CALCULATION OF Kv FLOW COEFFICIENTS

Sizing of control valves and pressure regulators can be performed through calculation of flow coefficient, analysis of flow characteristic curves, nomographs or other empirical methods. The IEC 60534-2-1 is typically used for such tasks, most commonly for control valve sizing.

This section provides a simplified method for sizing which is based on the valve flow coefficient. This method is sufficiently accurate for most simple industrial applications.

In cases where:

- Flow rate and/or upstream pressure varies significantly - high turndown ratios.
- Safety valve set pressure is too close to PRV set pressure.
- Critical applications where events such as high noise emissions, erosion, cavitation or flashing may occur.

Contact our technical department for selection using our software.

Kv: Flow rate coefficient which represents the quantity of water, expressed in m^3 at a temperature between 5 and 40 °C, that flows through the valve at a specified travel H with a differential pressure of 1 bar, in a one-hour period. Unit is m3/h.

Cv: Flow rate coefficient, similar to Kv, but in imperial units. The relationship is given by Kv = 0,865 · Cv. Unit is gpm.

Kvs: Flow coefficient Kv value of the valve at rated stroke H_{100}. This value is indicated and published on the valve Information sheet (IS). Unit is m3/h.

Kv_{100}: Actual Kv flow coefficient of the valve at rated stroke H_{100}. This value may deviate ±10 % from the indicated Kvs.

PRESSURE DROP	MEDIUM		
	LIQUIDS	SATURATED STEAM	GASES
$p_2 > \frac{p_1}{2}$	$Kv = \dot{V}_L \sqrt{\frac{\rho_L}{\Delta p \cdot 1000}}$	$Kv = \frac{\dot{m}_s}{22{,}4 \cdot \sqrt{\Delta p \cdot p_2}}$	$Kv = \frac{\dot{V}_G}{514} \sqrt{\frac{\rho_G \cdot T}{\Delta p \cdot p_2}}$
$p_2 < \frac{p_1}{2}$		$Kv = \frac{\dot{m}_s}{11{,}2 \cdot p_1}$	$Kv = \frac{\dot{V}_G}{257 \cdot p_1} \sqrt{\rho_G \cdot T}$

Kv – Flow coefficient [m^3/h]
p_1 – Upstream absolute pressure [bar]
p_2 – Downstream absolute pressure [bar]
Δp – Pressure drop (p1-p2) [bar]
$\dot{V}_L$ – Volumetric flow rate of liquid [m^3/h]
$\dot{V}_G$ – Volumetric flow rate of gas at 0 °C and 1013 mbar [Nm^3/h]
$\dot{m}_S$ – Mass flow rate of steam [kg/h]
ρ_L – Density of liquid [kg/m^3]
ρ_G – Density of gas [kg/m^3]
T – Absolute temperature (T = 273 + t [°C]) [K]

The formulas shown in the previous table allow Kv calculation in accordance with the type of fluid and its operating conditions. The valve Kvs can be retrieved from its respective Information sheet (IS).

Control valves: If realistic operating conditions have been considered, as a rule, the calculated Kv should be around 70% to 80% of the selected valve Kvs, hence Kvs ≥ 1,3 · Kv.

Pressure regulators: In theory the ideal pressure regulator working range is between 10% to 70% of its rated Kvs value. Thus, if realistic operating conditions have been considered the calculated Kv should be at a maximum of 70% of the selected regulator's Kvs, hence Kvs ≥ 1,3 · Kv.

CONTROL VALVE SEAT LEAKAGE

SEAT LEAKAGE RATES		
VALVE SEALING	**LEAKAGE CLASS ACC. TO IEC 60534-4**	**MAXIMUM SEAT LEAKAGE**
Metal to metal *	III	≤ 0,1% of Kvs
Metal to metal Pressure balanced trim	IV	≤ 0,01% of Kvs
Metal to metal (lapped)	V	$1{,}8 \cdot 10^{-5} \cdot \Delta p \cdot D$ (l/h) $10{,}8 \cdot 10^{-6} \cdot D$ (Nm^3/h)
Soft sealing	VI	$0{,}3 \cdot \Delta p \cdot f_L$

D – seat diameter in mm. **Δp** – differential pressure in bar. $\mathbf{f_L}$ – leakage rate factor. Refer to Table 3 in IEC 60534-4 section 5.5 for further details.
* Uncommon.

PIPE SIZING AND FLOW VELOCITY

Pipelines should be calculated considering flowrates and pressure drops, and various known methodologies are known and may be used for this purpose. To simplify and especially in cases where pipe lengths are small, sizing can be performed based exclusively on flow and velocity.

The values shown in the following table refer to recommended flow velocities in accordance with the type of fluid.

RECOMMENDED FLOW VELOCITIES [m/s]	
Flash and exhaust steam	15 to 25
Saturated steam	20 to 30
Superheated steam	35 to 65
Feedwater suction	0,5 to 1
Feedwater pressure	1,5 to 3,5
Drinking and service water	1 to 2
Compressed air and most other gases	15 to 20

The pipe inner diameter D in mm is given by

$$D = 18{,}8 \sqrt{\frac{\dot{V}}{u}}$$

where $\dot{V}$ is the volumetric flow rate in m^3/h and u is the pipe flow velocity in m/s.

ADCAPURE STAINLESS STEELS AND SPECIAL ALLOYS

The raw stainless steels and special alloys used in ADCAPure products are acquired according to the ASME BPE specifications and comply with the relevant standards.

Internally, these materials are subject to a strict quality control that involves, not only documentation and dimensions verification, but also, spectrographic chemical composition analysis in our facilities.

All materials are internally traceable, by means of quality system procedures.

STAINLESS STEELS AND SPECIAL ALLOYS *		
MATERIAL	**STANDARD**	**CHARACTERISTICS**
AISI304 (1.4301)	ASTM A276	Applied only to non-wetted parts.
AISI316L (1.4404)	ASTM A276	Intercrystalline corrosion resistant according to ISO 3651-2 Method A and ASTM A262 Practice E.
AISI316L (1.4435)	ASTM A276	Improved corrosion resistance compared to other CrNi steels due to its increased content of molybdenum.
AISI316Ti (1.4571)	ASTM A276	Intercrystalline corrosion resistant according to ISO 3651-2 Method A and ASTM A262 Practice E.
HASTELLOY® C22 (2.4602)	ASTM B574	Resistance to both oxidizing and non-oxidizing chemicals, protection from corrosion, pitting, crevice attack and stress corrosion cracking.
CF3M (1.4409)	ASTM A351	Ferrite content of less than 2% and low sulphur between 0,005% and 0,017%.

* For other high corrosion resistance steels, please consult factory.

ADCAPURE NON-METALLIC MATERIALS

It is crucial that non-metallic parts are selected to maintain the purity and integrity of the process fluid.

In order to achieve this, they should be compatible with stated process conditions, cleaning solutions and sterilization conditions, defined by the customer.

The following table features an overview of the non-metallic materials applied in the ADCAPure range and their respective approvals.

WETTED NON-METALLIC MATERIALS		
MATERIAL	**STANDARD APPROVALS**	**ON REQUEST**
GYLON® (modified PTFE)	FDA 21CFR177.1550 USP Class VI Ch. 87 & 88 USP Ch. 31, 281 & 661 EC1935/2004 EC2023/2006 ADI Free BAM NSF ROHS	3A Sanitary
EPDM	FDA 21 CFR 177.2600 USP Class VI Ch. 87 and/or 88 EC1935/2004 3A Sanitary ADI Free	ACS BAM NSF ROHS WRAS
FPM (VITON®)	FDA 21 CFR 177.2600 EC1935/2004 ADI Free	USP Class VI Ch. 87 or 88 ACS 3A Sanitary BAM
PTFE	FDA 21CFR 177.1550 & 177.2600 USP Class VI Ch. 88 EC1935/2004 EC2023/2006 ADI Free BAM ROHS	3A Sanitary DVGW W270
EPM	FDA 21 CFR 177.2600 EC1935/2004 EC2023/2006 ADI Free	–
FEPM (Fluoraz®)	FDA 21 CFR 177.2400 & 177.2600 USP Class VI Ch. 87 & 88 EC1935/2004 3A Sanitary ADI Free	–
FFKM (Kalrez®)	FDA 21CFR 177.2600 USP Class VI Ch. 87 & 88 EC1935/2004 EC2023/2006 3A Sanitary ADI Free	–
FEP/Silicone	FDA 21 CFR 177.1550 & 177.2600 USP Class VI Ch. 87 & 88 EC1935/2004 ADI Free 3A Sanitary ROHS	–
VMQ (Silicone)	FDA 21 CFR 177.2600 ADI Free BPE Free	–

ADCAPURE SURFACE FINISH

The surface quality, especially the area in contact with the fluid, greatly influences the cleanability of the equipment. All the products from the ADCAPure range are supplied with a standard internal surface finish that allows an efficient cleanability. Apart from the standard conditions, several combinations of roughnesses can be provided both internally and externally, for optimized performance according to customer requirements.

ASME BPE acceptance criteria are applied and achieved by internally controlled procedures, which in term apply visual inspection and carefull roughness measurements.

All metallic parts are produced on the factory with dedicated high end, high precision machines with tool wear control. This allows guaranteed controlled surface conditions directly from the machine.

Explanation of surface finishes

- Fine machining: Obtained with high performance turning and milling machines.
- Mechanical polishing: Polished surface, not necessary with a shiny finish.
- Electropolishing: Satin surface finish typical from electropolishing process.
- Mirror: Shiny "mirror like" finish obtained by mechanical polishing.
- As casted: Standard raw finish of a casted part.
- Satin bead blast: Obtained by sand blasting process, applicable as standard to parts such as pneumatic actuator covers, external surfaces of humidity separators and culinary filters.

SURFACE FINISH OPTIONS

Ra Max. [µm]	Ra Max. [µin]	MECHANICAL POLISHED *		ELECTROPOLISHED	
		ASME BPE SURFACE DESIGNATION	DIN 11866 HYGIENE CLASS	ASME BPE SURFACE DESIGNATION	DIN 11866 HYGIENE CLASS
0,25	10	-	H5	-	HE5
0,38	15	-	H4	SF4	HE4
0,51	20	SF1	-	SF5	-
0,64	25	SF2	-	SF6	-
0,76	30	SF3	-	-	HE3

* Or any other finishing method that meets the specified Ra values (according to ASME BPE).

SURFACE FINISH COMBINATIONS [a]

INTERNAL WETTED PARTS [b]	EXTERNAL SURFACES		ORDERING CODE LETTER [c]
	BAR STOCK	INVESTMENT CASTING	
SF1	SF3	"As casted"	**X**
	SF1	–	**C**
	SF1 incl. mirror finish	–	**D**
H4	SF3	"As casted"	**G**
	SF1	–	**I**
	SF1 incl. mirror finish	–	**J**
H5	SF3	"As casted"	**L**
	SF1	–	**N**
	SF1 incl. mirror finish	–	**O**
SF4	HE3	"As casted"	**Q**
	SF5	–	**S**
SF5	HE3	"As casted"	**E**
	SF5	–	**V**

a) In case of discrepancy, the information on the product Information sheet (IS) shall prevail. Other surface finishes and combinations on request.
b) Not applicable to regulating elements. Consult for certified roughness values.
c) The letter should be placed on the "Surface finish" field of the product ordering code. Refer to the product Information sheet (IS). If the product IS does not include a ordering code table, the required surface finish combination should be indicated in writing, in case it defers from the standard one.

ADCAPURE WELDING

The design of equipment which is part of the ADCAPure range is in accordance with the latest specifications of ASME BPE and EHDGE standards and guidelines. The welding procedures are performed by approved welders and according to welding specifications. The process is done manually or via mechanized and orbital machines in strictly controlled environment to avoid any contamination with external particles.

The welding is subject to a detailed visual inspection according to ASME BPE to guarantee its conformity with high demanding industries.

FROM CLEANING TO PACKING

After welding and surface finishing operations, the parts enter a certified clean room, to start the process of cleaning and passivation. A fully automatic ultra-sound cleaning machine allows efficient control of the cleaning procedure in all surfaces.

It is also possible to prepare the product parts for oxygen applications, by performing additional degreasing processes.

The parts follow to an ISO 14644 certified clean room, where they are assembled by trained personnel, according to internal procedures. In the final stage, still inside the clean room, and after all the necessary testing and quality verifications, the products are end capped and vacuum sealed with recyclable plastic film to avoid contamination.

