A • P • P • E • N • D • I • X

TECHNICAL DATA

TABLE 1A Base units of the International System of Units (SI) and their definitions

Symbol	Unit	Definition
m	meter[a]	Unit of length equal to 1,650,763.73 wavelengths in vacuum of the radiation corresponding to the transition between the $2p^{10}$ and $5d^5$ levels of the krypton-86 atom
kg	kilogram	Unit of mass equal to that of the international prototype of the kilogram
s	second	Unit of time equal to the duration of 9,192,631,770 periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of the cesium-133 atom
A	ampere	Unit of electric current equal to that which, if maintained in two straight parallel conductors of infinite length and negligible cross-section and placed 1 meter (m) apart in vacuum, produces between those conductors a force equal to 2×10^{-7} newtons per meter (N/m) of length
K	kelvin	Unit of thermodynamic temperature equal to the fraction 1/273.16 of the thermodynamic temperature of the triple point of water
cd	candela	Unit of luminous intensity equal to that (in the perpendicular direction) of a surface of 1/600,000 m^2 of a blackbody at the temperature of freezing platinum under a pressure of 101,325 newtons per square meter (N/m^2)
mol	mole	Unit of substance equal to the moment of substance of a system that contains as many elementary entities[b] as there are atoms in 0.012 kg of carbon-12

[a]Spelled *metre* in countries other than the United States.

[b]When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of each particles.

TABLE 1B Supplementary SI units

Symbol	Unit	Definition
rad	radian	Unit of measure of a planar angle with its vertex at the center of a circle subtended by an arc equal in length to the radius
sr	steradian	Unit of measure of a solid angle with its vertex at the center of a sphere and enclosing an area of the spherical surface equal to that of a square with sides equal in length to the radius

TABLE 2 Derived units of the SI system

Quantity	Unit	Symbol	Formula
Acceleration	meters per second per second	m/s^2	—
Angular acceleration	radians per second per second	rad/s^2	—
Angular velocity	radians per second	rad/s	—
Area	square meters	m^2	—
Density	kilograms per cubic meter	kg/m^3	—
Energy	joules	J	$N \cdot m$
Force	newtons	N	$kg \cdot m/s^2$
Frequency	hertz	Hz	cycle/s
Power	watts	W	J/s
Pressure	pascals	Pa	N/m^2
Stress	newtons per square meter	N/m^2	—
Velocity	meters per second	m/s	—
Viscosity, dynamic	newton-seconds per square meter	$N \cdot s/m^2$	—
Viscosity, kinematic	square meters per second	m^2/s	—
Volume	cubic meters	m^3	—
Work	joules	J	$N \cdot m$

TABLE 3 Prefixes for SI multiple and submultiple units

Prefix	SI symbol	Multiplication factor
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deka	da	10
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

TABLE 4 Velocity and frictional head loss in old cast iron piping based on Hazen-Williams $C = 100$

