

# Steam Density Reference Tables

For Vortex Flow Meter Sizing & Mass Flow Calculation

These tables provide saturated and superheated steam density values for engineering sizing of vortex flow meters and steam mass flow calculation. All pressures are **absolute pressure**.

**Table 1. Saturated Steam Density**

Density of saturated steam at the corresponding pressure and saturation temperature. Use this table when measuring steam at boiler outlet conditions or any process where the steam is at its saturation point.

T (°C)	P (bar abs)	$\rho$ (kg/m <sup>3</sup> )	T (°C)	P (bar abs)	$\rho$ (kg/m <sup>3</sup> )	T (°C)	P (bar abs)	$\rho$ (kg/m <sup>3</sup> )
100	1.103	0.600	176	9.137	4.723	252	41.138	20.690
101	1.050	0.611	177	9.353	4.829	253	41.831	21.050
102	1.088	0.639	178	9.574	4.937	254	42.534	21.420
103	1.127	0.660	179	9.798	5.048	255	43.246	21.790
104	1.167	0.632	180	10.027	5.160	256	43.967	22.170
105	1.208	0.705	181	10.259	5.274	257	44.697	22.550
106	1.250	0.728	182	10.496	5.391	258	45.437	22.940
107	1.294	0.751	183	10.738	5.509	259	46.185	23.330
108	1.339	0.776	184	10.983	5.629	260	46.943	23.730
109	1.385	0.801	185	11.233	5.752	261	47.711	24.140
110	1.433	0.827	186	11.488	5.877	262	48.488	24.550
111	1.482	0.853	187	11.747	6.003	263	49.275	24.970
112	1.532	0.880	188	12.010	6.132	264	50.071	25.400
113	1.583	0.907	189	12.278	6.264	265	50.877	25.830
114	1.636	0.936	190	12.551	6.397	266	51.693	26.270
115	1.691	0.965	191	12.829	6.533	267	52.519	26.720
116	1.746	0.995	192	13.111	6.671	268	53.356	27.170
117	1.804	1.025	193	13.398	6.812	269	54.202	27.630
118	1.863	1.057	194	13.690	6.955	270	55.058	28.100
119	1.923	1.089	195	13.987	7.100	271	55.925	28.570
120	1.985	1.122	196	14.298	7.248	272	56.802	29.060
121	2.049	1.155	197	14.596	7.398	273	57.689	29.550
122	2.115	1.190	198	14.909	7.551	274	58.587	30.040
123	2.182	1.225	199	15.226	7.706	275	59.496	30.550
124	2.250	1.261	200	15.549	7.864	276	60.415	31.060
125	2.321	1.298	201	15.877	8.025	277	61.346	31.580
126	2.393	1.336	202	16.210	8.188	278	62.287	32.110
127	2.467	1.375	203	16.549	8.354	279	63.239	32.650
128	2.543	1.415	204	16.893	8.522	280	64.202	33.190
129	2.622	1.455	205	17.243	8.694	281	65.176	33.750
130	2.701	1.497	206	17.598	8.868	282	66.162	34.310
131	2.783	1.539	207	17.959	9.045	283	67.158	34.880
132	2.867	1.583	208	18.326	9.225	284	68.167	35.470
133	2.953	1.627	209	18.699	9.408	285	69.186	36.060
134	3.041	1.672	210	19.077	9.593	286	70.218	36.660
135	3.131	1.719	211	19.462	9.782	287	71.261	37.270
136	3.223	1.766	212	19.852	9.974	288	72.315	37.890
137	3.317	1.815	213	20.249	10.170	289	73.382	38.520
138	3.414	1.864	214	20.651	10.370	290	74.461	39.160