ADCAPURE CERTIFICATES

Our quality system is certified by ISO 9001:2015 and guarantees the control of all the processes involved in the project, manufacturing and supply of our products. Various certificates and declarations can be supplied to attest the conformity of the products.

CERTIFICATES	
TYPE	**INFORMATION**
CE Conformity declaration	According to directive 2014/68/EU (PED)
ADCAPure specific inspection certificate	Include chemical composition, final testing records, elastomer specifications and approvals, surface finish report.
Hydrostatic test report	According to directive 2014/68/EU (PED)
Pneumatic test report	According to EN12266-1
Degreasing report	Includes treatment information
Ultra-sound cleaning report	Includes treatment information

MASS FLOW RATES OF SATURATED STEAM IN PIPES ACC. TO DIN 2448

p_m [bar]	u [m/s]	FLOW RATE [kg/h]													
		DN 15	DN 20	DN 25	DN 32	DN 40	DN 50	DN 65	DN 80	DN 100	DN 125	DN 150	DN 200	DN 250	DN 300
0,4	15	10	17	28	48	64	103	171	236	397	600	878	1476	2346	3319
	25	17	29	47	80	107	171	285	393	662	1000	1464	2459	3911	5532
	40	28	46	75	128	171	274	456	628	1058	1601	2342	3935	6257	8851
0,6	15	12	20	33	56	76	121	202	278	468	708	1036	1741	2769	3917
	25	20	34	55	94	126	202	336	463	781	1181	1727	2902	4615	6528
	40	33	54	89	151	202	324	538	741	1249	1889	2764	4644	7384	10445
0,8	15	13	22	35	60	81	130	216	297	501	757	1108	1862	2960	4187
	25	22	36	59	101	135	216	360	495	835	1262	1846	3103	4934	6979
	40	35	58	95	161	216	346	575	792	1335	2019	2954	4964	7894	11166
1	15	14	24	39	67	89	143	238	327	552	835	1221	2052	3263	4615
	25	24	40	65	111	149	238	396	546	920	1391	2035	3420	5438	7692
	40	38	64	104	178	238	381	634	873	1472	2226	3256	5471	8700	12307
1,5	15	18	29	48	82	110	176	293	404	681	1030	1507	2532	4026	5694
	25	30	49	80	137	184	294	489	673	1135	1716	2511	4219	6710	9491
	40	47	79	129	219	294	470	783	1078/	1816	2746	4018	6751	10735	15185
2	15	21	35	57	97	131	209	347	478	806	1219	1784	2998	4767	6743
	25	35	58	95	162	218	348	579	797	1344	2032	2973	4996	7945	11238
	40	56	93	152	259	348	557	927	1276	2150	3252	4757	7994	12711	17980
2,5	15	24	40	66	112	151	241	401	553	931	1409	2061	3463	5506	7789
	25	41	67	110	187	251	402	669	921	1552	2348	3435	5771	9177	12982
	40	65	108	176	300	402	643	1070	1474	2484	3756	5495	9234	14684	20770
3	15	28	46	75	127	171	273	454	626	1055	1595	2333	3921	6235	8820
	25	46	76	125	212	285	455	757	1043	1758	2658	3889	6535	10392	14699
	40	73	122	199	339	455	728	1212	1669	2813	4253	6223	10456	16627	23519
4	15	34	56	92	157	211	337	560	771	1300	1966	2876	4833	7685	10871
	25	57	94	154	261	351	561	934	1286	2167	3277	4794	8055	12809	18119
	40	90	150	246	418	561	898	1494	2057	3467	5243	7670	12888	20495	28990
5	15	40	67	109	186	250	400	665	916	1544	2334	3415	5738	9125	12907
	25	67	111	182	310	417	666	1109	1527	2573	3890	5692	9564	15208	21512
	40	107	178	292	496	667	1066	1774	2443	4116	6224	9107	15302	24333	34420
6	15	47	77	127	216	289	463	770	1061	1788	2703	3955	6646	10568	14948
	25	78	129	211	359	482	772	1284	1768	2979	4505	6592	11076	17613	24913
	40	124	206	338	575	772	1235	2054	2829	4767	7208	10546	17722	28180	39861
7	15	53	88	144	244	328	525	873	1202	2026	3064	4482	7532	11977	16941
	25	88	146	239	407	547	875	1455	2004	3377	5106	7470	12553	19961	28235
	40	141	234	383	652	875	1399	2328	3206	5402	8170	11953	20084	31937	45176
8	15	59	98	160	273	366	586	975	1342	2261	3420	5003	8407	13369	18911
	25	98	163	267	455	610	976	1624	2237	3769	5700	8339	14012	22282	31518
	40	157	261	427	727	977	1562	2599	3579	6031	9120	13342	22420	35651	50429
9	15	65	109	178	302	406	649	1080	1487	2506	3790	5545	9318	14816	20958
	25	109	181	296	504	676	1082	1800	2479	4177	6317	9242	15529	24694	34930
	40	174	289	474	806	1082	1731	2880	3966	6683	10107	14787	24847	39510	55888
10	15	72	119	195	331	445	711	1184	1630	2747	4154	6078	10212	16239	22971
	25	119	198	324	552	741	1186	1973	2717	4578/	6923	10129	17021	27066	38285
	40	191	317	519	884	1186	1897	3157	4347	7325	11077	16207	27233	43305	61255
12	15	84	139	228	388	521	834	1388	1911	3220	4869	7124	11971	19036	26926
	25	140	232	380	647	869	1390	2313	3185	5367	8115	11873	19951	31726	44877
	40	224	372	608	1036	1390	2224	3700	5095	8587	12985	18998	31922	50761	71803
14	15	96	160	261	444	596	954	1587	2186	3683	5570	8150	13694	21776	30802
	25	160	266	435	740	994	1590	2645	3643	6139	9284	13583	22823	36293	51336
	40	256	425	696	1185	1591	2544	4233	5829	9823	14854	21732	36517	58068	82138
16	15	108	180	294	501	673	1076	1791	2466	4156	6284	9194	15450	24567	34751
	25	181	300	491	835	1122	1794	2985	4110	6926	10474	15324	25749	40945	57918
	40	289	480	785	1337	1794	2870	4775	6576	11082	16758	24518	41199	65513	92668
18	15	121	201	328	559	750	1199	1995	2748	4631	7003	10245	17215	27375	38722
	25	201	334	547	931	1250	1999	3326	4580	7718	11671	17075	28692	45625	64537
	40	322	535	875	1489	2000	3198	5321	7328	12348	18673	27320	45907	73000	103259
20	15	134	222	363	617	829	1326	2205	3037	5118	7740	11324	19027	30256	42798
	25	223	369	604	1029	1381	2209	3676	5062	8530	12899	18873	31712	50427	71330
	40	356	591	967	1646	2210	3535	5881	8099	13648	20639	30196	50740	80684	114128

p_m – gauge pressure, u – flow velocity

MASS FLOW RATES OF SATURATED STEAM IN PIPES ACC. TO DIN 11866-A (DIN 11850-2)

bar(g)	m/s	FLOW RATE [kg/h]														
		6	8	10	15	20	25	32	40	50	65	80	100	125	150	200
0,4	15	1	2	3	9	14	23	35	50	87	151	227	346	541	779	1384
	25	2	4	6	15	23	39	59	83	144	251	378	577	901	1298	2307
	40	3	6	9	24	37	62	94	133	231	402	605	923	1442	2076	3691
0,6	15	1	3	4	10	16	26	40	57	98	171	257	392	612	881	1566
	25	2	4	7	17	26	44	67	94	163	284	428	653	1020	1469	2611
	40	4	7	10	27	42	71	107	151	261	455	685	1044	1632	2350	4177
0,8	15	2	3	4	11	17	30	45	63	109	190	287	437	683	983	1748
	25	3	5	7	19	29	49	75	105	182	317	478	728	1138	1638	2913
	40	4	7	12	30	47	79	119	168	291	507	764	1165	1820	2621	4660
1	15	2	3	5	12	19	33	49	70	120	210	316	482	753	1084	1927
	25	3	5	8	21	32	54	82	116	201	350	527	803	1255	1807	3212
	40	5	8	13	33	51	87	132	186	321	560	843	1285	2008	2891	5139
1,5	15	2	4	6	15	24	40	61	86	148	258	389	593	927	1334	2372
	25	4	6	10	25	40	67	101	143	247	431	649	988	1544	2224	3954
	40	6	10	16	40	63	107	162	228	395	689	1038	1582	2471	3558	6326
2	15	3	4	7	18	28	48	72	102	176	306	461	703	1098	1582	2812
	25	4	7	12	30	47	79	120	169	293	510	769	1172	1831	2636	4687
	40	7	12	19	48	75	127	192	271	469	817	1230	1875	2929	4218	7499
2,5	15	3	5	8	21	32	55	83	117	203	354	533	812	1269	1827	3248
	25	5	9	14	35	54	91	139	195	338	589	888	1353	2115	3045	5413
	40	8	14	22	55	87	146	222	313	541	943	1421	2165	3383	4872	8661
3	15	3	6	9	24	37	62	94	133	230	401	604	920	1438	2070	3680
	25	6	10	15	39	61	104	157	221	383	668	1006	1533	2396	3450	6134
	40	9	16	25	63	98	166	251	354	613	1069	1610	2454	3834	5521	9814
4	15	4	7	11	29	45	77	116	164	284	494	744	1134	1772	2552	4538
	25	7	12	19	48	76	128	194	273	473	824	1240	1891	2954	4254	7563
	40	11	19	30	77	121	204	310	437	756	1318	1985	3025	4727	6806	12100
5	15	5	9	13	34	54	91	138	194	337	587	884	1347	2104	3030	5387
	25	8	14	22	57	90	152	230	324	561	978	1473	2245	3507	5050	8978
	40	13	23	36	92	144	243	368	519	898	1564	2356	3591	5611	8080	14365
6	15	6	10	16	40	62	105	159	225	389	678	1022	1558	2434	3505	6230
	25	9	17	26	66	104	175	266	375	649	1131	1703	2596	4056	5841	10384
	40	15	27	42	106	166	281	425	600	1038	1809	2725	4154	6490	9346	16614
7	15	6	11	18	45	71	119	181	255	442	770	1160	1767	2762	3977	7070
	25	11	19	29	75	118	199	302	425	736	1283	1933	2946	4603	6628	11783
	40	17	30	47	121	189	319	483	681	1178	2053	3092	4713	7364	10605	18852
8	15	7	13	20	51	79	134	202	285	494	861	1297	1976	3088	4447	7906
	25	12	21	33	84	132	223	337	476	824	1435	2161	3294	5147	7412	13176
	40	19	34	53	135	211	356	540	761	1318	2296	3458	5270	8235	11859	21082
9	15	8	14	22	56	87	148	224	315	546	952	1433	2185	3414	4916	8739
	25	13	23	36	93	146	246	373	526	910	1586	2389	3641	5690	8193	14566
	40	21	37	58	149	233	394	597	841	1457	2538	3823	5826	9104	13109	23305
10	15	9	15	24	61	96	162	245	346	598	1042	1570	2393	3739	5384	9571
	25	14	26	40	102	160	270	408	576	997	1737	2617	3988	6231	8973	15952
	40	23	41	64	163	255	431	653	921	1595	2780	4186	6381	9970	14357	25524

p_m – gauge pressure. **u** – flow velocity.

