DATA SHEET FOR *ADCATROL* CONTROL VALVES

Valve sizing

The valve sizing is based on the calculation of the Kv coefficient. The Kv represents the quantity of water, expressed in cubic meters (m3) at 15ºC that flows through the valve with a pressure drop of 1 bar, in a one hour period. The formulas, below indicated, allow the Kv calculation in accordance with the type of fluid and its operating condition.
After the Kv calculation, the corresponding Kvs is available from the valve data sheet. If real operating data have been used for the calculation, as a rule, the calculated Kv should be around 70% to 80% of the selected valve Kvs in order to guaranty the proper regulation of maximum flow rate at the given operating conditions preventing that sometimes some *precautionary additions* will result in undesirable valve over sizing. At the same time it is necessary to check whether the minimum flow rate can be even regulated or not considering the chosen valve rangeability.
For critical applications (critical flow velocities, for example), noise prediction, etc, please fill the data sheet available in the next pages and submit it to our technical department for proper selection using our software.

CALCULATION OF KV VALUE			
PRESSURE DROP	MEDIUM		
	LIQUIDS	SATURATED STEAM	GASES
a) $P2 > \frac{P1}{2}$ $Dp < \frac{P1}{2}$	$Kv = Q1\sqrt{\frac{d1}{Dp \times 1000}}$	$Kv = \frac{Q2}{22{,}4\sqrt{Dp \times P2}}$	$Kv = \frac{Q3}{514}\sqrt{\frac{d2 \times T}{Dp \times P2}}$
b) $P2 < \frac{P1}{2}$ $Dp > \frac{P1}{2}$	$Kv = Q1\sqrt{\frac{d1}{Dp \times 1000}}$	$Kv = \frac{Q2}{11{,}2 \times P1}$	$Kv = \frac{Q3}{257 \times P1}\sqrt{d2 \times T}$

Remarks: *For superheated steam and other fluids please consult.*
a) *Subcritical pressure drop: downstream absolute pressure more than 50% of the absolute upstream pressure in the valve.*
b) *Supercritical pressure drop: downstream absolute pressure is equal or less than 50% of the upstream absolute pressure in the valve.*

Kv	*Flow coefficient*	*m3/h*
P1	*Upstream absolute pressure*	*bar*
P2	*Downstream absolute pressure*	*bar*
Dp	*Pressure drop (P1 – P2)*	*bar*
Q1	*Flow rate*	*m3/h*
Q2	*Flow rate*	*Kgs/h*
Q3	*Flow rate*	*N.m3/h (0ºC – 1013 mbar)*
d1	*Specific weight of liquid*	*Kg/m3*
d2	*Specific weight of gas*	*Kg/m3*
T	*Absolute temperature (T=273 + t ºC)*	*ºK*
t	*Fluid temperature*	*ºC*

RECOMMENDED FLOW VELOCITIES AT THE INLET OF VALVES			
LIQUIDS	***GASES***	***SATURATED STEAM***	***SUPERHEATED STEAM***
2,5 m/s	20 m/s	25 m/s	50 m/s

STAINLESS STEEL AND NON-METALLIC MATERIALS

Stainless steels

The raw stainless steel used in AdcaPure products are acquired according to the ASME BPE specifications and comply with the relevant standards.

Internally it is subject to a strict quality control that involves, not only documentation and dimensions verification, but also, chemical composition check in our facilities by means of a spectrometry analysis.
All materials are internally traceable, by means of the quality system procedures.
For special high corrosion resistance steels, please consult factory, since we can provide non-standard solutions.

STAINLESS STEEL		
MATERIAL	***STANDARD***	***CHARACTERISTICS***
AISI304 (1.4301)	ASTM A276	APPLIED ONLY IN NONWETTED PARTS
AISI316 L (1.4404)	ASTM A276	INTERCRYSTALLINE CORROSION RESISTANT ACC.TO ISO3651-2 METHOD A AND ASTM A262 PRACTICE E.
AISI316Ti (1.4571)	ASTM A276	INTERCRYSTALLINE CORROSION RESISTANT ACC.TO ISO3651-2 METHOD A AND ASTM A262 PRACTICE E.
CF3M (1.4409)	A 351	FERRITE CONTENT OF LESS THEN 3% AND LOW SULPHUR BETWEEN 0,005% AND 0,017%.