T (°C)	P (bar abs)	$\rho$ (kg/m <sup>3</sup> )	T (°C)	P (bar abs)	$\rho$ (kg/m <sup>3</sup> )	T (°C)	P (bar abs)	$\rho$ (kg/m <sup>3</sup> )
139	3.513	1.915	215	21.060	10.570	291	75.551	39.810
140	3.614	1.967	216	21.475	10.770	292	76.654	40.480
141	3.717	2.019	217	21.869	10.980	293	77.770	41.150
142	3.823	2.073	218	22.324	11.190	294	78.897	41.830
143	3.931	2.129	219	22.758	11.410	295	80.037	42.530
144	4.042	2.185	220	23.198	11.620	296	81.189	43.240
145	4.155	2.242	221	23.645	11.840	297	82.355	43.960
146	4.271	2.301	222	24.099	12.070	298	83.532	44.690
147	4.398	2.361	223	24.560	12.300	299	84.723	45.430
148	4.510	2.422	224	25.027	12.530	300	85.927	46.190
149	4.634	2.484	225	25.501	12.760	301	87.124	46.960
150	4.760	2.584	226	25.982	13.000	302	88.374	47.750
151	4.889	2.613	227	26.470	13.240	303	89.617	48.540
152	5.021	2.679	228	26.965	13.490	304	90.873	49.360
153	5.155	2.747	229	27.467	13.740	305	92.144	50.180
154	5.293	2.816	230	27.976	14.000	306	93.427	51.020
155	5.433	2.886	231	28.493	14.250	307	94.725	51.880
156	5.577	2.958	232	29.016	14.520	308	96.036	52.750
157	5.732	3.032	233	29.547	14.780	309	97.361	53.640
158	5.872	3.106	234	30.086	15.050	310	98.700	54.540
159	6.025	3.182	235	30.632	15.330	311	100.050	55.470
160	6.181	3.260	236	31.186	15.610	312	101.420	56.400
161	6.339	3.339	237	31.747	15.890	313	102.800	57.360
162	6.502	3.420	238	32.317	16.180	314	104.200	58.330
163	6.667	3.502	239	32.893	16.470	315	105.610	59.330
164	6.836	3.586	240	33.478	16.760	316	107.040	60.340
165	7.008	3.671	241	34.071	17.060	317	108.480	61.370
166	7.183	3.758	242	34.672	17.370	318	109.930	62.430
167	7.362	3.847	243	35.281	17.680	319	111.400	63.500
168	7.545	3.937	244	35.898	17.990	320	112.890	64.600
169	7.731	4.029	245	36.523	18.310	325	120.560	70.450
170	7.920	4.123	246	37.157	18.640	330	128.630	76.990
171	8.114	4.218	247	37.799	18.970	335	137.120	84.360
172	8.311	4.316	248	38.449	19.300	340	146.050	92.760
173	8.511	4.415	249	39.108	19.640	345	155.450	102.400
174	8.716	4.515	250	39.776	19.990	350	165.350	113.600
175	8.924	4.618	251	40.452	20.360	355	175.770	127.200

**Note:** To convert absolute pressure to gauge pressure, subtract 1.013 bar (atmospheric pressure). 1 bar = 0.1 MPa = 14.5 psi.

**Table 2. Superheated Steam Density (140 – 240 °C)**

Density of superheated steam (kg/m<sup>3</sup>) at given absolute pressure and temperature. Use when steam temperature exceeds the saturation temperature for the given pressure. "-" means the operating point is below the saturation line, so the steam is not superheated at that condition.