MASS FLOW RATES OF SATURATED STEAM IN PIPES ACC. TO DIN 11866-B (ISO 1127)

bar(g)	m/s	FLOW RATE [kg/h]														
		6	8	10	15	20	25	32	40	50	65	80	100	125	150	200
0,4	15	2	4	7	11	19	31	51	68	110	180	246	416	626	920	1583
	25	3	6	11	19	32	51	85	113	183	300	410	694	1043	1534	2639
	40	5	10	18	30	52	81	136	181	292	480	656	1110	1669	2455	4222
0,6	15	2	4	8	13	22	35	58	77	124	204	278	471	708	1042	1792
	25	3	7	13	21	37	58	96	128	207	339	464	785	1181	1736	2986
	40	5	11	20	34	59	92	154	205	331	543	742	1257	1889	2778	4778
0,8	15	2	5	9	14	25	39	64	86	138	227	310	526	790	1162	1999
	25	4	8	14	24	41	64	107	143	231	379	517	876	1317	1937	3331
	40	6	12	23	38	65	103	172	229	369	606	828	1402	2108	3099	5330
1	15	2	5	9	16	27	43	71	95	153	250	342	580	872	1282	2205
	25	4	9	16	26	45	71	118	158	255	417	571	966	1453	2136	3674
	40	6	14	25	42	72	113	189	252	407	668	913	1546	2324	3418	5879
1,5	15	3	6	12	19	33	52	87	116	188	308	421	714	1073	1578	2714
	25	5	10	19	32	56	87	146	194	313	514	702	1190	1788	2629	4523
	40	8	17	31	51	89	140	233	310	501	822	1124	1903	2861	4207	7236
2	15	3	7	14	23	39	62	104	138	223	365	500	846	1272	1870	3217
	25	6	12	23	38	66	103	173	230	371	609	833	1410	2120	3117	5361
	40	9	20	37	61	105	165	276	368	594	975	1332	2256	3391	4987	8578
2,5	15	4	9	16	26	46	72	120	159	257	422	577	977	1469	2160	3715
	25	7	14	27	44	76	119	200	266	429	703	962	1629	2448	3600	6192
	40	11	23	42	70	122	191	319	425	686	1126	1539	2606	3917	5760	9907
3	15	5	10	18	30	52	81	136	181	292	478	654	1107	1664	2448	4210
	25	8	16	30	50	86	135	226	301	486	797	1090	1845	2774	4079	7016
	40	12	26	48	79	138	216	362	482	778	1275	1744	2953	4439	6527	11226
4	15	6	12	22	37	64	100	167	223	360	590	806	1365	2052	3018	5190
	25	9	20	37	61	106	167	279	371	599	983	1344	2275	3420	5029	8650
	40	15	32	59	98	170	267	446	594	959	1573	2150	3640	5472	8047	13840
5	15	7	14	26	44	76	119	199	264	427	700	957	1621	2436	3582	6162
	25	11	24	44	73	126	198	331	440	711	1167	1595	2701	4060	5971	10269
	40	18	38	70	116	202	317	530	705	1138	1867	2552	4322	6497	9553	16431
6	15	8	17	31	50	87	137	230	306	494	810	1107	1874	2818	4143	7127
	25	13	28	51	84	146	229	383	509	823	1350	1845	3124	4696	6906	11878
	40	20	44	81	135	233	366	612	815	1317	2159	2952	4998	7514	11049	19004
7	15	9	19	35	57	99	156	261	347	560	919	1256	2127	3197	4702	8087
	25	14	31	58	95	165	260	434	578	934	1531	2093	3545	5329	7836	13478
	40	23	50	92	153	265	416	695	925	1494	2450	3349	5672	8526	12538	21564
8	15	10	21	39	64	111	174	291	388	626	1027	1405	2378	3575	5258	9043
	25	16	35	65	107	185	291	486	646	1044	1712	2341	3964	5959	8763	15071
	40	26	56	103	171	296	465	777	1034	1671	2740	3745	6343	9534	14020	24114
9	15	11	23	43	71	123	193	322	429	693	1136	1553	2629	3952	5812	9996
	25	18	39	71	118	205	321	537	715	1154	1893	2588	4382	6587	9687	16661
	40	29	62	114	189	327	514	859	1143	1847	3029	4140	7011	10540	15499	26657
10	15	12	25	47	78	134	211	353	470	758	1244	1700	2880	4329	6365	10948
	25	20	42	78	129	224	352	588	783	1264	2073	2834	4799	7214	10609	18247
	40	31	68	125	207	358	563	941	1252	2023	3317	4535	7679	11543	16974	29195

p_m – gauge pressure. **u** – flow velocity.

MASS FLOW RATES OF SATURATED STEAM IN PIPES ACC. TO DIN 11866-C (ASME BPE)

p_m [bar]	u [m/s]	FLOW RATE [kg/h]								
		1/2"	3/4"	1"	11/2"	2"	21/2"	3"	4"	6"
0,4	15	3	9	17	42	78	125	184	328	746
	25	5	14	28	70	130	209	306	547	1244
	40	8	23	45	112	208	334	490	875	1990
0,6	15	3	10	19	47	88	142	208	371	845
	25	6	16	32	79	147	237	347	619	1408
	40	9	26	51	126	236	378	555	990	2252
0,8	15	4	11	21	53	99	158	232	414	942
	25	6	18	36	88	164	264	387	690	1570
	40	10	29	57	141	263	422	619	1105	2513
1	15	4	12	24	58	109	175	256	457	1039
	25	7	20	39	97	181	291	427	762	1732
	40	11	32	63	156	290	466	683	1218	2771
1,5	15	5	15	29	72	134	215	315	562	1279
	25	9	25	48	120	223	358	525	937	2132
	40	14	39	77	192	357	573	840	1500	3411
2	15	6	17	34	85	159	255	374	667	1516
	25	10	29	57	142	264	425	623	1111	2527
	40	17	47	92	227	423	679	996	1778	4043
2,5	15	7	20	40	98	183	294	432	770	1751
	25	12	34	66	164	305	490	719	1283	2919
	40	19	54	106	262	489	785	1151	2053	4670
3	15	8	23	45	111	208	333	489	873	1984
	25	14	38	75	186	346	556	815	1454	3307
	40	22	61	120	297	554	889	1304	2327	5292
4	15	10	28	55	137	256	411	603	1076	2447
	25	17	47	92	229	427	685	1005	1793	4078
	40	27	75	148	366	683	1096	1608	2869	6524
5	15	12	33	66	163	304	488	716	1277	2905
	25	20	56	110	272	506	813	1193	2128	4841
	40	32	89	175	435	810	1301	1909	3406	7746
6	15	14	39	76	189	351	564	828	1477	3359
	25	23	64	127	314	586	941	1380	2462	5599
	40	37	103	203	503	937	1505	2207	3939	8958
7	15	16	44	86	214	399	641	939	1676	3812
	25	26	73	144	357	665	1068	1565	2793	6353
	40	42	117	230	571	1063	1708	2505	4469	10165
8	15	17	49	97	239	446	716	1050	1874	4263
	25	29	82	161	399	743	1194	1751	3124	7105
	40	47	131	257	638	1189	1910	2801	4998	11367
9	15	19	54	107	265	493	792	1161	2072	4712
	25	32	90	178	441	822	1320	1935	3453	7854
	40	51	145	285	706	1315	2111	3096	5525	12566
10	15	21	59	117	290	540	867	1272	2269	5161
	25	35	99	195	483	900	1445	2119	3782	8601
	40	56	158	312	773	1440	2312	3391	6051	13762

p_m – gauge pressure. **u** – flow velocity.

PROPERTIES OF SATURATED STEAM

p_m [bar]	p [bar]	t_s [°C]	v [m^3/kg]	h_f [kcal/kg]	h_f [kJ/kg]	h_{fg} [kcal/kg]	h_{fg} [kJ/kg]	h_g [kcal/kg]	h_g [kJ/kg]
0	1,013	100,0	1,673	100,1	419,1	539,4	2258,4	639,5	2677,5
0,05	1,063	101,4	1,601	101,5	425,0	538,4	2254,2	639,9	2679,1
0,1	1,113	102,6	1,533	102,8	430,4	537,7	2251,2	640,5	2681,6
0,15	1,163	105,1	1,471	104,1	435,8	536,9	2247,9	641,0	2683,7
0,2	1,213	106,2	1,414	105,3	440,9	536,2	2245,0	641,5	2685,8
0,3	1,313	107,4	1,312	107,6	450,5	534,7	2238,7	642,3	2689,2
0,4	1,413	109,5	1,225	109,8	459,7	533,3	2232,8	643,1	2692,5
0,5	1,513	111,6	1,149	111,9	468,5	531,9	2227,0	643,8	2695,5
0,6	1,613	113,5	1,038	113,8	476,5	530,6	2221,5	644,4	2698,0
0,7	1,713	115,4	1,024	115,7	484,4	529,5	2216,9	645,2	2701,3
0,8	1,813	117,1	0,971	117,5	491,9	528,3	2211,9	645,8	2703,8
0,9	1,913	118,8	0,923	119,2	499,1	527,1	2206,9	646,3	2705,9
1	2,013	120,4	0,881	120,8	505,8	526,0	2202,3	646,8	2708,0
1,1	2,113	121,9	0,841	122,4	512,5	525,1	2198,5	647,5	2711,0
1,2	2,213	123,4	0,806	124,0	519,2	524,1	2194,3	648,1	2713,5
1,3	2,313	124,9	0,773	125,4	525,0	523,1	2190,1	648,5	2715,1
1,4	2,413	126,3	0,743	126,8	530,9	522,2	2186,3	649,0	2717,2
1,5	2,513	127,6	0,714	128,1	536,3	521,1	2181,7	649,2	2718,1
1,6	2,613	128,9	0,689	129,5	542,2	520,4	2178,8	649,9	2721,0
1,7	2,713	130,1	0,665	130,7	547,2	519,5	2175,0	650,2	2722,3
1,8	2,813	131,4	0,643	132,0	552,7	518,6	2171,3	650,6	2723,9
1,9	2,913	132,5	0,622	133,2	557,7	517,8	2167,9	651,0	2725,6
2	3,013	133,7	0,603	134,4	562,7	517,0	2164,6	651,4	2727,3
2,2	3,213	135,9	0,568	136,6	571,9	515,5	2158,3	652,1	2730,2
2,4	3,413	138,0	0,536	138,8	581,1	514,0	2152,0	652,8	2733,1
2,6	3,613	140,0	0,509	140,8	589,5	512,6	2146,2	653,4	2735,7
2,8	3,813	141,9	0,483	142,8	597,9	511,2	2140,3	654,0	2738,2
3	4,013	143,7	0,461	144,7	605,8	509,9	2134,8	654,6	2740,7
3,2	4,213	145,4	0,440	146,4	612,9	508,6	2129,4	655,0	2742,4
3,4	4,413	147,2	0,422	148,2	620,5	507,4	2124,4	655,6	2744,9
3,6	4,613	148,8	0,405	149,9	627,6	506,1	2118,9	656,0	2746,5
3,8	4,813	150,4	0,389	151,5	634,3	505,0	2114,3	656,5	2748,6
4	5,013	152,0	0,374	153,1	641,0	503,8	2109,3	656,9	2750,3
4,2	5,213	153,4	0,361	154,6	647,3	502,7	2104,7	657,3	2752,0
4,4	5,413	154,8	0,348	156,1	653,6	501,6	2100,1	657,7	2753,7
4,6	5,613	156,2	0,336	157,6	659,8	500,6	2095,9	658,2	2755,8
4,8	5,813	157,6	0,325	159,0	665,7	499,5	2091,3	658,5	2757,0
5	6,013	158,9	0,315	160,3	671,1	498,5	2087,1	658,8	2758,3
5,5	6,513	162,1	0,292	163,6	685,0	496,1	2077,1	659,7	2762,0
6	7,013	165,0	0,272	166,7	697,9	493,8	2067,4	660,5	2765,4
6,5	7,513	167,8	0,255	169,6	710,1	491,6	2058,2	661,2	2768,3
7	8,013	170,5	0,240	172,4	721,8	489,4	2049,0	661,8	2770,8
7,5	8,513	173,0	0,227	175,1	733,1	487,4	2040,6	662,5	2773,8
8	9,013	175,4	0,215	177,6	743,6	485,4	2032,3	663,0	2775,8
8,5	9,513	177,7	0,204	180,0	753,6	483,5	2024,3	663,5	2777,9
9	10,013	180,0	0,194	182,3	763,3	481,6	2016,4	663,9	2779,6
9,5	10,513	182,1	0,185	184,6	772,9	479,8	2008,8	664,4	2781,7
10	11,013	184,1	0,177	186,8	782,1	478,0	2001,3	664,8	2783,4
11	12,013	188,0	0,163	190,9	799,3	474,6	1987,1	665,5	2786,3
12	13,013	191,7	0,151	194,8	815,6	471,4	1973,7	666,2	2789,2
13	14,013	195,1	0,141	198,5	831,1	468,3	1960,7	666,8	2791,8
14	15,013	198,3	0,132	202,0	845,7	465,3	1948,1	667,3	2793,9
15	16,013	201,4	0,124	205,3	859,6	462,5	1936,4	667,8	2795,9
16	17,013	204,4	0,117	208,5	872,9	459,7	1924,7	668,2	2797,6
17	18,013	207,2	0,110	211,5	885,5	457,0	1913,4	668,5	2798,9
18	19,013	209,9	0,105	214,4	897,8	454,4	1902,5	668,8	2800,1
19	20,013	212,5	0,100	217,2	909,4	451,8	1891,6	669,0	2801,0
20	21,013	215,0	0,095	220,0	921,1	449,4	1881,5	669,4	2802,6
21	22,013	217,3	0,090	222,6	932,0	447,0	1871,5	669,6	2803,5
22	23,013	219,6	0,087	225,1	942,4	444,6	1861,5	669,7	2803,9
23	24,013	221,8	0,083	227,6	952,9	442,2	1851,4	669,8	2804,3
24	25,013	224,0	0,080	230,0	963,0	440,0	1842,2	670,0	2805,2
25	26,013	226,1	0,077	232,3	972,6	437,7	1832,6	670,0	2805,2

p_m – gauge pressure. **p** – absolute pressure. t_s – saturation temperature. **v** – specific volume. h_f – specific enthalpy of liquid. h_{fg} – specific enthalpy of vaporization (r). h_g – specific enthalpy of saturated steam.