Nonmetallic materials

It is important that the non-metallic parts are selected to maintain the purity and integrity of the process fluid.
In order to achieve that, they should be compatible with stated processing conditions, cleaning solutions and sterilization conditions, defined by the customer.

The following table has an overview of the non-metallic materials applied in AdcaPure range and the respective approvals under the USP class VI and FDA 21 CFR requirements. All the wetted parts provide full traceability in compliance with the EU Food regulation 1935/2004.

NON-METALLIC MATERIALS	
MATERIAL DESIGNATION	***APROVALLS***
GYLON 3504	FDA 21CFR177.1550, 21CFR170.30 & 21CFR175.300 USP CL.VI Ch. 31, 87, 88, 281, 661 121ºC
GYLON 3522	FDA 21 CFR 177.155 USP CL.VI Ch. 31, 87, 88, 281, 661 121ºC
70EPDM 291	FDA 21 CFR 177.2600 USP CL.VI Ch. 87 & 88, 121ºC
75 FKM	FDA 21 CFR 177.2600
FKM 675301	FDA 21 CFR 177.2600
TFM 1705 PTFE	FDA 21CFR 177.1550 USP CL.VI Ch. 87, 121ºC
VITON	FDA 21 CFR 177.2600

* All materials comply with EC1935/2004.

SURFACE FINISH

The surface quality, especially the area in contact with the fluid, greatly influences the cleanability of the equipment. All the products in AdcaPure range are supplied with a standard internal finishing surface that allows an efficient cleanability. Apart from the standard conditions, we can supply several combinations of roughness internally and externally, for optimized performance according to customers' requests.

We apply ASME BPE acceptance criteria, achieved by internal controlled procedures, which in term apply visual inspection and roughness measurements.
AdcaPure range parts are produced in Valsteam factory, in dedicated top line machines with high precision, high speed and wear tools control. This allows Valsteam to guarantee controlled surface conditions directly from the machined parts.

Explanation of surface finishes

- **Fine machined:** Obtain by high performance turning and milling machines. Mechanical polishing where necessary;
- **Mechanical polishing:** Polished surface, not necessary with a shiny finish;
- **Electro polishing:** Satin surface finish typical from electro polishing process;
- **Mirror:** Shiny surface finish;
- **Satin bead blast finishing:** Obtained by sand blasting process, applicable for actuators, humidity separators, etc.

STANDARD SURFACE CONDITION **				
SURFACE AREA	*Ra ≤ [µm]*	*Ra ≤ [µin]*	*CODE ASME BPE*	*AVAIABLE SURFACE FINISHINGS*
INTERNAL WETTED PARTS *	0,51	20	SF1	MECHANICAL POLISHING
EXTERNAL SURFACES	0,76	30	SF3	FINE MACHINED

* Not applied to regulating elements. Consult factory for certified roughness dimensions. ** Do not substitute the information for standard conditions on each product catalogue.

OPTIONAL SURFACE CONDITION *				
Ra ≤ [µm]	*Ra ≤ [µin]*	*CODE ASME BPE*	*CODE ADCA*	*AVAIABLE SURFACE FINISHINGS*
MECHANICAL POLISHING				
0,38	15	-	AS03	MIRROR
0,51	20	SF1	-	MIRROR
0,64	25	SF2	-	FINE MACHINED AND/OR MECHANICAL POLISHING
0,76	30	SF3	-	AS STANDARD
ELECTRO POLISHING				
0,38	15	SF4	-	MECHANICAL AND ELECTRO POLISHED
0,51	20	SF5	-	ELECTRO POLISHED
0,64	25	SF6	-	ELECTRO POLISHED
0,76	30	-	AS07	ELECTRO POLISHED

* Can be applied to any surface, with exception of regulating elements, under request. Please consult.