P (MPa abs)	140 °C	150 °C	160 °C	170 °C	180 °C	190 °C	200 °C	210 °C	220 °C	230 °C	240 °C
0.20	1.070	1.042	1.016	0.992	0.969	0.947	0.926	0.906	0.887	0.868	0.851
0.30	1.622	1.578	1.537	1.499	1.463	1.428	1.396	1.365	1.336	1.308	1.281
0.40	-	2.127	2.067	2.014	1.964	1.916	1.872	1.829	1.789	1.751	1.715
0.50	-	-	2.608	2.538	2.472	2.411	2.353	2.299	2.247	2.198	2.152
0.55	-	-	2.882	2.803	2.729	2.661	2.596	2.535	2.478	2.424	2.372
0.60	-	-	3.159	3.071	2.989	2.912	2.841	2.773	2.710	2.650	2.593
0.65	-	-	-	3.341	3.250	3.165	3.087	3.013	2.943	2.877	2.815
0.70	-	-	-	3.614	3.514	3.421	3.334	3.253	3.117	3.105	3.037
0.75	-	-	-	3.889	3.779	3.678	3.584	3.495	3.413	3.335	3.261
0.80	-	-	-	-	4.048	3.937	3.835	3.739	3.649	3.565	3.486
0.85	-	-	-	-	4.318	4.198	4.087	3.984	3.887	3.797	3.711
0.90	-	-	-	-	4.591	-	4.342	4.231	4.127	4.030	3.938
1.00	-	-	-	-	5.145	4.995	4.856	4.729	4.610	4.499	4.395
1.10	-	-	-	-	-	5.537	5.379	5.233	5.098	4.973	4.855
1.20	-	-	-	-	-	6.089	5.909	5.744	5.593	5.452	5.321
1.30	-	-	-	-	-	-	6.448	6.263	6.093	5.936	5.790
1.40	-	-	-	-	-	-	6.996	6.789	6.600	6.426	6.265
1.50	-	-	-	-	-	-	7.554	7.324	7.114	6.922	6.744
1.60	-	-	-	-	-	-	-	7.867	7.635	7.424	7.229
1.70	-	-	-	-	-	-	-	8.418	8.163	7.931	7.719
1.80	-	-	-	-	-	-	-	8.978	8.699	8.446	8.214
1.90	-	-	-	-	-	-	-	9.548	9.243	8.967	8.715
2.00	-	-	-	-	-	-	-	-	9.795	9.495	9.222
2.10	-	-	-	-	-	-	-	-	10.36	10.03	9.735
2.20	-	-	-	-	-	-	-	-	10.93	10.57	10.25
2.30	-	-	-	-	-	-	-	-	11.51	11.12	10.78
2.40	-	-	-	-	-	-	-	-	-	11.68	11.31
2.50	-	-	-	-	-	-	-	-	-	12.25	11.85
2.60	-	-	-	-	-	-	-	-	-	12.83	12.40
2.70	-	-	-	-	-	-	-	-	-	13.41	12.96
2.80	-	-	-	-	-	-	-	-	-	-	13.52
2.90	-	-	-	-	-	-	-	-	-	-	14.09
3.00	-	-	-	-	-	-	-	-	-	-	14.67
3.10	-	-	-	-	-	-	-	-	-	-	15.26
3.20	-	-	-	-	-	-	-	-	-	-	15.86
3.30	-	-	-	-	-	-	-	-	-	-	16.47
3.40	-	-	-	-	-	-	-	-	-	-	-
3.50	-	-	-	-	-	-	-	-	-	-	-
4.00	-	-	-	-	-	-	-	-	-	-	-

**Table 3. Superheated Steam Density (250 – 350 °C)**

P (MPa abs)	250 °C	260 °C	270 °C	280 °C	290 °C	300 °C	310 °C	320 °C	330 °C	340 °C	350 °C
0.20	0.834	0.818	0.803	0.788	0.774	0.760	0.747	0.734	0.721	0.709	0.698
0.30	1.256	1.230	1.208	1.185	1.163	1.142	1.122	1.103	1.084	1.066	1.049