PROPERTIES OF SUPERHEATED STEAM

p [bar]		TOTAL TEMPERATURE [°C]															
		200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500
1	v	2,172	2,266	2,359	2,453	2,546	2,639	2,732	2,824	2,917	3,010	3,102	3,195	3,288	3,380	3,473	3,565
	h	2875,4	2915,0	2954,6	2994,4	3034,4	3074,5	3114,8	3155,3	3196,0	3237,0	3278,2	3319,7	3361,4	3403,4	3445,6	3488,1
2	v	1,0804	1,1280	1,1753	1,2224	1,2693	1,3162	1,3629	1,4095	1,4561	1,5027	1,5492	1,5956	1,6421	1,6885	1,7349	1,7812
	h	2870,5	2910,8	2951,1	2991,4	3031,7	3072,1	3112,6	3153,3	3194,2	3235,4	3276,7	3318,3	3360,1	3402,1	3444,5	3487,0
3	v	0,7164	0,7486	0,7805	0,8123	0,8438	0,8753	0,9066	0,9379	0,9691	1,0003	1,0314	1,0625	1,0935	1,1245	1,1556	1,1865
	h	2865,5	2906,6	2947,5	2988,2	3028,9	3069,7	3110,5	3151,4	3192,4	3233,7	3275,2	3316,8	3358,8	3400,9	3443,3	3486,0
4	v	0,5343	0,5589	0,5831	0,6072	0,6311	0,6549	0,6785	0,7021	0,7256	0,7491	0,7725	0,7959	0,8192	0,8426	0,8659	0,8892
	h	2860,4	2902,3	2943,9	2985,1	3026,2	3067,2	3108,3	3149,4	3190,6	3232,1	3273,6	3315,4	3557,4	3399,7	3442,1	3484,9
5	v	0,4250	0,4450	0,4647	0,4841	0,5034	0,5226	0,5416	0,5606	0,5795	0,5984	0,6172	0,6359	0,6547	0,6734	0,6921	0,7108
	h	2855,1	2898,0	2940,1	2981,9	3023,4	3064,8	3106,1	3147,4	3188,8	3230,4	3272,1	3314,0	3356,1	3398,4	3441,0	3483,8
6	v	0,3520	0,3690	0,3857	0,4021	0,4183	0,4344	0,4504	0,4663	0,4821	0,4979	0,5136	0,5293	0,5450	0,5606	0,5762	0,5918
	h	2849,7	2893,5	2936,4	2978,7	3020,6	3062,3	3103,9	3145,4	3187,0	3228,7	3270,6	3312,6	3354,8	3397,2	3439,8	3482,7
7	v	0,2929	0,3147	0,3292	0,3435	0,3575	0,3714	0,3852	0,3989	0,4125	0,4261	0,4396	0,4531	0,4666	0,4801	0,4935	0,5069
	h	2844,2	2888,9	2932,5	2975,4	3017,7	3059,8	3101,6	3143,4	3185,2	3227,1	3269,0	3311,2	3353,4	3395,9	3439,6	3481,6
8	v	0,2608	0,2740	0,2869	0,1995	0,3119	0,3241	0,3363	0,3483	0,3603	0,3723	0,3842	0,3960	0,4078	0,4196	0,4314	0,4432
	h	2838,6	2884,2	2928,6	2972,1	3014,9	3057,3	3099,4	3141,4	3183,4	3225,4	3267,5	3309,7	3352,1	3394,7	3437,5	3480,5
9	v	0,2303	0,2423	0,2539	0,2653	0,2764	0,2874	0,2983	0,3090	0,3197	0,3304	0,3410	0,3516	0,3621	0,3726	0,3831	0,3936
	h	2832,7	2879,5	2924,6	2968,7	3012,0	3054,7	3097,1	3139,4	3181,6	3223,7	3266,0	3308,3	3350,8	3393,5	3436,3	3479,4
10	v	0,2059	0,2169	0,2276	0,2379	0,2480	0,2580	0,2678	0,2776	0,2873	0,2969	0,3065	0,3160	0,3256	0,3350	0,3445	0,3540
	h	2826,8	2874,6	2920,6	2965,2	3009,0	3052,1	3094,9	3137,4	3179,7	3222,0	3264,4	3306,9	3349,5	3392,2	3435,1	3478,3
11	v	0,1859	0,1961	0,2060	0,2155	0,2248	0,2339	0,2429	0,2518	0,2607	0,2695	0,2782	0,2870	0,2956	0,3043	0,3129	0,3215
	h	2820,7	2869,6	2916,4	2961,8	3006,0	3049,6	3092,6	3135,3	3177,9	3220,3	3262,9	3305,4	3348,1	3391,0	3434,0	3477,2
12	v	0,1692	0,1788	0,1879	0,1968	0,2054	0,2139	0,2222	0,2304	0,2386	0,2467	0,2547	0,2627	0,2707	0,2787	0,2866	0,2945
	h	2814,4	2864,5	2912,2	2958,2	3003,0	3046,9	3090,3	3133,2	3176,0	3218,7	3261,3	3304,0	3346,8	3389,7	3432,8	3476,1
13	v	0,1551	0,1641	0,1727	0,1810	0,1890	0,1969	0,2046	0,2123	0,2198	0,2273	0,2348	0,2422	0,2496	0,2570	0,2643	0,2716
	h	2808,0	2859,3	2908,0	2954,7	3000,0	3044,3	3088,0	3131,2	3174,1	3217,0	3259,2	3302,5	3345,4	3388,5	3431,6	3475,0
14	v	0,1429	0,1515	0,1596	0,1674	0,1749	0,1823	0,1896	0,1967	0,2038	0,2108	0,2177	0,2246	0,2315	0,2384	0,2452	0,2520
	h	2801,4	2854,0	2903,6	2951,0	2996,9	3041,6	3085,6	3129,1	3172,3	3215,3	3258,2	3301,1	3344,1	3387,2	3430,5	3473,9
15	v	0,1324	0,1406	0,1483	0,1556	0,1628	0,1697	0,1765	0,1832	0,1898	0,1964	0,2029	0,2094	0,2158	0,2223	0,2287	0,2350
	h	2794,7	2848,6	2899,2	2947,3	2993,7	3038,9	3083,3	3127,0	3170,4	3213,5	3256,6	3299,7	3342,8	3386,0	3429,3	3472,8
16	v	–	0,1310	0,1383	0,1453	0,1521	0,1587	0,1651	0,1714	0,1777	0,1838	0,1900	0,1961	0,2021	0,2082	0,2142	0,2202
	h	–	2843,1	2894,7	2943,6	2990,6	3036,2	3080,9	3124,9	3168,5	3211,8	3255,0	3298,2	3341,4	3384,7	3428,1	3471,7
18	v	–	0,1150	0,1217	0,1282	0,1343	0,1402	0,1460	0,1517	0,1573	0,1629	0,1684	0,1738	0,1793	0,1847	0,1900	0,1954
	h	–	2831,7	2885,4	2935,9	2984,1	3030,7	3076,1	3120,6	3164,7	3208,4	3251,9	3295,3	3338,7	3382,2	3425,8	3469,5
20	v	–	0,1021	0,1084	0,1144	0,1200	0,1255	0,1308	0,1360	0,1411	0,1461	0,1511	0,1561	0,1610	0,1659	0,1707	0,1756
	h	–	2819,9	2875,9	2928,1	2977,5	3025,0	3071,2	3116,3	3160,8	3204,9	3248,7	3292,4	3336,0	3379,7	3423,4	3467,3
22	v	–	0,09152	0,09752	0,10309	0,10837	0,11343	0,11833	0,12311	0,12780	0,13243	0,13700	0,14152	0,14602	0,15048	0,15492	0,15934
	h	–	2807,5	2866,0	2920,0	2970,8	3019,3	3066,2	3112,0	3156,9	3201,4	3245,5	3289,4	3333,3	3377,1	3421,1	3465,1
24	v	–	–	0,08839	0,09367	0,09863	0,10336	0,10793	0,11237	0,11672	0,12100	0,12522	0,12940	0,13355	0,13766	0,14175	0,14582
	h	–	–	2855,7	2911,6	2963,8	3013,4	3061,1	3107,5	3153,0	3197,8	3242,3	3386,5	3330,6	3374,6	3418,7	3462,9
26	v	–	–	0,08064	0,08567	0,09037	0,09483	0,09912	0,10328	0,10734	0,11133	0,11526	0,11914	0,12299	0,12681	0,13061	0,13438
	h	–	–	2845,2	2903,0	2956,7	3007,4	3056,0	3103,0	3149,0	3194,3	3239,0	3283,5	3327,8	3372,1	3416,3	3460,6
28	v	–	–	0,07397	0,07880	0,08328	0,08751	0,09156	0,09548	0,09929	0,10303	0,10671	0,11035	0,11395	0,11752	0,12106	0,12458
	h	–	–	2834,2	2894,2	2949,5	3001,3	3050,8	3098,5	3145,0	3190,7	3235,8	3280,5	3325,1	3369,5	3413,9	3458,4
30	v	–	–	0,06816	0,07283	0,07712	0,08116	0,08500	0,08871	0,09232	0,09584	0,09931	0,10273	0,10611	0,10946	0,11278	0,11608
	h	–	–	2822,9	2885,1	2942,0	2995,1	3045,4	3093,9	3140,9	3187,0	3232,5	3277,5	3322,3	3367,0	3411,6	3456,2
32	v	–	–	0,06305	0,06759	0,07173	0,07559	0,07926	0,08279	0,08621	0,08955	0,09283	0,09606	0,09925	0,10241	0,10554	0,10865
	h	–	–	2811,2	2875,8	2934,4	2988,7	3040,0	3089,2	3136,8	3183,4	3229,2	3274,5	3319,5	3364,4	3409,2	3454,0
34	v	–	–	–	0,06295	0,06695	0,07068	0,07419	0,07756	0,08082	0,08400	0,08711	0,09017	0,09319	0,09618	0,09915	0,10209
	h	–	–	–	2866,2	2926,6	2982,2	3034,5	3084,4	3132,7	3179,7	3225,9	3271,5	3316,8	3361,8	3406,8	3451,7
36	v	–	–	–	0,05880	0,06270	0,06630	0,06968	0,07291	0,07603	0,07906	0,08202	0,08494	0,08781	0,09065	0,09347	0,09626
	h	–	–	–	2856,3	2918,6	2975,6	3028,9	3079,6	3128,4	3175,9	3222,5	3268,4	3314,0	3359,2	3404,4	3449,5
38	v	–	–	–	0,05508	0,05888	0,06237	0,06564	0,06875	0,07174	0,07464	0,07747	0,08025	0,08300	0,08570	0,08838	0,09104
	h	–	–	–	2846,1	2910,4	2968,9	3023,3	3074,8	3124,2	3172,2	3219,1	3265,4	3311,2	3356,6	3402,0	3447,2
40	v	–	–	–	0,05172	0,05544	0,05883	0,06200	0,06499	0,06787	0,07066	0,07338	0,07604	0,07866	0,08125	0,08381	0,08634
	h	–	–	–	2835,6	2902,0	2962,0	3017,5	3069,8	3119,9	3168,4	3215,7	3262,3	3308,3	3354,0	3399,6	3445,0

p – absolute pressure, **v** – specific volume in m^3/kg, **h** – specific enthalpy of superheated steam (total heat) in kJ/kg