WELDING

The design of the AdcaPure range valves are in accordance with to the latest specifications of ASME BPE and EHDGE directives. The welding tasks are performed by approved welders and according to welding specifications. The process is done manually or via mechanized and orbital machines, inside dedicated rooms with 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 the welding and surface finishing operations, the parts enter a certified clean room, to start the process of cleaning and passivation. A full automatic ultra-sound cleaning machine allows us to control the cleaning and protection of the surfaces parts with efficiency.
It is also possible to prepare the equipment's for oxygen applications, with a guaranteed degreasing process.

The parts are then assembled and tested in an ISO14644 clean room, by trained personnel, according to our internal procedures. In the final stage, still inside the clean room, and after all the necessary quality verifications are performed, the products are end capped and vacuum sealed with recyclable plastic film to avoid any contamination.

CERTIFICATES

Our quality system is certified by ISO9001:2015 and guarantees the control of all the processes involved in the project, manufacturing and supply of equipment's. We can supply various sorts of certificates and declarations to attest the conformity of the supplied products.

CERTIFICATES	
TYPE	***INFORMATION***
CE Conformity declaration	According to the PED directive
AdcaPure specific inspection certificate	Include Chemical composition, final testing records, elastomers specifications and approvals, surface finishing requirements.
Hydrostatic test report	According to the PED directive
Pneumatic test report	According to EN12666
Degreasing certificate	Includes treatment information
Ultra-sound cleaning report	Includes treatment information

Others on request against extra price.