gpm[a]	v[b]	f[c]	v	f	v	f	v	f	v	f	v	f	v	f	v	f	v	f	gpm
							3-in ID pipe[d]		4-in ID pipe										
30							1.36	0.534	0.77	0.131	5-in ID pipe								30
40							1.81	0.910	1.02	0.224									40
50							2.27	1.38	1.28	0.338	0.82	0.114	6-in ID pipe						50
60							2.72	1.92	1.53	0.475	0.98	0.160							60
70							3.18	2.56	1.79	0.631	1.14	0.213	0.79	0.088					70
80							3.63	3.28	2.04	0.808	1.31	0.273	0.91	0.112					80
90							4.08	4.08	2.30	1.01	1.47	0.339	1.02	0.139					90
100							4.54	4.96	2.55	1.22	1.63	0.412	1.14	0.170	8-in ID pipe				100
125							5.68	7.50	3.19	1.85	2.04	0.623	1.42	0.256					125
150							6.81	10.5	3.83	2.59	2.47	0.874	1.70	0.360	0.96	0.89			150
175							7.95	14.0	4.47	3.44	2.86	1.16	1.99	0.478	1.12	0.118			175
200							9.08	17.9	5.10	4.41	3.27	1.49	2.27	0.613	1.28	0.151	10-in ID pipe		200
225							10.2	22.3	5.74	5.48	3.68	1.85	2.55	0.762	1.44	0.188			225
250							11.3	27.1	6.38	6.67	4.08	2.25	2.84	0.926	1.60	0.228	1.02	0.077	250
275							12.5	32.3	7.02	7.96	4.50	2.68	3.12	1.11	1.76	0.272	1.12	0.092	275
	12-in ID pipe																		
300							13.6	37.9	7.65	9.34	4.90	3.13	3.41	1.30	1.91	0.320	1.23	0.108	300
350	0.99	0.059	14-in ID pipe				15.9	50.4	8.93	12.4	5.72	4.20	3.97	1.73	2.23	0.425	1.43	0.144	350
400	1.13	0.076					18.2	64.6	10.2	15.9	6.54	5.38	4.54	2.21	2.55	0.545	1.63	0.184	400
450	1.28	0.094	0.94	0.044					11.5	19.8	7.36	6.68	5.10	2.75	2.87	0.678	1.84	0.228	450
500	1.42	0.114	1.04	0.054				12.8	24.1	8.18	8.12	5.68	3.34	3.19	0.823	2.04	0.278		500
					16-in ID pipe														
550	1.56	0.136	1.15	0.064					14.0	28.7	8.99	9.69	6.24	3.99	3.51	0.982	2.24	0.331	550
600	1.70	0.160	1.25	0.076	0.96	0.039			15.3	33.7	9.81	11.4	6.81	4.68	3.82	1.15	2.45	0.389	600
650	1.84	0.186	1.36	0.088	1.04	0.046	18-in ID pipe		16.6	39.1	10.6	13.2	7.38	5.43	4.15	1.34	2.65	0.452	650
700	1.99	0.214	1.46	0.100	1.12	0.052			17.9	44.9	11.4	15.1	7.94	6.23	4.47	1.53	2.86	0.518	700
750	2.13	0.242	1.56	0.114	1.20	0.060	0.95	0.034			12.3	17.2	8.51	7.08	4.78	1.74	3.06	0.589	750
800	2.27	0.273	1.67	0.129	1.28	0.067	1.01	0.038	20-in ID pipe		13.1	19.4	9.08	7.98	5.10	1.97	3.26	0.666	800
900	2.55	0.339	1.88	0.160	1.44	0.084	1.13	0.047			14.7	24.1	10.2	9.92	5.74	2.44	3.67	0.825	900
1,000	2.83	0.412	2.08	0.195	1.60	0.102	1.26	0.057	1.02	0.034	16.3	29.3	11.4	12.1	6.38	2.97	4.08	1.00	1,000
1,100	3.12	0.492	2.29	0.232	1.76	0.121	1.39	0.068	1.12	0.041	18.0	35.0	12.5	14.4	7.02	3.55	4.50	1.20	1,100
,200	3.40	0.578	2.50	0.273	1.92	0.143	1.51	0.080	1.23	0.048			13.6	16.9	7.66	4.17	4.90	1.41	1,200

TABLE 4 Continued.