PROPERTIES OF SUPERHEATED STEAM (CONTINUED)

p [bar]		TOTAL TEMPERATURE [°C]												
		260	280	300	320	340	360	380	400	420	440	460	480	500
42	v	0,04865	0,05231	0,05562	0,05870	0,06160	0,06437	0,06706	0,06967	0,07222	0,07474	0,07722	0,07967	0,08209
	h	2824,8	2893,5	2955,0	3011,6	3064,8	3115,5	3164,5	3212,3	3259,2	3305,5	3351,4	3397,7	3442,7
44	v	0,04585	0,04946	0,05270	0,05569	0,05850	0,06119	0,06378	0,06630	0,06876	0,07117	0,07355	0,07590	0,07823
	h	2813,6	2884,7	2947,8	3005,7	3059,7	3111,1	3160,6	3208,8	3256,0	3302,6	3348,8	3394,7	3440,5
46	v	0,04328	0,04685	0,05003	0,05294	0,05568	0,05828	0,06079	0,06321	0,06559	0,06791	0,07020	0,07247	0,07470
	h	2802,0	2875,6	2940,5	2999,6	3054,6	3106,7	3156,7	3205,3	3252,9	3299,8	3346,2	3392,3	3438,2
48	v	–	0,04444	0,04757	0,05042	0,05309	0,05561	0,05604	0,06039	0,06268	0,06493	0,06714	0,06931	0,07147
	h	–	2866,4	2933,1	2993,4	3049,4	3102,2	3152,8	3201,8	3249,7	3296,9	3343,5	3389,8	3435,9
50	v	–	0,04222	0,04530	0,04810	0,05070	0,05316	0,05551	0,05779	0,06001	0,06218	0,06431	0,06642	0,06849
	h	–	2856,9	2925,5	2987,2	3044,1	3097,6	3148,8	3198,3	3246,6	3294,0	3340,9	3387,4	3433,7
55	v	–	0,03733	0,04034	0,04302	0,04549	0,04780	0,05001	0,05213	0,05419	0,05620	0,05817	0,06011	0,06202
	h	–	2831,8	2905,7	2971,0	3030,5	3085,9	3138,6	3189,3	3238,5	3286,7	3334,2	3381,2	3427,9
60	v	–	0,03317	0,03614	0,03874	0,04111	0,04330	0,04539	0,04738	0,04931	0,05118	0,05302	0,05482	0,05659
	h	–	2804,9	2885,0	2954,2	3016,5	3074,0	3128,3	3180,1	3230,3	3279,3	3327,4	3375,0	3422,2
70	v	–	–	0,02946	0,03198	0,03420	0,03623	0,03812	0,03992	0,04165	0,04331	0,04494	0,04653	0,04809
	h	–	–	2839,4	2918,3	2987,0	3049,1	3106,7	3161,2	3213,5	3264,2	3313,7	3362,4	3410,6
80	v	–	–	0,02426	0,02681	0,02896	0,03088	0,03265	0,03431	0,03589	0,03740	0,03887	0,04030	0,04170
	h	–	–	2786,8	2878,7	2955,3	3022,7	3084,2	3141,6	3196,2	3248,7	3299,7	3349,6	3398,8
90	v	–	–	–	0,02269	0,02484	0,02669	0,02837	0,02993	0,03140	0,03280	0,03415	0,03546	0,03674
	h	–	–	–	2834,3	2920,9	2994,8	3060,5	3121,2	3178,2	3232,7	3285,3	3336,5	3386,8
100	v	–	–	–	0,01926	0,02147	0,02331	0,02493	0,02641	0,02779	0,02911	0,03036	0,03158	0,03276
	h	–	–	–	2783,5	2883,4	2964,8	3035,7	3099,9	3159,7	3216,2	3270,5	3323,2	3374,6
110	v	–	–	–	0,01628	0,01864	0,02049	0,02208	0,02351	0,02483	0,02608	0,02726	0,02840	0,02950
	h	–	–	–	2723,5	2841,7	2932,8	3009,6	3077,8	3140,5	3199,4	3255,5	3309,6	3362,2
120	v	–	–	–	–	0,01619	0,01811	0,01969	0,02108	0,02236	0,02355	0,02467	0,02575	0,02679
	h	–	–	–	–	2794,7	2898,1	2982,0	3054,8	3120,7	3182,0	3240,0	3295,7	3349,6
130	v	–	–	–	–	0,01401	0,01604	0,01764	0,01902	0,02025	0,02140	0,02247	0,02350	0,02440
	h	–	–	–	–	2740,6	2860,2	2952,7	3030,7	3100,2	3164,1	3224,2	3281,6	3336,8
140	v	–	–	–	–	0,01200	0,01421	0,01586	0,01723	0,01844	0,01955	0,02059	0,02157	0,02251
	h	–	–	–	–	2675,7	2818,1	2921,4	3005,6	3079,0	3145,8	3208,1	3267,1	3323,8
150	v	–	–	–	–	–	0,01256	0,01428	0,01566	0,01686	0,01794	0,01895	0,01989	0,02080
	h	–	–	–	–	–	2770,8	2887,7	2979,1	3057,0	3126,9	3191,5	3252,4	3310,6
160	v	–	–	–	–	–	0,01104	0,01287	0,01427	0,01546	0,01653	0,01751	0,01842	0,01929
	h	–	–	–	–	–	2716,5	2851,1	2951,3	3034,2	3107,5	3174,5	3237,4	3297,1
180	v	–	–	–	–	–	0,008104	0,01040	0,01191	0,01311	0,01416	0,01510	0,01597	0,01678
	h	–	–	–	–	–	2569,1	2766,6	2890,3	2985,8	3066,9	3139,4	3206,5	3269,6
200	v	–	–	–	–	–	–	0,008246	0,009947	0,01120	0,01224	0,01315	0,01399	0,01477
	h	–	–	–	–	–	–	2660,2	2820,5	2932,9	3023,7	3102,7	3174,4	3241,1
250	v	–	–	–	–	–	–	–	0,006014	0,007580	0,008696	0,009609	0,01041	0,01113
	h	–	–	–	–	–	–	–	2582,0	2774,1	2901,7	3002,3	3088,5	3165,9

p – absolute pressure. **v** – specific volume in m^3/kg. **h** – specific enthalpy of superheated steam (total heat) in kJ/kg.

PROPERTIES OF WATER

t [°C]	ρ [kg/m³]	v [dm³/kg]	Ca [kcal/kg °C]	λ [kcal/m h °C]	t [°C]	ρ [kg/m³]	v [dm³/kg]	Ca [kcal/kg °C]	λ [kcal/m h °C]
0	999,87	1,00013	–	–	**70**	977,81	1,02269	1,0002	0,57
4	999,99	1,00001	–	–	**71**	977,23	1,0233	–	–
6	999,97	1,00003	–	–	**72**	976,66	1,0239	–	–
8	999,89	1,00011	–	–	**73**	976,07	1,02452	–	–
10	999,75	1,00025	1	0,493	**74**	975,48	1,02514	–	–
12	999,55	1,00045	–	–	**75**	974,89	1,02576	1,0013	0,574
14	999,3	1,0007	–	–	**76**	974,29	1,02639	–	–
16	999	1,001	–	–	**77**	973,68	1,02703	–	–
18	998,65	1,00135	–	–	**78**	973,07	1,02768	–	–
20	998,2	1,0018	1	0,51	**79**	972,45	1,02833	–	–
22	997,83	1,00217	–	–	**80**	971,83	1,02899	1,0025	0,577
24	997,37	1,00264	–	–	**81**	971,21	1,02964	–	–
26	996,87	1,00314	–	–	**82**	970,57	1,03032	–	–
28	996,33	1,00368	–	–	**83**	969,94	1,03099	–	–
30	995,76	1,00426	1	0,526	**84**	969,3	1,03167	–	–
32	995,12	1,0049	–	–	**85**	968,65	1,03236	1,0037	0,58
34	994,49	1,00554	–	–	**86**	968	1,03306	–	–
36	993,74	1,0063	–	–	**87**	967,34	1,03376	–	–
38	993,02	1,00703	–	–	**88**	966,68	1,03447	–	–
40	992,24	1,00782	1	0,539	**89**	966,01	1,03519	–	–
41	991,86	1,00821	–	–	**90**	965,34	1,0359	1,0049	0,582
42	991,47	1,0086	–	–	**91**	964,67	1,03662	–	–
43	991,07	1,00901	–	–	**92**	963,99	1,03736	–	–
44	990,66	1,00943	–	–	**93**	963,3	1,0381	–	–
45	990,25	1,00985	–	–	**94**	962,61	1,03884	–	–
46	989,82	1,01028	–	–	**95**	961,92	1,03959	1,006	0,584
47	989,4	1,01071	–	–	**96**	961,22	1,04034	–	–
48	988,96	1,01116	–	–	**97**	960,51	1,04111	–	–
49	988,52	1,01161	–	–	**98**	959,81	1,04187	–	–
50	988,07	1,01207	1	0,551	**99**	959,09	1,04266	–	–
51	987,62	1,01254	–	–	**100**	958,38	1,04343	1,0061	0,586
52	987,15	1,01302	–	–	**105**	–	–	1,0071	0,588
53	986,69	1,01349	–	–	**110**	951	1,0515	1,0084	0,589
54	986,21	1,01398	–	–	**115**	–	–	1,0098	0,59
55	985,73	1,01448	1	0,556	**120**	943,1	1,0603	1,0114	0,591
56	985,25	1,01497	–	–	**125**	–	–	1,0132	0,591
57	984,75	1,01549	–	–	**130**	934,8	1,0697	1,0152	0,592
58	984,25	1,016	–	–	**135**	–	–	1,0175	0,592
59	983,75	1,01652	–	–	**140**	926,1	1,0798	1,02	0,592
60	983,24	1,01705	1	0,561	**145**	–	–	1,0228	0,591
61	982,72	1,01758	–	–	**150**	916,9	1,0906	1,0258	0,591
62	982,2	1,01812	–	–	**160**	907,4	1,1021	1,0328	0,589
63	981,67	1,01867	–	–	**170**	897,3	1,1144	1,0411	0,586
64	981,13	1,01923	–	–	**180**	886,9	1,1275	1,0507	0,582
65	980,59	1,01979	1	0,566	**190**	876	1,1415	1,0619	0,578
66	980,05	1,02036	–	–	**200**	864,7	1,1565	1,0746	0,572
67	979,5	1,02093	–	–	**210**	–	–	1,089	0,565
68	978,94	1,02151	–	–	**220**	–	–	1,1052	0,558
69	978,38	1,0221	–	–	**230**	–	–	1,1234	0,55

t – temperature. **ρ** – density. **v** – specific volume. **Ca** – actual specific heat capacity at t. **λ** – thermal conductivity at t.
Remark: To convert specific volume from cubic decimeters per kilogram (dm^3/kg) to cubic meters per kilogragm (m^3/kg) devide values by 10^3.