STEAM EQUIPMENT

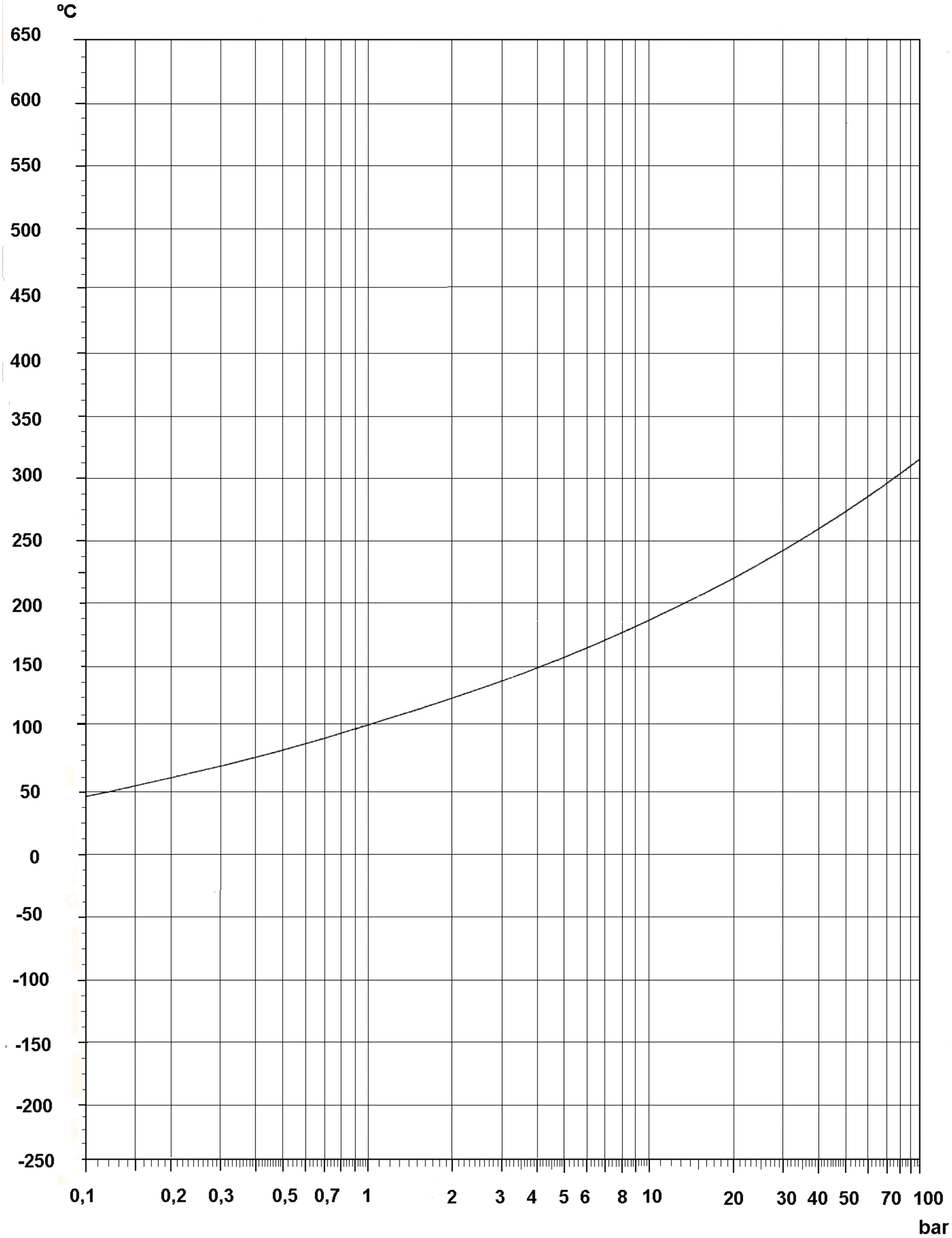
PHYSICAL PROPERTIES OF SATURATED STEAM									
Pm (bar)	***Pa (bar)***	***T (°C)***	***V (m^3/Kg)***	***he (Kcal/Kg)***	***he (KJ/Kg)***	***r (Kcal/Kg)***	***r (KJ/Kg)***	***hg (Kcal/Kg)***	***hg (KJ/Kg)***
0,00	1,013	100,0	1,673	100,1	419,1	539,4	2258,4	639,5	2677,5
0,05	1,063	101,4	1,601	101,5	425,0	538,4	2254,2	639,9	2679,1
0,10	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
0,20	1,213	106,2	1,414	105,3	440,9	536,2	2245,0	641,5	2685,8
0,30	1,313	107,4	1,312	107,6	450,5	534,7	2238,7	642,3	2689,2
0,40	1,413	109,5	1,225	109,8	459,7	533,3	2232,8	643,1	2692,5
0,50	1,513	111,6	1,149	111,9	468,5	531,9	2227,0	643,8	2695,5
0,60	1,613	113,5	1,038	113,8	476,5	530,6	2221,5	644,4	2698,0
0,70	1,713	115,4	1,024	115,7	484,4	529,5	2216,9	645,2	2701,3
0,80	1,813	117,1	0,971	117,5	491,9	528,3	2211,9	645,8	2703,8
0,90	1,913	118,8	0,923	119,2	499,1	527,1	2206,9	646,3	2705,9
1,00	2,013	120,4	0,881	120,8	505,8	526,0	2202,3	646,8	2708,0
1,10	2,113	121,9	0,841	122,4	512,5	525,1	2198,5	647,5	2711,0
1,20	2,213	123,4	0,806	124,0	519,2	524,1	2194,3	648,1	2713,5
1,30	2,313	124,9	0,773	125,4	525,0	523,1	2190,1	648,5	2715,1
1,40	2,413	126,3	0,743	126,8	530,9	522,2	2186,3	649,0	2717,2
1,50	2,513	127,6	0,714	128,1	536,3	521,1	2181,7	649,2	2718,1
1,60	2,613	128,9	0,689	129,5	542,2	520,4	2178,8	649,9	2721,0
1,70	2,713	130,1	0,665	130,7	547,2	519,5	2175,0	650,2	2722,3
1,80	2,813	131,4	0,643	132,0	552,7	518,6	2171,3	650,6	2723,9
1,90	2,913	132,5	0,622	133,2	557,7	517,8	2167,9	651,0	2725,6
2,00	3,013	133,7	0,603	134,4	562,7	517,0	2164,6	651,4	2727,3
2,20	3,213	135,9	0,568	136,6	571,9	515,5	2158,3	652,1	2730,2
2,40	3,413	138,0	0,536	138,8	581,1	514,0	2152,0	652,8	2733,1
2,60	3,613	140,0	0,509	140,8	589,5	512,6	2146,2	653,4	2735,7
2,80	3,813	141,9	0,483	142,8	597,9	511,2	2140,3	654,0	2738,2
3,00	4,013	143,7	0,461	144,7	605,8	509,9	2134,8	654,6	2740,7
3,20	4,213	145,4	0,440	146,4	612,9	508,6	2129,4	655,0	2742,4
3,40	4,413	147,2	0,422	148,2	620,5	507,4	2124,4	655,6	2744,9