gpm[a]	v[b]	f[c]	v	f	v	f	v	f	v	f	v	f	v	f	v	f	v	f	gpm
1,300	3.69	0.671	2.71	0.316	2.08	0.165	1.64	0.093	1.33	0.056	24-in ID pipe		14.8	19.6	8.30	4.83	5.31	1.63	1,300
1,400	3.97	0.770	2.92	0.363	2.24	0.190	1.76	0.107	1.43	0.064			15.9	22.5	8.93	5.54	5.72	1.87	1,400
1,500	4.25	0.875	3.12	0.413	2.40	0.215	1.89	0.121	1.53	0.073	1.06	0.030	17.0	25.5	9.55	6.30	6.12	2.13	1,500
1,600	4.54	0.985	3.33	0.465	2.55	0.243	2.02	0.137	1.63	0.082	1.13	0.034	18.2	28.8	10.2	7.10	6.53	2.39	1,600
1,800	5.11	1.22	3.75	0.578	2.87	0.302	2.27	0.170	1.84	0.102	1.28	0.042			11.5	8.83	7.35	2.98	1,800
2,000	5.67	1.49	4.17	0.703	3.19	0.367	2.52	0.207	2.04	0.124	1.42	0.051			12.8	10.7	8.17	3.62	2,000
2,500	7.09	2.25	5.21	1.06	3.99	0.555	3.15	0.312	2.55	0.187	1.77	0.077			16.0	16.2	10.2	5.48	2,500
3,000	8.51	3.16	6.25	1.49	4.78	0.778	3.78	0.438	3.06	0.262	2.13	0.108			19.1	22.8	12.3	7.67	3,000
3,500	9.93	4.20	7.29	1.98	5.59	1.04	4.41	0.583	3.57	0.349	2.48	0.143					14.3	10.2	3,500
4,000	11.3	5.38	8.33	2.54	6.39	1.33	5.04	0.746	4.08	0.447	2.83	0.184					16.3	13.1	4,000
4,500	12.8	6.68	9.38	3.15	7.18	1.65	5.67	0.928	4.59	0.555	3.19	0.228					18.4	16.3	4,500
5,000	14.2	8.13	10.4	3.83	7.98	2.00	6.30	1.13	5.10	0.675	3.54	0.278							5,000
5,500	15.6	9.70	11.5	4.58	8.78	2.39	6.93	1.35	5.61	0.806	3.90	0.332							5,500
6,000	17.0	11.4	12.5	5.38	9.68	2.81	7.56	1.58	6.12	0.947	4.25	0.390							6,000
6,500	18.4	13.2	13.6	6.24	10.4	3.26	8.19	1.83	6.73	1.10	4.61	0.452							6,500
7,000	19.9	15.2	14.6	7.16	11.2	3.74	8.82	2.11	7.15	1.26	4.96	0.518							7,000
7,500			15.6	8.13	12.0	4.24	9.45	2.39	7.66	1.43	5.32	0.589							7,000
8,000			16.7	9.16	12.8	4.79	10.1	2.69	8.17	1.61	5.66	0.664							8,000
9,000			18.8	11.4	14.4	5.95	11.3	3.39	9.18	2.01	6.38	0.825							9,000
10,000					16.0	7.24	12.6	4.07	10.2	2.44	7.09	1.00							10,000
11,000					17.6	8.63	13.9	4.86	11.2	2.91	7.80	1.20							11,000
12,000					19.2	10.1	15.1	5.71	12.3	3.42	8.51	1.41							12,000
13,000							16.4	6.62	13.3	3.96	9.12	1.63							13,000
14,000							17.6	7.59	14.3	4.54	9.93	1.87							14,000
15,000							18.9	8.63	15.3	5.27	10.6	2.13							15,000
16,000									16.3	5.82	11.3	2.40							16,000
18,000									18.4	7.24	12.8	2.98							18,000
20,000											14.2	3.62							20,000
25,000											17.7	5.48							25,000

[a] 1 gpm = 6.31 × 10−5 m^3/s = 0.227 m^3/h = 0.0631 liters/s

[b] Velocity, in feet per second. 1 ft/s = 0.305 m/s

[c] Frictional head loss, in feet of water per 100 feet of pipe. 1 ft = 0.305 m. Friction values apply to cast iron pipes after 15 years of service handling average water at 60°F (15.6°C). Based on Hazen-Williams formula with $C = 100$. See Figure 1 for other values of C.