P (MPa abs)	250 °C	260 °C	270 °C	280 °C	290 °C	300 °C	310 °C	320 °C	330 °C	340 °C	350 °C
0.40	1.680	1.647	1.615	1.585	1.555	1.527	1.500	1.474	1.449	1.424	1.401
0.50	2.108	2.066	2.025	1.986	1.949	1.914	1.879	1.846	1.814	1.784	1.754
0.55	2.323	2.276	2.231	2.188	2.147	2.108	2.070	2.033	1.998	1.964	1.931
0.60	2.539	2.487	2.438	2.391	2.345	2.302	2.260	2.220	2.182	2.145	2.109
0.65	2.755	2.699	2.696	2.594	2.544	2.497	2.452	2.408	2.366	2.326	2.287
0.70	2.973	2.912	2.853	2.797	2.744	2.693	2.643	2.596	2.551	2.507	2.465
0.75	3.191	3.125	3.062	3.001	2.994	2.889	2.836	2.785	2.736	2.689	2.643
0.80	3.411	3.339	3.271	3.206	3.144	3.085	3.028	2.974	2.921	2.871	2.822
0.85	3.631	3.554	3.481	3.412	3.345	3.282	3.221	3.163	3.107	3.053	3.001
0.90	3.852	3.770	3.692	3.618	3.547	3.480	3.415	3.353	3.293	3.236	3.181
1.00	4.296	4.204	4.116	4.032	3.952	3.876	3.804	3.734	3.667	3.603	3.541
1.10	4.745	4.641	4.542	4.449	4.360	4.275	4.194	4.116	4.042	3.971	3.902
1.20	5.198	5.082	4.972	4.869	4.770	4.676	4.587	4.501	4.419	4.340	4.265
1.30	5.654	5.526	5.405	5.291	5.182	5.079	4.981	4.887	4.798	4.711	4.629
1.40	6.114	5.974	5.841	5.716	5.598	5.485	5.378	5.275	5.178	5.084	4.994
1.50	6.579	6.425	6.280	6.144	6.015	5.893	5.776	5.665	5.560	5.458	5.361
1.60	7.049	6.880	6.723	6.575	6.435	6.303	6.177	6.057	5.943	5.834	5.729
1.70	7.522	7.340	7.169	7.009	6.858	6.715	6.580	6.451	6.329	6.211	6.099
1.80	8.001	7.803	7.619	7.446	7.284	7.131	6.985	6.847	6.716	6.590	6.470
1.90	8.484	8.271	8.072	7.886	7.712	7.584	7.393	7.245	7.105	6.971	6.843
2.00	8.973	8.743	8.529	8.330	8.144	7.968	7.802	7.645	7.496	7.353	7.217
2.10	9.466	9.219	8.990	8.777	8.578	8.391	8.214	8.047	7.888	7.737	7.593
2.20	9.965	9.700	9.455	9.228	9.015	8.815	8.628	8.451	8.283	8.123	7.970
2.30	10.47	10.19	9.924	9.682	9.456	9.244	9.045	8.857	8.679	8.510	8.349
2.40	10.98	10.68	10.40	10.14	9.899	9.675	9.464	9.266	9.078	8.899	8.730
2.50	11.50	11.17	10.87	10.60	10.35	10.11	9.886	9.676	9.478	9.290	9.112
2.60	12.02	11.67	11.36	11.07	10.80	10.55	10.31	10.09	9.880	9.683	9.495
2.70	12.55	12.18	11.84	11.53	11.25	10.98	10.74	10.50	10.28	10.08	9.880
2.80	13.08	12.69	12.33	12.01	11.71	11.43	11.17	10.92	10.69	10.47	10.27
2.90	13.62	13.21	12.83	12.48	12.17	11.87	11.60	11.34	11.10	10.87	10.66
3.00	14.17	13.73	13.33	12.97	12.63	12.32	12.03	11.76	11.51	11.27	11.05
3.10	14.73	14.26	13.84	13.45	13.10	12.77	12.47	12.19	11.92	11.67	11.44
3.20	15.30	14.80	14.35	13.94	13.57	13.23	12.91	12.62	12.34	12.08	11.83
3.30	15.87	15.34	14.86	14.44	14.05	13.69	13.36	13.05	12.76	12.48	12.23
3.40	16.45	15.89	15.39	14.94	14.53	14.15	13.80	13.48	13.18	12.89	12.63
3.50	17.04	16.44	15.91	15.44	15.01	14.61	14.25	13.91	13.60	13.30	13.02
4.00	-	19.34	18.65	18.04	17.49	17.00	16.55	16.13	15.74	15.39	15.05

**How to use:** Locate the row matching the operating absolute pressure and the column matching the operating temperature. The intersection gives the steam density. Multiply density by volumetric flow rate (m<sup>3</sup>/h) to get mass flow rate (kg/h).

## Quick Formulas for Vortex Steam Flow Meter Sizing

**Volumetric flow:**  $Q_v = Q_m / \rho$

$Q_v$  in m<sup>3</sup>/h,  $Q_m$  in kg/h,  $\rho$  in kg/m<sup>3</sup>

**Steam velocity in pipe:**  $v = Q_v / (3600 \times A)$

$v$  in m/s,  $A = \pi \times (D/2)^2$  in m<sup>2</sup>,  $D$  = pipe inner diameter in m

**Recommended velocity range** for vortex flow meters on steam: **5 to 70 m/s** (best 10 – 50 m/s). If actual velocity is below 5 m/s, reduce the meter size by one or two steps below the pipe size.

## Need a Sizing Report for Your Project?

Send the following four parameters and we will return a complete sizing report and quotation within 12 hours:

1. Steam pressure (MPa or bar, gauge or absolute)
2. Steam temperature (°C), saturated or superheated
3. Pipe size (DN or inch)
4. Flow range: min / normal / max (kg/h or t/h)

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