3,60	4,613	148,8	0,405	149,9	627,6	506,1	2118,9	656,0	2746,5
3,80	4,813	150,4	0,389	151,5	634,3	505,0	2114,3	656,5	2748,6
4,00	5,013	152,0	0,374	153,1	641,0	503,8	2109,3	656,9	2750,3
4,20	5,213	153,4	0,361	154,6	647,3	502,7	2104,7	657,3	2752,0
4,40	5,413	154,8	0,348	156,1	653,6	501,6	2100,1	657,7	2753,7
4,60	5,613	156,2	0,336	157,6	659,8	500,6	2095,9	658,2	2755,8
4,80	5,813	157,6	0,325	159,0	665,7	499,5	2091,3	658,5	2757,0
5,00	6,013	158,9	0,315	160,3	671,1	498,5	2087,1	658,8	2758,3
5,50	6,513	162,1	0,292	163,6	685,0	496,1	2077,1	659,7	2762,0
6,00	7,013	165,0	0,272	166,7	697,9	493,8	2067,4	660,5	2765,4
6,50	7,513	167,8	0,255	169,6	710,1	491,6	2058,2	661,2	2768,3
7,00	8,013	170,5	0,240	172,4	721,8	489,4	2049,0	661,8	2770,8
7,50	8,513	173,0	0,227	175,1	733,1	487,4	2040,6	662,5	2773,8
8,00	9,013	175,4	0,215	177,6	743,6	485,4	2032,3	663,0	2775,8
8,50	9,513	177,7	0,204	180,0	753,6	483,5	2024,3	663,5	2777,9
9,00	10,013	180,0	0,194	182,3	763,3	481,6	2016,4	663,9	2779,6
9,50	10,513	182,1	0,185	184,6	772,9	479,8	2008,8	664,4	2781,7
10,00	11,013	184,1	0,177	186,8	782,1	478,0	2001,3	664,8	2783,4
11,00	12,013	188,0	0,163	190,9	799,3	474,6	1987,1	665,5	2786,3
12,00	13,013	191,7	0,151	194,8	815,6	471,4	1973,7	666,2	2789,2
13,00	14,013	195,1	0,141	198,5	831,1	468,3	1960,7	666,8	2791,8
14,00	15,013	198,3	0,132	202,0	845,7	465,3	1948,1	667,3	2793,9
15,00	16,013	201,4	0,124	205,3	859,6	462,5	1936,4	667,8	2795,9
16,00	17,013	204,4	0,117	208,5	872,9	459,7	1924,7	668,2	2797,6
17,00	18,013	207,2	0,110	211,5	885,5	457,0	1913,4	668,5	2798,9
18,00	19,013	209,9	0,105	214,4	897,8	454,4	1902,5	668,8	2800,1
19,00	20,013	212,5	0,100	217,2	909,4	451,8	1891,6	669,0	2801,0
20,00	21,013	215,0	0,095	220,0	921,1	449,4	1881,5	669,4	2802,6
21,00	22,013	217,3	0,090	222,6	932,0	447,0	1871,5	669,6	2803,5
22,00	23,013	219,6	0,087	225,1	942,4	444,6	1861,5	669,7	2803,9
23,00	24,013	221,8	0,083	227,6	952,9	442,2	1851,4	669,8	2804,3
24,00	25,013	224,0	0,080	230,0	963,0	440,0	1842,2	670,0	2805,2
25,00	26,013	226,1	0,077	232,3	972,6	437,7	1832,6	670,0	2805,2