[d] 1 in = 25.4 mm

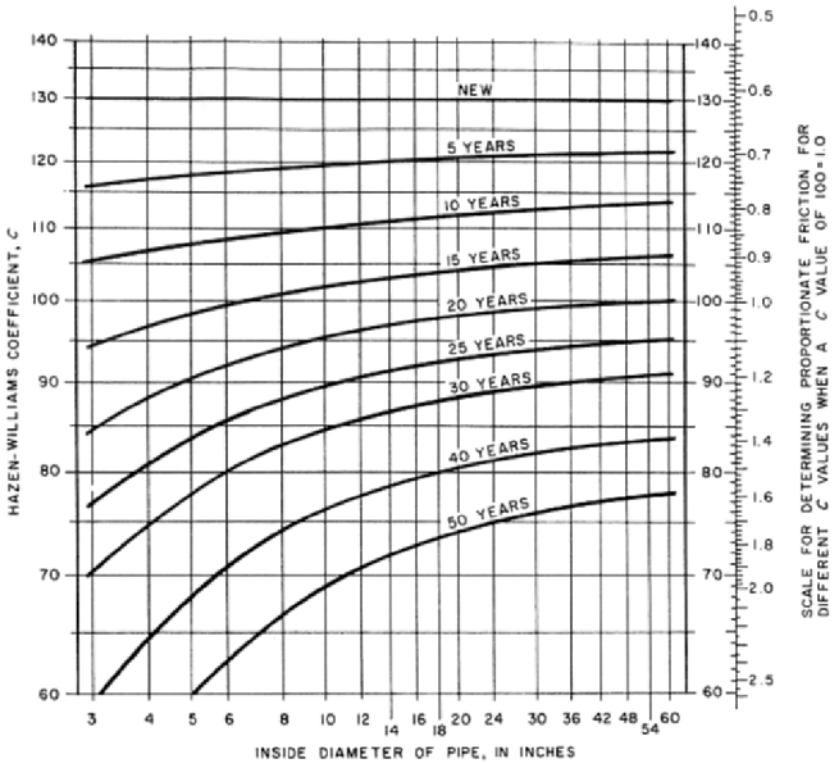

FIGURE 1 Change in Hazen-Williams coefficient C with years of service, for cast iron pipes handling soft, clear, unfiltered water at 60°F (15.6°C). To correct head loss from Table 4, which is based on $C = 100$, multiply by the conversion factor. For example, with a flow of 700 gpm through a 6-in pipe, the frictional head loss is 6.23 ft per 100 ft of pipe with $C = 100$. For $C = 130$, the conversion factor is 0.613; therefore, the frictional head loss is $6.23 \times 0.613 = 3.82$ ft per 100 ft of pipe (see also Section 8.1) (1 in = 25.4 mm).

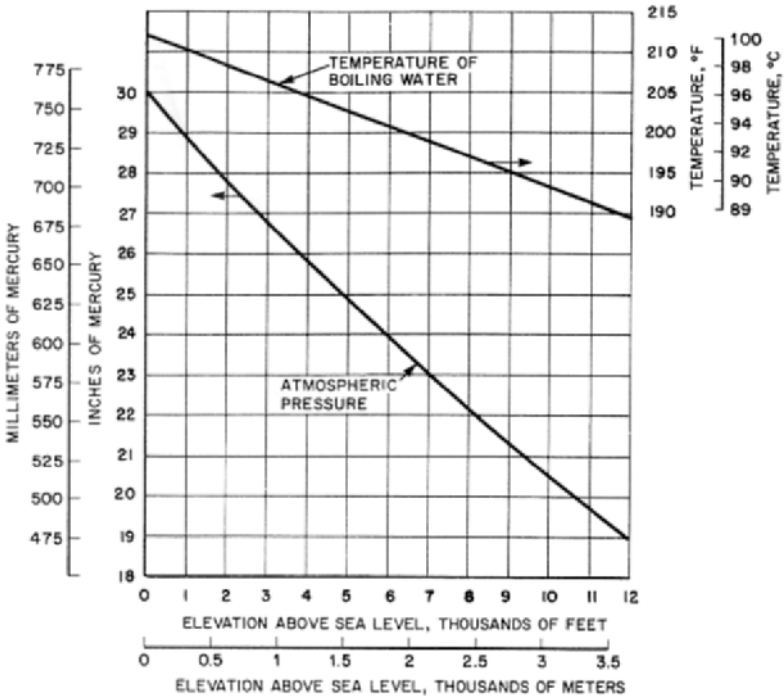

FIGURE 2 Atmospheric pressures for altitudes up to 12,000 ft (3600 m)

TABLE 5 Velocity and frictional head loss in new schedule 40 (standard weight) steel piping based on Darcy-Weisbach