PROPERTIES OF GASES

Gas	Formula	ρ [kg/m³]	t_f [°C]	t_e [°C]	ρ_e [kg/m³]	v [m³/kg]	Cp [kcal/kg h °C]	λ [kcal/m h °C]
Acetone	C_3H_6O	2,591	-94,8	56,2	749	0,386	0,296	0,0083
Acetylene	C_2H_2	1,162	-83,3	-83,6	613	0,861	0,386	0,0158
Ammonia	NH_3	0,76	-77,9	-33,4	680	1,316	0,491	0,0187
Argon	Ar	1,782	189,2	-185,7	1820	0,561	0,125	0,014
Benzole	C6H6	3,485	–	–	–	0,287	0,227	0,0076
Butane	C_4H_{10}	2,593	-138,4	-0,5	602	0,386	0,382	0,0119
Carbon dioxide	CO_2	1,964	-56,6	-78,2	1219	0,509	0,195	0,0122
Carbon disulphide	CS2	3,397	–	–	–	0,294	0,139	0,0058
Carbon monoxide	CO	1,25	-205	-191,6	801	0,8	0,248	0,0191
Chlorine	Cl_2	3,164	-101	-34,6	1512	0,316	0,116	0,0073
Diethyl ether	C4H10O	3,307	–	–	–	0,302	0,345	0,0108
Dry air	–	1,293	-213	-192,3	875	0,773	0,24	0,0209
Ethane	C_2H_6	1,342	-183,3	-88,6	546	0,745	0,394	0,0155
Ethyl alcohol	C_2H_6O	2,055	-114,2	78,3	747	0,487	0,364	0,0119
Ethylene	C_2H_4	1,251	-169,5	-103,7	568	0,799	0,349	0,0144
Helium	He	0,179	-272,2	-268,9	125	5,599	1,25	0,1233
Hydrochloric acid	HCl	1,627	-111,2	-84,8	1135	0,615	0,19	0,0072
Hydrogen	H_2	0,09	-259,1	-252,9	71	11,118	3,45	0,1508
Hydrogen sulphide	H_2S	1,52	-85,6	-60,4	957	0,658	0,237	0,0108
Methane	CH_4	0,716	-182,5	-161,5	415	1,397	0,517	0,0263
Methyl alcohol	CH_4O	1,429	-97,6	64,7	737	0,7	0,32	0,012
Nitrogen	N_2	1,25	-209,9	-195,8	810	0,8	0,247	0,0205
Oxygen	O_2	1,428	-218,4	-183	1131	0,7	0,218	0,0208
Propane	C_3H_8	1,968	-187,7	-42,1	585	0,508	0,37	0,013
Propylene	C_3H_6	1,877	-185	-47,8	686	0,533	0,34	–
Sulfur dioxide	SO2	2,858	–	–	–	0,35	0,14	0,0072

ρ – density. **t_f** – melting temperature. **t_e** – boiling temperature. **ρ_e** – density of liquid at t_e. **v** – specific volume. **Cp** – specific heat capacity at constant pressure. **λ** – thermal conductivity of substance.
Remark: Values are referenced to 0 °C and 1013,25 mbar.

DENSITY OF DRY AIR [kg/m³]

t [°C]	GAUGE PRESSURE [bar]										
	0	0,5	1	1,5	2	2,5	3	3,5	4	4,5	5
0	1,293	1,931	2,569	3,207	3,845	4,483	5,121	5,759	6,397	7,036	7,674
10	1,247	1,863	2,478	3,094	3,709	4,325	4,941	5,556	6,172	6,787	7,403
20	1,205	1,799	2,394	2,988	3,583	4,177	4,772	5,367	5,961	6,556	7,150
30	1,165	1,740	2,315	2,890	3,465	4,040	4,615	5,189	5,764	6,339	6,914
40	1,128	1,684	2,241	2,798	3,354	3,911	4,467	5,024	5,580	6,137	6,693
50	1,093	1,632	2,172	2,711	3,250	3,790	4,329	4,868	5,408	5,947	6,486
60	1,060	1,583	2,106	2,630	3,153	3,676	4,199	4,722	5,245	5,768	6,292
70	1,029	1,537	2,045	2,553	3,061	3,569	4,077	4,585	5,092	5,600	6,108
80	1,000	1,494	1,987	2,481	2,974	3,468	3,961	4,455	4,948	5,442	5,935
90	0,973	1,453	1,932	2,412	2,892	3,372	3,852	4,332	4,812	5,292	5,772
100	0,947	1,414	1,881	2,348	2,815	3,282	3,749	4,216	4,683	5,150	5,617
110	0,922	1,377	1,832	2,286	2,741	3,196	3,651	4,106	4,561	5,016	5,471
120	0,898	1,342	1,785	2,228	2,672	3,115	3,558	4,002	4,445	4,888	5,331
130	0,876	1,308	1,741	2,173	2,605	3,038	3,470	3,902	4,335	4,767	5,199
140	0,855	1,277	1,699	2,120	2,542	2,964	3,386	3,808	4,230	4,651	5,073
150	0,835	1,247	1,658	2,070	2,482	2,894	3,306	3,718	4,130	4,542	4,953
160	0,815	1,218	1,620	2,023	2,425	2,827	3,230	3,632	4,034	4,437	4,839
170	0,797	1,190	1,584	1,977	2,370	2,763	3,157	3,550	3,943	4,337	4,730
180	0,779	1,164	1,549	1,933	2,318	2,702	3,087	3,472	3,856	4,241	4,626
190	0,763	1,139	1,515	1,891	2,268	2,644	3,020	3,397	3,773	4,149	4,526
200	0,746	1,115	1,483	1,852	2,220	2,588	2,957	3,325	3,693	4,062	4,430
220	0,716	1,070	1,423	1,776	2,130	2,483	2,837	3,190	3,543	3,897	4,250
240	0,688	1,028	1,368	1,707	2,047	2,386	2,726	3,066	3,405	3,745	4,085
260	0,662	0,989	1,316	1,643	1,970	2,297	2,624	2,951	3,278	3,605	3,931
280	0,639	0,954	1,269	1,584	1,899	2,214	2,529	2,844	3,159	3,474	3,789
300	0,616	0,920	1,224	1,528	1,833	2,137	2,441	2,745	3,049	3,353	3,657

t [°C]	GAUGE PRESSURE [bar]										
	6	7	8	9	10	12	14	16	18	20	25
0	8,950	10,226	11,502	12,778	14,054	16,606	19,159	21,711	24,263	26,815	33,196
10	8,634	9,865	11,096	12,327	13,558	16,020	18,482	20,944	23,406	25,868	32,024
20	8,339	9,528	10,717	11,906	13,095	15,473	17,852	20,230	22,608	24,986	30,931
30	8,064	9,214	10,364	11,514	12,663	14,963	17,263	19,562	21,862	24,162	29,911
40	7,807	8,920	10,033	11,146	12,259	14,485	16,711	18,938	21,164	23,390	28,956
50	7,565	8,644	9,722	10,801	11,880	14,037	16,194	18,352	20,509	22,666	28,060
60	7,338	8,384	9,430	10,470	11,523	13,616	5,708	17,800	19,893	21,986	27,217
70	7,124	8,140	9,156	10,171	11,187	13,219	15,250	17,280	19,314	21,345	26,424
80	6,922	7,909	8,896	9,883	10,870	12,845	14,819	16,793	18,767	20,741	25,676
90	6,732	7,692	8,651	9,611	10,571	12,491	14,411	16,330	18,250	20,170	24,969
100	6,551	7,485	8,420	9,354	10,288	12,156	14,024	15,893	17,761	19,629	24,300
110	6,380	7,290	8,200	9,110	10,019	11,839	13,658	15,478	17,297	19,117	23,666
120	6,218	7,105	7,991	8,878	9,764	11,538	13,311	15,084	16,857	18,631	23,064
130	6,064	6,928	7,793	8,658	9,522	11,252	12,981	14,710	16,439	18,168	22,492
140	5,917	6,761	7,604	8,448	9,292	10,979	12,667	14,354	16,041	17,729	21,947
150	5,777	6,601	7,425	8,248	9,072	10,720	12,367	14,015	15,662	17,310	21,429
160	5,644	6,449	7,253	8,058	8,863	10,472	12,082	13,691	15,301	16,910	20,934
170	5,516	6,303	7,090	7,876	8,663	10,236	11,809	13,382	14,955	16,529	20,461
180	5,395	6,164	6,933	7,702	8,472	10,010	11,548	13,087	14,625	16,164	20,010
190	5,278	6,031	6,783	7,536	8,289	9,794	11,299	12,804	14,310	15,815	19,578
200	5,167	5,903	6,640	7,377	8,114	9,587	11,060	12,534	14,007	15,481	19,164
220	4,957	5,664	6,371	7,078	7,784	9,198	10,612	12,025	13,439	14,853	18,387
240	4,764	5,443	6,123	6,802	7,481	8,840	10,198	11,557	12,915	14,274	17,670
260	4,585	5,443	5,893	6,547	7,200	8,508	9,816	11,123	12,431	13,738	17,007
280	4,419	5,050	5,680	6,310	6,940	8,200	9,461	10,721	11,981	13,242	16,392
300	4,265	4,873	5,482	6,090	6,698	7,914	9,131	10,347	11,563	12,780	15,820

t – temperature

PROPERTIES OF LIQUIDS

LIQUID	t_{ref} [ºC]	ρ [kg/m³]	Ca [kcal/kg ºC]	λ [kcal/m h ºC]
Acetic acid	25	1049	0,51	0,166
Acetone	20	790	0,515	0,139
Ammonia solution (25%)	20	771	–	0,425
Apple juice	20	1356	0,446	–
Argon	-186	1430	–	–
Automobile oils	15	880 - 940	–	0,125
Beer	10	1010	–	–
Benzene	20	870	0,43	0,138
Benzole	20	879	0,43	0,132
	80	–	0,44	0,13
Butane	25	599	0,55	–
Butter	20	911	0,56 - 0,69	–
Carbon tetrachloride	25	1584	0,207	0,089
Carbon disulphide	20	1266	0,241	0,138
Chloride	25	1560	–	–
Chloroform	20	1489	0,251	0,11
Citric acid	25	1660	–	–
Crude oil	20	900	–	0,113
Diesel	20	800	–	–
Ethane (liquid)	-89	570	–	–
Ethyl acetate	20	901	–	–
Ethyl alcohol (95% vol.)	0	789	0,547	0,166
	40	-	0,648	0,144
Fuel oil	20	840 - 920	0,471	0,103
Gasoline	20	803	0,53	0,129
Glycerine	10	1260	0,576	0,25
Glycerol	25	1126	–	–
Helium	-271	147	–	–
Honey	20	1420	0,54 - 0,6	0,00648
Hydrazine	25	795	–	–
Hydrochloric acid (25%)	20	1150	0,75	0,404
Kerosene	16	820,1	0,48	0,125

LIQUID	t_{ref} [ºC]	ρ [kg/m³]	Ca [kcal/kg ºC]	λ [kcal/m h ºC]
Methane	-90	162	–	–
Methanol	20	791	0,33	–
Methyl alcohol (95% vol.)	20	792	0,596	0,174
Milk, cow, heavy cream	20	994	0,94	0,434
Naphta	15	665	0,92	–
Nitric acid	20	1520	0,411	0,456
Nitrogen	-201	808	–	–
Oil, coconut	20	924	–	–
Oil, corn	20	922	–	–
Oil, castor	25	956,1	0,43	0,155
Oil, cotton seed	15	926	–	–
Oil, olive	10	918	0,47	0,146
Oil, palm	20	915	–	–
Oil, soya	20	927	0,47	–
Oil, sunflower	20	920	–	–
Oil, peanut	20	914	–	–
Oil, whale	15	925	–	–
Oxygen (liquid)	-186	1155	–	–
Petrol	30	680 - 710	0,45	0,112
Phenol	25	1072	0,34	0,163
Propanol	25	804	–	–
Propyl alcohol	25	800	0,57	0,138
Sea water	25	1025	0,94	–
Sodium carbonate	20	2530	0,86	0,516
Sodium Hydroxide (caustic soda)	15	1250	0,77	0,37
Sulphuric acid	12	1853	0,33	0,28
Sulphurous acid (96%)	20	1840	0,351	0,43
Water	8	999,88	1	0,485
	41	991,66	1	0,538
	72	976,36	1	0,58
	100	958,38	1,006	0,586
	200	0 - 200	1,037	0,572

t_{ref} – reference temperature. **ρ** – density at 20 ºC. **v** – specific volume. **Ca** – actual specific heat capacity at t_{ref}. **λ** – thermal conductivity at t_{ref}.