Pm-gauge pressure; **Pa**-absolute pressure; **T**-temperature; **V**-specific volume; **he**-specific enthalpy of liquid; **r**-specific enthalpy of vaporization; **Hg**-specific enthalpy of saturated steam.

MASS FLOWRATES OF SATURATED STEAM FOR DIFFERENT VELOCITIES IN PIPES DIN2448 - STANDARD

Pm bar	v m/s	FLOWRATE (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

VAPOUR TENSION OF WATER



CONVERSION FACTORS

FLOW RATE IN VOLUME					
UNIT		***m^3/s***	***L/s***	***cfm***	***gpm***
Cubic metre per second	***m^3/s***	1	1×10^{3}	2118,88	15850
Litre per second	***L/s***	1×10^{-3}	1	2,1189	15,85
Cubic foot per minute	***cfm***	$0,4719\times10^{-3}$	0,4719	1	7,48
Gallon per minute	***gpm***	$0,6309\times10^{-4}$	0,06309	0,1337	1

MASS				
UNIT		***Kg***	***lb***	***ton***
Kilogramme	***Kg***	1	2,2046	1×10^{-3}
Pound	***lb***	0,4536	1	$0,454\times10^{-3}$
Ton short (US)	***ton***	907,1847	2000	1

AREA					
UNIT		***m^2***	***cm^2***	***in^2***	***ft^2***
Square metre	***m^2***	1	1×10^{4}	1550	10,764
Square centimetre	***cm^2***	1×10^{-4}	1	0,155	$10,764\times10^{-4}$
Square inch	***in^2***	$6,452\times10^{-4}$	6,452	1	$6,944\times10^{-3}$
Square foot	***ft^2***	$9,290\times10^{-2}$	928,03	144	1

LENGTH						
UNIT		***m***	***cm***	***mm***	***in***	***ft***
Metre	***m***	1	1×10^{2}	1×10^{3}	39,370	3,281
Centimetre	***cm***	1×10^{-2}	1	10	0,390	0,033
Milimetre	***mm***	1×10^{-3}	1×10^{-1}	1	0,039	$3,28\times10^{-3}$
Inch	***in***	$2,54\times10^{-2}$	2,540	25,4	1	0,083
Foot	***ft***	0,305	30,480	304,8	12	1

VOLUME						
UNIT		***m^3***	***L***	***in^3***	***ft^3***	***gal***
Cubic metre	***m^3***	1	1×10^{3}	$61,024\times10^{3}$	35,315	219,969
Cubic dcm or liter	***dm^3 (L)***	1×10^{-3}	1	61,024	0,353	0,220
Cubic inch	***in^3***	$0,0164\times10^{-3}$	0,016	1	$5,787\times10^{-4}$	$3,605\times10^{-3}$
Cubic foot	***ft^3***	0,028	28,317	1728	1	6,229
Gallon (UK)	***gal***	$4,546\times10^{-3}$	4,546	277,419	0,161	1

WORK, ENERGY, HEAT AND ENTHALPY						
UNIT		***J***	***Kgfm***	***Kcal***	***Wh***	***Btu***
Joule	***J***	1	0,1020	$0,2388\times10^{-3}$	$0,2778\times10^{-3}$	$0,9478\times10^{-3}$
Kilogramme metre	***Kgfm***	9,807	1	$2,342\times10^{-3}$	$2,724\times10^{-3}$	$9,295\times10^{-3}$
Kilocalorie	***KCal***	4186,8	426,92	1	3,968	3,968
Watt hour	***Wh***	3600	367,08	0,861	1	3,413
British thermal unit	***Btu***	1055,06	107,58	0,252	0,293	1

POWER								
UNIT		**W**	**Kcal/h**	**Kgm/s**	**BTU/h**	**ft lb/s**	**BHP**	**CV**
Watt	***W***	1	0,8605	0,102	3,413	0,7375	$1{,}341\times10^{-3}$	$1{,}360\times10^{-3}$
Kilocalorie/hour	***Kcal/h***	1,1628	1	0,1186	3,9683	0,8576	$1{,}559\times10^{-3}$	$1{,}581\times10^{-3}$
Kilogramme metre/sec	***Kgm/s***	9,807	8,434	1	33,47	7,233	$1{,}315\times10^{-2}$	$1{,}333\times10^{-2}$
British thermal unit/hour	***BTU/h***	0,293	0,252	0,02988	1	0,2161	$0{,}393\times10^{-3}$	$0{,}398\times10^{-3}$
Foot pound/second	***ft lb/s***	1,356	1,166	0,1383	4,627	1	$1{,}818\times10^{-3}$	$1{,}844\times10^{-3}$
Brake horsepower	***BHP***	745,7	641,3	76,04	2547	550	1	1,0139
Horsepower (metric)	***CV***	735,5	632,53	75	2512,2	542,4	0,986	1

