1372	22.055	87839	97.284	30.714	65.922	896.54	53.960	126.33
154	1.2408	21.794	87972	98.123	30.656	67.019	871.87	52.008	123.49
156	1.3509	21.526	88107	98.961	30.608	68.241	846.82	50.124	120.64
158	1.4680	21.249	88244	99.801	30.569	69.611	821.35	48.303	117.79
160	1.5921	20.964	88384	100.64	30.541	71.156	795.43	46.541	114.93
162	1.7235	20.668	88526	101.49	30.526	72.912	769.03	44.832	112.06
164	1.8626	20.360	88671	102.34	30.525	74.924	742.10	43.172	109.18
166	2.0096	20.040	88820	103.19	30.541	77.252	714.59	41.556	106.29
168	2.1647	19.706	88972	104.06	30.576	79.979	686.42	39.978	103.38
170	2.3283	19.355	89129	104.94	30.634	83.218	657.52	38.432	100.46
172	2.5007	18.984	89290	105.83	30.721	87.130	627.77	36.911	97.508
174	2.6822	18.591	89457	106.74	30.843	91.954	597.05	35.407	94.534
176	2.8732	18.170	89631	107.67	31.011	98.060	565.18	33.911	91.535
178	3.0740	17.716	89814	108.64	31.24	106.05	531.94	32.411	88.513
180	3.2852	17.218	90006	109.65	31.554	116.99	497.01	30.888	85.482
182	3.5071	16.664	90213	110.72	31.996	132.94	459.94	29.320	82.478
184	3.7405	16.028	90438	111.87	32.641	158.52	420.00	27.665	79.598
186	3.9860	15.267	90693	113.16	33.654	206.68	375.88	25.848	77.150
188	4.2448	14.270	91003	114.73	35.503	332.70	324.57	23.683	76.437
190	4.5186	12.515	91488	117.18	41.746	450.8	250.31	20.291	94.151

TABLE 2 Thermophysical Properties of Methane Vapor at Liquid-Vapor Equilibrium

T K	p MPa	ρ mol·L ⁻¹	H J·mol ⁻¹	S J·mol ⁻¹ ·K ⁻¹	C_v J·mol ⁻¹ ·K ⁻¹	C_p J·mol ⁻¹ ·K ⁻¹	c m·s ⁻¹	μ Pa·s	mW m ⁻¹ ·K ⁻¹
90.7	0.011705	0.015641	92999	164.06	25.244	33.851	249.13	3.5980	8.7991
92	0.013801	0.018199	93039	163.15	25.272	33.916	250.76	3.6414	8.9478
94	0.017613	0.022770	93101	161.81	25.32	34.025	253.20	3.7087	9.1797
96	0.022233	0.028198	93163	160.54	25.372	34.145	255.57	3.7765	9.4154
98	0.027778	0.034587	93224	159.34	25.427	34.279	257.87	3.8449	9.6551
100	0.034376	0.042048	93283	158.20	25.487	34.425	260.09	3.9139	9.8989
102	0.042160	0.050695	93343	157.12	25.550	34.585	262.24	3.9832	10.147
104	0.051275	0.060649	93401	156.09	25.617	34.760	264.31	4.0530	10.400
106	0.061868	0.072034	93458	155.11	25.688	34.950	266.29	4.1232	10.657
108	0.074099	0.084980	93514	154.18	25.763	35.156	268.20	4.1938	10.920
110	0.088130	0.099622	93569	153.28	25.842	35.378	270.01	4.2647	11.188
112	0.10413	0.11610	93623	152.43	25.925	35.619	271.75	4.3360	11.461
114	0.12228	0.13455	93676	151.61	26.011	35.879	273.39	4.4077	11.740
116	0.14275	0.15514	93727	150.83	26.102	36.159	274.94	4.4797	12.026
118	0.16574	0.17801	93777	150.07	26.196	36.461	276.40	4.5521	12.318
120	0.19143	0.20332	93826	149.35	26.295	36.786	277.76	4.6250	12.617
122	0.22002	0.23125	93873	148.65	26.397	37.137	279.03	4.6983	12.923
124	0.25170	0.26197	93918	147.97	26.505	37.514	280.21	4.7721	13.237
126	0.28667	0.29567	93962	147.32	26.616	37.922	281.28	4.8465	13.560
128	0.32514	0.33254	94004	146.69	26.733	38.361	282.25	4.9215	13.891
130	0.36732	0.37278	94045	146.07	26.854	38.836	283.13	4.9972	14.232
132	0.41341	0.41662	94083	145.47	26.981	39.350	283.90	5.0738	14.583
134	0.46363	0.46428	94120	144.89	27.113	39.907	284.57	5.1512	14.944
136	0.51819	0.51601	94154	144.32	27.252	40.511	285.13	5.2297	15.317
138	0.57730	0.57209	94186	143.76	27.397	41.169	285.58	5.3094	15.703
140	0.64118	0.63279	94216	143.21	27.549	41.885	285.93	5.3904	16.102
142	0.71006	0.69843	94243	142.67	27.709	42.668	286.16	5.4730	16.515
144	0.78415	0.76935	94268	142.14	27.877	43.525	286.29	5.5573	16.945
146	0.86368	0.84593	94291	141.61	28.054	44.467	286.30	5.6436	17.391
148	0.94887	0.92857	94310	141.09	28.241	45.507	286.19	5.7323	17.857
150	1.0400	1.0177	94326	140.57	28.439	46.657	285.97	5.8236	18.344
152	1.1372	1.1140	94340	140.05	28.649	47.936	285.63	5.9179	18.854
154	1.2408	1.2178	94350	139.54	28.872	49.365	285.16	6.0157	19.390
156	1.3509	1.3299	94356	139.02	29.110	50.971	284.57	6.1176	19.957
158	1.4680	1.4511	94358	138.50	29.363	52.785	283.86	6.2242	20.557
160	1.5921	1.5821	94356	137.97	29.636	54.849	283.01	6.3362	21.197
162	1.7235	1.7241	94349	137.43	29.928	57.217	282.03	6.4546	21.884
164	1.8626	1.8782	94338	136.89	30.244	59.958	280.91	6.5803	22.625
166	2.0096	2.0459	94321	136.33	30.588	63.165	279.65	6.7149	23.433
168	2.1647	2.2289	94297	135.76	30.962	66.963	278.23	6.8599	24.322
170	2.3283	2.4294	94267	135.16	31.374	71.527	276.66	7.0175	25.314
172	2.5007	2.6500	94229	134.54	31.829	77.111	274.93	7.1906	26.436
174	2.6822	2.8944	94182	133.89	32.337	84.089	273.02	7.3827	27.732
176	2.8732	3.1671	94124	133.20	32.912	93.049	270.92	7.5989	29.263
178	3.0740	3.4744	94054	132.46	33.570	104.95	268.60	7.8460	31.127
180	3.2852	3.8257	93967	131.65	34.338	121.51	266.04	8.1346	33.484
182	3.5071	4.2349	93860	130.75	35.257	146.04	263.17	8.4811	36.620
184	3.7405	4.7255	93724	129.73	36.397	185.97	259.89	8.9141	41.100
186	3.9860	5.3422	93544	128.49	37.893	262.03	255.97	9.4902	48.246
188	4.2448	6.1945	93286	126.87	40.109	461.61	250.72	10.354	62.294
190	4.5186	7.8027	92783	124.00	45.796	2259.0	238.55	12.237	120.52