PROPERTIES OF THE ELEMENTS

ELEMENT	SYMBOL	ATOMIC NUMBER	MASS NUMBER *	t_f [°C]	t_e [°C]
Actinium	Ac	89	(227)	1600	–
Aluminum	Al	13	27	659.7	2057
Americum	Am	95	(243)	–	–
Antimony	Sb	51	121	630.5	1380
Argon	Ar	18	40	-189.2	-185.7
Arsenic	As	33	75	–	–
Astatine	At	85	(210)	–	–
Barium	Ba	56	138	850	1140
Berkelium	Bk	97	(247)	–	–
Beryllium	Be	4	9	1278±5	2970
Bismuth	Bi	83	209	271.3	1560±5
Boron	B	5	11	2300	2550
Bromine	Br	35	79	-7.2	58.78
Cadmium	Cd	48	114	320.9	767±2
Calcium	Ca	20	40	842±8	1240
Californium	Cf	98	(249)	–	–
Carbon	C	6	12	>3550	4200
Cerium	Ce	58	140	804	1400
Cesium	Cs	55	133	-103±5	670
Chlorine	Cl	17	35	28.5	-34.6
Chromium	Cr	24	52	1890	2480
Cobalt	Co	27	59	1495	2900
Copper	Cu	29	63	1083	2336
Curium	Cm	96	(248)	–	–
Dysprosium	Dy	66	164	–	–
Einsteinium	Es	99	(254)	–	–
Erbium	Er	68	166	–	–
Europium	Eu	63	153	1150±50	–
Fermium	Fm	100	(252)	–	–
Fluourine	F	9	19	-223	-188
Francium	Fr	87	(223)	–	–
Gadolinium	Gd	64	158	–	–
Gallium	Ga	31	69	29.78	1983
Germanium	Ge	32	74	958.5	2700
Gold	Au	79	197	1063	2600
Hafnium	hf	72	180	–	–
Helium	he	2	4	-272	-268.9
Holmium	ho	67	165	–	–
Hydrogen	h	1	1	-259.14	-252.8
Indium	In	49	115	156.4	2000±10
Iodine	I	53	127	113.7	184.35
Iridium	Ir	77	193	2454	>4800
Iron	Fe	26	56	1535	3000
Krypton	Kr	36	84	-156.6	-152.9
Lanthanum	La	57	139	826	–
Lawrencium	Lw	103	(257)	–	–
Lead	Pb	82	208	327.43	1620
Lithium	Li	3	7	186	1336±5
Lutetium	Lu	71	175	–	–
Magnesium	Mg	12	24	651	1107
Manganese	Mn	25	55	1260	1900
–	–	–	–	–	–

ELEMENT	SYMBOL	ATOMIC NUMBER	MASS NUMBER *	t_f [°C]	t_e [°C]
Mendelevium	Mv	101	(256)	–	–
Mercury	hg	80	202	-38.87	356.58
Molybdenum	Mo	42	98	2620±10	4800
Neodymium	Nd	60	142	840	–
Neon	Ne	10	20	-248.67	-245.9
Neptunium	Np	93	(237)	–	–
Nickel	Ni	28	58	1455	2900
Niobium	Nb	41	93	2500±50	3700
Nitrogen	N	7	14	-209.86	-195.8
Nobelium	No	102	(253)	–	–
Osmium	Os	76	192	2700	>5300
Oxygen	O	8	16	-218.4	-182.86
Palladium	Pd	46	106	1549.4	2000
Phosphorus	P	15	31	–	–
Platinum	Pt	78	195	1773.5	4300
Plutonium	Pu	94	(242)	–	–
Polonium	Po	84	(209)	–	–
Potassium	K	19	39	53.3	760
Praseody-mium	Pr	59	141	940	–
Promethium	Pm	61	(145)	–	–
Protactinium	Pa	91	(231)	–	–
Radium	Ra	88	(226)	700	–
Radon	Rn	86	(222)	-71	1140
Rhenium	Re	75	187	3167±60	-61.8
Rhodium	Rh	45	103	1966±3	>2500
Rubidium	Rb	37	85	38.5	700
Ruthenium	Ru	44	102	2450	2700
Samarium	Sm	62	152	>1300	–
Scandium	Sc	21	45	1200	2400
Selenium	Se	34	80	217	688
Silicon	Si	14	28	1420	2355
Silver	Ag	47	107	960.8	1950
Sodium	Na	11	23	97.5	880
Strontium	Sr	38	88	800	1150
Sulfur	S	16	32	–	–
Tantalum	Ta	73	180	2996±50	–
Technetium	Tc	43	(99)	–	–
Tellurium	Te	52	130	452	1390
Terbium	Tb	65	159	327±5	–
Thallium	Tl	81	205	302	1457±10
Thorium	Th	90	232	1845	4500
Thulium	Tm	69	169	–	–
Tin	Sn	50	120	231.89	2270
Titanium	Ti	22	48	1800	>3000
Tungsten	W	74	184	3370	5900
Uranium	U	92	238	1133	–
Vanadium	V	23	51	1710	3000
Xenon	Xe	54	132	-112	-107.1
Ytterbium	Yb	70	174	1800	–
Yttrium	Y	39	89	1490	2500
Zinc	Zn	30	64	419.47	907
Zirconium	Zr	40	90	1857	>2900

t_f – melting temperature. t_e – boiling temperature.

* From the most common and stable isotop. Values in parentheses refer to the isotope with the longest half-life for those elements having an unstable

PROPERTIES AND COMPATIBILITY OF ELASTOMERS

ELASTOMER	NITRILE (NBR)	ETHYLENE-PROPYLENE (EPDM)	NEOPRENE (CR)	SILICONE (VMQ)	POLY-URETHANE (EU)	FLUORO-ELASTOMER (FPM)	PETROFLUORO ELASTOMER (FFKM)
Maximum temperature *	110 ºC	130 ºC	120 ºC	230 ºC	80 ºC	210 ºC	326 ºC
Minimum temperature *	-35 ºC	-55 ºC	-45 ºC	-55 ºC	-30 ºC	-15 ºC	-58 ºC
Compression set	B	C	C	A	E	C	B
Wear resistance	C	C	C	E	A	C	C
Gas permeability	C	C	C	E	B	C	C
Weather resistance	E	A	C	A	A	A	A
Ozone resistance	E	A	A	A	A	A	A
Air, Ambient	A	A	A	A	A	A	A
Air, Hot (90 ºC)	U	A	C	A	U	A	A
Alcohol	B	A	B	B	U	E	A
Aldehydes	U	B	U	C	U	U	B
Aliphatic Hydrocarbons	C	U	E	E	C	A	A
Alkalis	B	A	C	B	B	C	A
Amines	B	B	B	E	U	U	B
Animal Fats	B	U	C	C	C	B	A
Aromatic Hydrocarbons	D	U	D	U	D	A	A
Esters, Alkyl Phosphate	U	B	U	C	U	U	A
Esters, Aryl Phosphate	U	A	U	C	U	A	A
Esters, Silicate	C	U	E	U	U	A	A
Ethers	U	E	U	U	E	U	A
Halogenated hydrocarbons	U	U	U	U	E	A	A
Inorganic Acids	E	C	B	B	U	A	A
Ketones	U	A	A	C	U	U	B
Lacquer, Solvents	B	E	E	E	E	E	A
L.P. Gases & Fuel oils	A	E	A	C	B	A	A
Mineral Oil, high analine fats	B	U	C	C	A	A	A
Mineral Oil, low analine fats	B	U	U	E	B	A	A
Organic Acids	C	C	C	B	U	C	A
Petroleum	A	E	A	E	E	A	A
Silicone Oils	A	A1	A	E	A	A	A
Vegetable Oils	A	U	C	B	E	A	A
Water / Steam	C	A	E	E	U	B2	C2

* Reference values. Actual values are strongly dependent on the specific compound and operating medium.

A – good. **B** – satisfactory. **C** – fair. **D** – Doubtful. **E** – Poor. **U** – Unsatisfactory. **1** – EPDM may shrink. **2** – Depending on compound.
Remarks: This information is intended only as a guideline. Detailed chemical compatibility lists should be consulted.
Whenever possible the fluid compatibility of the O-ring compound should be rated “A". For a static seal application a rating “B" is usually acceptable, but it should be tested.
Where a “B" rated compound must be used, do not expect to re-use it after disassembly. It may have swollen enough that it cannot be reassembled.
When a compound rated “C" is to be tried, be sure it is first tested under the full range of operating conditions.
Common trade names: NBR - Perbunan N®, Buna N®. FPM - Viton®, Fluorel®. FFKM - Kalrez®, Chemraz®, Parafluor®.

CONVERSION FACTORS

MASS					
UNIT	**kg**	**lb**	**oz**	**ton (US)**	**ton (UK)**
kg	1	2,2046	35,274	$1{,}1\times10^{-3}$	$9{,}8\times10^{-4}$
lb	0,4536	1	16	5×10^{-4}	$4{,}5\times10^{-4}$
oz	0,0283	0,0625	1	$3{,}125\times10^{-5}$	$2{,}79\times10^{-5}$
ton (US)	907,19	2 000	32 000	1	0,8929
ton (UK)	1 016,05	2 240	35 840	1,12	1

LENGTH					
UNIT	**m**	**in**	**ft**	**yd**	**mi**
m	1	39,37	3,2808	1,0936	0,00062
in	0,0254	1	0,0833	0,0278	$1{,}578\times10^{-5}$
ft	0,3048	12	1	0,3333	0,00019
yd	0,914	36	3	1	0,00057
mi	1 609	63 360	5 280	1 760	1

AREA					
UNIT	**m^2**	**in^2**	**ft^2**	**yd^2**	**ac**
m^2	1	1 550	10,764	10,764	$2{,}47\times10^{-4}$
in^2	$6{,}452\times10^{-4}$	1	$6{,}944\times10^{-3}$	$7{,}7\times10^{-4}$	1,594
ft^2	$9{,}29\times10^{-2}$	144	1	0,111	$2{,}296\times10^{-5}$
yd^2	0,836	1 296	9	1	2×10^{-4}
ac	4 046,86	6 272 640	43 560	4 840	1

VOLUME					
UNIT	**dm^3**	**in^3**	**ft^3**	**gal (US)**	**gal (UK)**
dm^3	1	61,024	0,353	0,264	0,22
in^3	0,016	1	$5{,}787\times10^{-4}$	0,0043	$3{,}605\times10^{-3}$
ft^3	28,317	1728	1	7,48	6,229
gal (US)	3,785	231	0,13	1	0,83
gal (UK)	4,546	277,419	0,161	1,2	1

VOLUMETRIC FLOW RATE					
UNIT	**m^3/h**	**l/h**	**cfm**	**gpm (US)**	**gpm (UK)**
m^3/h	1	1000	0,589	4,403	3,67
l/h	1×10^{-3}	1	$5{,}886\times10^{-4}$	$4{,}4\times10^{-3}$	$3{,}7\times10^{-3}$
cfm	1,699	1 699	1	7,481	6,229
gpm (US)	0,227	227,125	0,161	1	0,833
gpm (UK)	0,272	270,27	0,161	1,2	1

ENERGY					
UNIT	**J**	**kcal**	**Wh**	**Btu**	**kgf m**
J	1	$0{,}239\times10^{-3}$	$0{,}278\times10^{-3}$	$0{,}948\times10^{-3}$	0,102
kcal	4 186,8	1	1,162	3,966	426,92
Wh	3600	0,861	1	3,413	367,08
Btu	1055,06	0,252	0,293	1	107,58
kgf m	9,807	$2{,}342\times10^{-3}$	$2{,}724\times10^{-3}$	$9{,}295\times10^{-3}$	1

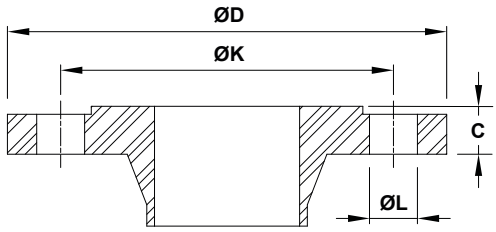
POWER					
UNIT	**W**	**kcal/h**	**Btu/h**	**hp**	**ft lb/s**
W	1	0,8598	3,412	$1{,}34\times10^{-3}$	0,7376
kcal/h	1,163	1	3,968	$1{,}6\times10^{-3}$	0,858
Btu/h	0,293	0,252	1	$3{,}93\times10^{-4}$	0,216
hp	745,7	641,19	2 545	1	550
ft lb/s	1,356	1,166	4,63	$1{,}818\times10^{-3}$	1

PRESSURE					
UNIT	**Pa**	**bar**	**atm**	**psi**	**mm Hg**
Pa	1	1×10^{-5}	$9{,}869\times10^{-6}$	$1{,}45\times10^{-4}$	$7{,}5\times10^{-3}$
bar	1×10^{5}	1	0,987	14,504	750,06
atm	101 325	1,01325	1	14,696	760
psi	6 894,76	0,06894	0,068	1	51,715
mm Hg	133,32	$1{,}333\times10^{-3}$	$1{,}316\times10^{-3}$	0,0193	1

VELOCITY				
UNIT	**m/s**	**ft/s**	**km/h**	**mph**
m/s	1	3,281	3,6	2,237
ft/s	0,305	1	1,097	0,682
km/h	0,278	0,911	1	0,621
mph	0,447	1,467	1,609	1