VELOCITY				
UNIT		**m/s**	**ft/s**	**Km/h**
Metre per second	***m/s***	1	3,2808	3,6
Foot per second	***ft/s***	0,3048	1	1,0973
Kilometre per hour	***Km/h***	0,2778	0,9113	1

PRESSURE								
UNIT		**Pa**	**bar**	**at**	**mm Hg**	**Kgf/m²**	**psi**	**lbf/ft²**
Pascal	***Pa***	1	$1\text{x}10^{-5}$	$1{,}0197\text{x}10^{-5}$	0,0075	0,10197	$0{,}145\text{x}10^{-3}$	0,02088
Bar	***bar***	$1\text{x}10^{5}$	1	1,0197	750,07	10197	14,5050	2088
Atmosphere (Kgf/cm²)	***at***	98070	0,9807	1	735,56	10000	14,223	2048,16
Millimetre of mercury	***mm Hg***	133,32	$1{,}3332\text{x}10^{-3}$	$1{,}3595\text{x}10^{-3}$	1	13,595	0,0193	1,392
Kilogramme per sq. mtr.	***Kgf/m²***	9,807	$9{,}807\text{x}10^{-5}$	$1\text{x}10^{-4}$	0,0735	1	0,0014	0,205
Pounds per sq. Inch	***psi***	6894,14	0,06894	0,0703	51,719	703,07	1	144
Pounds per sq. foot	***lbf/ft²***	47,876	$4{,}7876\text{x}10^{-4}$	$4{,}8824\text{x}10^{-4}$	0,7183	4,8824	0,00694	1

WATER HARDNESS					
UNIT		**ºFr**	**ºdH**	**GPG**	**ppm**
French degree	***ºFr***	1	0,56	0,583	10,0
German degree	***ºdH***	1,79	1	1,040	17,9
Grain/US gallon	***GPG***	1,71	0,958	1	17,1
Parts per million	***ppm***	0,10	0,056	0,0583	1

TEMPERATURE							
ºC	**ºF**	**ºC**	**ºF**	**ºC**	**ºF**	**ºC**	**ºF**
-35	-31	40	104	115	239	190	374
-30	-22	45	113	120	248	195	383
-25	-13	50	122	125	257	200	392
-20	-4	55	131	130	266	205	401
-15	5	60	140	135	275	210	410
-10	14	65	149	140	284	215	419
-5	23	70	158	145	293	220	428
0	32	75	167	150	302	225	437
5	41	80	176	155	311	230	446
10	50	85	185	160	320	235	455
15	59	90	194	165	329	240	464
20	68	95	203	170	338	245	473
25	77	100	212	175	347	250	482
30	86	105	221	180	356	255	491
35	95	110	230	185	365	260	500
Conversion equations		T(ºF) = (1,8 × T(ºC)) + 32					
		T(ºC) = 0,55 × (T(ºF) - 32)					
		T(K) = T(ºC) + 273,15					

MASS PER UNIT VOLUME OF DRY AIR IN Kg/m³ for temperatures from 0ºC to 300ºC and pressures from 0 to 25bar

t (ºC)	***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 (ºC)	***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

PHYSICAL PROPERTIES OF GASES AND VAPOURS - SI UNITS

Referred to 0ºC (32F) and 1013,25 mbar (14,7 psia)

ρ - mass per unit volume

t_f - melting temperature

t_e - boiling temperature

ρe - mass per unit volume of the liquid at t_e

V - specific volume

Cp - specific heat at constant pressure

λ - thermal conductivity

Gas or Vapour	Formula	ρ (kg/m³)	t_f (ºC)	t_e (ºC)	ρ_e (kg/m³)	V (m³/Kg)	Cp (Kcal/Kg.h.º C)	λ (Kcal/m.h.º 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
Biogas (40% CH4)	-	1,467	-	-	-	-	-	-
Biogas (56% CH4)	-	1,267	-	-	-	-	-	-
Biogas (70% CH4)	-	1,092	-	-	-	-	-	-
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
Natural gas	-	0,6	-	-	-	-	-	-
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