WATER HARDNESS					
UNIT	**mg/L**	**ppm**	**gpg**	**°fH**	**°dH**
mg/L	1	1	0,058	0,1	0,056
ppm	1	1	0,058	0,1	0,056
gpg	17,1	17,1	1	1,71	0,958
°fH	10	10	0,583	1	0,56
°dH	17,8	17,8	1,04	1,79	1

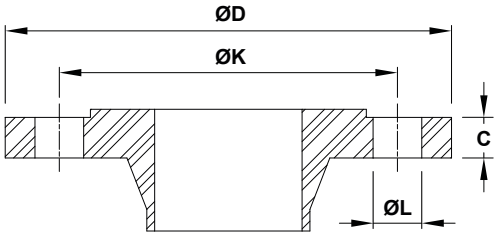
EN 1092-1 FLANGE DIMENSIONS



PN 16						
DN	ØD	ØK	C	ØL	BOLTING	
					Nº	SIZE
10	90	60	16	14	4	M12
15	95	65	16	14	4	M12
20	105	75	18	14	4	M12
25	115	85	18	14	4	M12
32	140	100	18	18	4	M16
40	150	110	18	18	4	M16
50	165	125	18	18	4	M16
65	185	145	18	18	8	M16
80	200	160	20	18	8	M16
100	220	180	20	18	8	M16
125	250	210	22	18	8	M16
150	285	240	22	22	8	M20
200	340	295	24	22	12	M20
250	405	355	26	26	12	M24
300	460	410	28	26	12	M24
350	520	470	30	26	16	M24
400	580	525	32	30	16	M27

PN 40						
DN	ØD	ØK	C	ØL	BOLTING	
					Nº	SIZE
10	90	60	16	14	4	M12
15	95	65	16	14	4	M12
20	105	75	18	14	4	M12
25	115	85	18	14	4	M12
32	140	100	18	18	4	M16
40	150	110	18	18	4	M16
50	165	125	20	18	4	M16
65	185	145	22	18	8	M16
80	200	160	24	18	8	M16
100	235	190	24	22	8	M20
125	270	220	26	26	8	M24
150	300	250	28	26	8	M24
200	375	320	34	30	12	M27
250	450	385	38	33	12	M30
300	515	450	42	33	16	M30
350	580	510	46	36	16	M33
400	660	585	50	39	16	M36

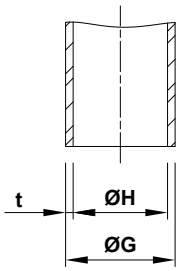
ASME B16.5 FLANGE DIMENSIONS



CLASS 150						
NPS	ØD	ØK	C	ØL	BOLTING	
					Nº	SIZE
1/2"	90	60,3	9,6	15,88	4	1/2"
3/4"	100	69,9	11,2	15,88	4	1/2"
1"	110	79,4	12,7	15,88	4	1/2"
1 1/4"	115	88,9	14,3	15,88	4	1/2"
1 1/2"	125	98,4	15,9	15,88	4	1/2"
2"	150	120,7	17,5	19,05	4	5/8"
2 1/2"	180	139,7	20,7	19,05	4	5/8"
3"	190	152,4	22,3	19,05	4	5/8"
3 1/2"	215	177,8	22,3	19,05	8	5/8"
4"	230	190,5	22,3	19,05	8	5/8"
5"	255	215,9	22,3	22,23	8	3/4"
6"	280	241,3	23,9	22,23	8	3/4"
8"	345	298,5	27	22,23	8	3/4"
10"	405	362	28,6	25,40	12	7/8"
12"	485	431,8	30,2	25,40	12	7/8"
14"	535	476,3	33,4	28,58	12	1"
16"	595	539,8	35	28,58	16	1"

CLASS 300						
NPS	ØD	ØK	C	ØL	BOLTING	
					Nº	SIZE
1/2"	95	66,7	12,7	15,88	4	1/2"
3/4"	115	82,6	14,3	19,05	4	5/8"
1"	125	88,9	15,9	19,05	4	5/8"
1 1/4"	135	98,4	17,5	19,05	4	5/8"
11/2"	155	114,3	19,1	22,23	4	3/4"
2"	165	127	20,7	19,05	8	5/8"
2 1/2"	190	149,2	23,9	22,23	8	3/4"
3"	210	168,3	27	22,23	8	3/4"
3 1/2"	230	184,2	28,6	22,23	8	3/4"
4"	255	200	30,2	22,23	8	3/4"
5"	280	235	33,4	22,23	8	3/4"
6"	320	269,9	35	22,23	12	3/4"
8"	380	330,2	39,7	25,4	12	7/8"
10"	445	387,4	46,1	28,58	16	1"
12"	520	450,8	49,3	31,75	16	1 1/8"
14"	585	514,4	52,4	31,75	20	1 1/8"
16"	650	571,5	55,6	34,93	20	1 1/4"

DIN 11866 SANITARY TUBE DIMENSIONS



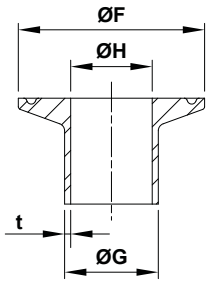
DIN 11866

ASEPTIC STAINLESS STEEL TUBES ACC. TO DIN 11866-A															
DN	**6**	**8**	**10**	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**	**200**
ØG	8	10	13	19	23	29	35	41	53	70	85	104	129	154	204
ØH	6	8	10	16	20	26	32	38	50	66	81	100	125	150	200
t	1	1	1,5	1,5	1,5	1,5	1,5	1,5	1,5	2	2	2	2	2	2

ASEPTIC STAINLESS STEEL TUBES ACC. TO DIN 11866-B															
OD	**10,2**	**13,5**	**17,2**	**21,3**	**26,9**	**33,7**	**42,4**	**48,3**	**60,3**	**76,1**	**88,9**	**114,3**	**139,7**	**168,3**	**219,1**
ØG	10,2	13,5	17,2	21,3	26,9	33,7	42,4	48,3	60,3	76,1	88,9	114,3	139,7	168,3	219,1
ØH	7	10,3	14	18,1	23,7	29,7	38,4	44,3	56,3	72,1	84,3	109,7	134,5	163,1	213,9
t	1,6	1,6	1,6	1,6	1,6	2	2	2	2	2	2,3	2,3	2,6	2,6	2,6

ASEPTIC STAINLESS STEEL TUBES ACC. TO DIN 11866-C											
NPS	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**11/2"**	**2"**	**21/2"**	**3"**	**4"**	**6"**
ØG	6,35	9,53	12,7	19,05	25,4	38,1	50,8	63,5	76,2	101,6	152,4
ØH	4,57	7,75	9,4	15,75	22,1	34,8	47,5	60,2	72,9	97,38	146,86
t	0,89	0,89	1,65	1,65	1,65	1,65	1,65	1,65	1,65	2,11	2,77

DIN 32676 SANITARY FERRULE DIMENSIONS



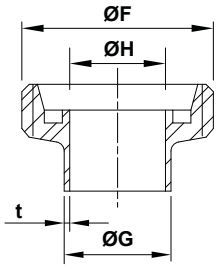
DIN 32676

ASEPTIC FERRULES ACC. TO DIN 32676-A FOR TUBES ACC. TO DIN 11866-A															
DN	**6**	**8**	**10**	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**	**200**
ØF	25	25	34	34	34	50,5	50,5	50,5	64	91	106	119	155	183	233,5
ØG	8	10	13	19	23	29	35	41	53	70	85	104	129	154	204
ØH	6	8	10	16	20	26	32	38	50	66	81	100	125	150	200
t	1	1	1,5	1,5	1,5	1,5	1,5	1,5	1,5	2	2	2	2	2	2

ASEPTIC FERRULES ACC. TO DIN 32676-B FOR TUBES ACC. TO DIN 11866-B															
DN	**6**	**8**	**10**	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**	**200**
ØF	25	25	25	50,5	50,5	50,5	64	64	77,5	91	106	130	155	183	233,5
ØG	10,2	13,5	17,2	21,3	26,9	33,7	42,4	48,3	60,3	76,1	88,9	114,3	139,7	168,3	219,1
ØH	7	10,3	14	18,1	23,7	29,7	38,4	44,3	56,3	72,1	84,3	109,7	134,5	163,1	213,9
t	1,6	1,6	1,6	1,6	1,6	2	2	2	2	2	2,3	2,3	2,6	2,6	2,6

ASEPTIC FERRULES ACC. TO ASME BPE (DIN 32676-C) FOR TUBES ACC. TO DIN 11866-C											
NPS	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**11/2"**	**2"**	**21/2"**	**3"**	**4"**	**6"**
ØF	25	25	25	25	50,4	50,4	63,9	77,4	90,9	118,9	168,9
ØG	6,4	9,4	12,7	19,1	25,4	38,1	50,8	63,5	76,2	101,6	152,4
ØH	4,6	7,8	9,4	15,8	22,1	34,8	47,5	60,2	72,9	97,4	146,9
t	0,89	0,89	1,65	1,65	1,65	1,65	1,65	1,65	1,65	2,11	2,77

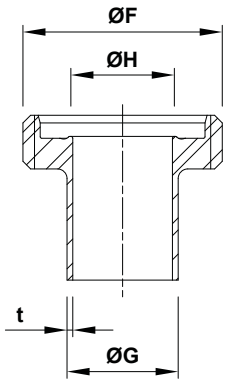
DIN 11851 SANITARY FITTING DIMENSIONS



DIN 11851

HYGIENIC MALE THREADS ACC. TO DIN 11851 FORM A FOR TUBES ACC. TO DIN 11850												
DN	**10**	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**
ØF	RD 28 x 1/8	RD 34 x 1/8	RD 44 x 1/6	RD 52 x 1/6	RD 58 x 1/6	RD 65 x 1/6	RD 78 x 1/6	RD 95 x 1/6	RD 110 x 1/4	RD 130 x 1/4	RD 160 x 1/4	RD 190 x 1/4
ØG	13	19	23	29	35	41	53	70	85	104	129	154
ØH	10	16	20	26	32	38	50	66	81	100	125	150
t	1,5	1,5	1,5	1,5	1,5	1,5	1,5	2	2	2	2	2

DIN 11864-1 SANITARY FITTING DIMENSIONS



DIN 11864-1

HYGIENIC MALE THREADS ACC. TO DIN 11864-1 FORM A FOR TUBES ACC. TO DIN 11866-A										
DN	**10**	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**
ØF	RD 28 x 1/8	RD 34 x 1/8	RD 44 x 1/6	RD 52 x 1/6	RD 58 x 1/6	RD 65 x 1/6	RD 78 x 1/6	RD 95 x 1/6	RD 110 x 1/4	RD 130 x 1/4
ØG	13	19	23	29	35	41	53	70	85	104
ØH	10	16	20	26	32	38	50	66	81	100
t	1,5	1,5	1,5	1,5	1,5	1,5	1,5	2	2	2

HYGIENIC MALE THREADS ACC. TO DIN 11864-1 FORM A FOR TUBES ACC. TO DIN 11866-B										
OD	**13,5**	**17,2**	**21,3**	**26,9**	**33,7**	**42,4**	**48,3**	**60,3**	**76,1**	**88,9**
ØF	RD 28 x 1/8	RD 34 x 1/8	RD 44 x 1/6	RD 52 x 1/6	RD 58 x 1/6	RD 65 x 1/6	RD 78 x 1/6	RD 95 x 1/6	RD 110 x 1/4	RD 130 x 1/4
ØG	13,5	17,2	21,3	26,9	33,7	42,4	48,3	60,3	76,1	88,9
ØH	10,3	14	18,1	23,7	29,7	38,4	44,3	56,3	72,1	84,3
t	1,6	1,6	1,6	1,6	2	2	2	2	2	2,3

HYGIENIC MALE THREADS ACC. TO DIN 11864-1 FORM A FOR TUBES ACC. TO DIN 11866-C								
NPS	**1/2"**	**3/4"**	**1"**	**11/2"**	**2"**	**21/2"**	**3"**	**4"**
ØF	RD 28 x 1/8	RD 34 x 1/8	RD 52 x 1/6	RD 65 x 1/6	RD 78 x 1/6	RD 95 x 1/6	RD 110 x 1/4	RD 130 x 1/4
ØG	12,7	19,1	25,4	38,1	50,8	63,5	76,2	101,6
ØH	9,4	15,8	22,1	34,8	47,5	60,2	72,9	97,4
t	1,65	1,65	1,65	1,65	1,65	1,65	1,65	2,11