PHYSICAL PROPERTIES OF WATER - SI UNITS

t_{ref} - reference temperature for

M_s - mass per unit volume at 20ºC (68ºF)

Ca - actual specific heat at t_{ref}

λ- rthermal condivity at t_{ref}

Temp. (ºC)	Ms (kg/m³)	V (m³/Kgx1000)	Ca (Kcal/Kg.ºC)	λ (Kcal/m.h.ºC)	Temp. (ºC)	Ms (kg/m³)	V (m³/Kgx1000)	Ca (Kcal/Kg.ºC)	λ (Kcal/m.h.ºC)
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	–	–	1,0084	0,589
54	986,21	1,01398	–	–	115	–	–	1,0098	0,59
55	985,73	1,01448	1	0,556	120	–	–	1,0114	0,591
56	985,25	1,01497	–	–	125	–	–	1,0132	0,591
57	984,75	1,01549	–	–	130	–	–	1,0152	0,592
58	984,25	1,016	–	–	135	–	–	1,0175	0,592
59	983,75	1,01652	–	–	140	–	–	1,02	0,592
60	983,24	1,01705	1	0,561	145	–	–	1,0228	0,591
61	982,72	1,01758	–	–	150	–	–	1,0258	0,591
62	982,2	1,01812	–	–	160	–	–	1,0328	0,589
63	981,67	1,01867	–	–	170	–	–	1,0411	0,586
64	981,13	1,01923	–	–	180	–	–	1,0507	0,582
65	980,59	1,01979	1	0,566	190	–	–	1,0619	0,578
66	980,05	1,02036	–	–	200	–	–	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

PHYSICAL PROPERTIES OF LIQUIDS - SI UNITS

t_{ref} - reference temperature for

M_s - mass per unit volume at 20ºC (68ºF)

Ca - actual specific heat at $_{tref}$

λ- thermal conditivity at t_{ref}

Liquid	t_{ref} (ºC)	Ms (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 sol. (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	0,557-0,688	-
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
Lubricating oil	81	920	-	0,105
	0	-	-	0,133
	100	-	-	0,128
	200	-	-	0,122

Liquid	t_{ref} (ºC)	Ms (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

PHYSICAL PROPERTIES OF METALS - SI UNITS

t_{ref} - reference temperature for

Ms - mass per unit volume at 20ºC

λ - thermal conditivity at t_{ref}

Ca - actual specific heat at t_{ref}

Metal	***t_{ref} (ºC)***	***Ms (kg/m^3)***	***λ (Kcal/m.h.ºC)***	***Ca (Kcal/Kg.h.ºC)***
Alloy Steel (5%Cr)	20	7790	28	0,11
(20%Cr)	20	7670	20	0,11
(10%Cr)	20	7760	27	0,11
Alloy Steel (5%Ni)	30	7850	25	-
(10%Ni)	30	-	22	-
(40%Ni)	30	8120	9	-
(20%Ni)	30	-	14	-
Aluminum	0	2700	173	0,21
	100	-	176	0,224
	300	-	198	0,241
Brass	20	8400	79-96	-
	100	-	90-110	-
Bronze	20	8700	50	0,0913
	100	-	62	0,0937
Carbon Steel (0,1%C)	100	7830	47	-
	300	-	43	-
	600	-	32	-
Carbon Steel (0,5%C)	100	7820	45	0,113
	300	-	38	-
	600	-	31	-
Carbon Steel (1,5%C)	100	7740	32	-
	300	-	31	-
	600	-	29	-
Cast Iron (4%C)	20	-	50	-
Chromium	0	7190	-	0,102
	100	-	-	0,113
	300	-	-	0,125
Copper	20	8960	332	0,0911
Gold	0	19320	268	0,0311
	200	-	266	-
Magnesium	100	1738	135	0,257
Nikel	10	8902	54	0,105
	500	-	44	-
Silver	0	10500	360	0,057
	100	-	312	0,0572
	900	-	-	0,0676
Tin	0	7310	56	0,0536
	200	-	52	-
Zinc	0	7133	95	0,0918
	200	-	90	-

FLASH STEAM FROM BOILING CONDENSATE