gpm[a]	*v*[b]	*f*[c]	*v*	*f*	*v*	*f*	*v*	*f*	*v*	*f*	*v*	*f*	*v*	*f*	*v*	*f*	gpm
					1-in pipe[d] (1.049-in ID)		$1\frac{1}{4}$-in pipe (1.380-in ID)		$1\frac{1}{2}$-in pipe (1.610-in ID)								
1					0.37	0.11											1
2					0.74	0.39	0.43	0.10									2
3					1.11	0.82	0.64	0.21	0.47	0.10							3
4					1.49	1.37	0.86	0.36	0.63	0.17	2-in pipe						4
5					1.86	2.08	1.07	0.54	0.79	0.26	(2.067-in ID)						5
													$2\frac{1}{2}$-in pipe				
6					2.23	2.83	1.28	0.76	0.95	0.35	0.57	0.10	(2.469-in ID)				6
8					2.97	4.88	1.72	1.29	1.26	0.61	0.76	0.17			3-in pipe		8
10					3.71	7.12	2.14	1.95	1.57	0.90	0.96	0.26	0.67	0.11	(3.068-in ID)		10
15	$3\frac{1}{2}$-in pipe				5.56	15.0	3.21	4.06	2.36	1.87	1.43	0.54	1.00	0.23			15
20	(3.548-in ID)				7.41	25.6	4.28	6.80	3.15	3.12	1.91	0.92	1.34	0.38	0.87	0.13	20
			4-in pipe														
25	0.81	0.10	(4.026-in ID)				5.35	10.3	3.94	4.70	2.38	1.39	1.67	0.58	1.08	0.20	25
30	0.97	0.13					6.43	14.4	4.72	6.60	2.86	1.92	2.00	0.81	1.30	0.28	30
40	1.30	0.23	1.01	0.12					6.30	11.2	3.82	3.35	2.68	1.36	1.73	0.47	40
50	1.62	0.34	1.26	0.18	5-in pipe				7.87	16.6	4.77	5.00	3.34	2.06	2.16	0.72	50
60	1.94	0.48	1.51	0.25	(5.047-in ID)						5.72	7.00	4.02	2.85	2.60	0.99	60
70	2.27	0.63	1.76	0.34	1.12	0.11	6-in pipe				6.68	9.40	4.68	3.80	3.03	1.33	70
80	2.59	0.82	2.01	0.43	1.28	0.15	(6.065-in ID)				7.62	11.9	5.35	4.95	3.46	1.72	80
90	2.91	1.00	2.27	0.54	1.44	0.18					8.60	14.7	6.02	6.05	3.89	2.13	90
100	3.24	1.24	2.52	0.65	1.60	0.22	1.11	0.09			9.56	18.7	6.70	7.47	4.83	2.58	100
125	4.05	1.82	3.15	1.00	2.00	0.33	1.39	0.13					8.37	11.1	5.41	3.90	125
150	4.86	2.55	3.78	1.39	2.40	0.47	1.66	0.18	8-in pipe				10.0	15.4	6.50	5.44	150
175	5.66	3.40	4.40	1.90	2.80	0.62	1.94	0.24	(7.981-in ID)				11.7	20.8	7.58	7.30	175
200	6.48	4.35	5.04	2.40	3.20	0.80	2.22	0.31							8.66	9.18	200
225	7.30	5.44	5.66	2.98	3.60	0.97	2.50	0.38	1.44	0.10					9.75	11.6	225
250	8.10	6.59	6.29	3.68	4.00	1.19	2.77	0.47	1.60	0.12					10.8	14.0	250

TABLE 5 Continued.

gpm[a]	v[b]	f[c]	v	f	v	f	v	f	v	f	v	f	v	f	v	f	gpm
275	8.91	7.90	6.92	4.35	4.40	1.43	3.05	0.56	1.76	0.15	10-in pipe				11.9	16.9	275
300	9.72	9.30	7.55	5.04	4.80	1.65	3.32	0.66	1.92	0.17	(10.020-in ID)				13.0	19.6	300
350	11.3	12.2	8.80	6.85	5.60	2.21	3.88	0.88	2.24	0.23							350
400	13.0	15.9	10.1	8.67	6.40	2.89	4.44	1.12	2.56	0.29	1.62	0.10					400
450	14.6	20.0	11.3	10.9	7.20	3.56	4.99	1.40	2.88	0.37	1.82	0.12					450
500			12.6	13.3	8.00	4.36	5.54	1.72	3.20	0.45	2.03	0.15					500
550			13.9	16.0	8.80	5.17	6.10	2.06	3.52	0.55	2.23	0.18					550
600			15.1	19.1	9.60	6.16	6.65	2.42	3.84	0.63	2.44	0.21					600
650					10.4	7.22	7.20	2.78	4.16	0.73	2.64	0.24					650
700					11.2	8.29	7.75	3.25	4.47	0.85	2.84	0.28					700
750					12.0	9.40	8.31	3.63	4.80	0.97	3.04	0.31					750
800					12.8	10.3	8.87	4.11	5.11	1.11	3.25	0.35					800
900					14.4	13.0	9.96	5.12	5.75	1.33	3.65	0.44					900
1,000					16.0	15.8	11.1	6.17	6.40	1.64	4.06	0.55					1,000
1,100					17.6	19.0	12.2	7.45	7.04	1.98	4.46	0.64					1,100
1,200							13.3	8.73	7.67	2.36	4.87	0.75					1,200
1,300							14.4	10.2	8.31	2.71	5.27	0.88					1,300
1,400							15.5	11.9	8.95	3.10	5.68	1.02					1,400
1,500							16.7	13.2	9.60	3.49	6.09	1.18					1,500
1,600							17.8	15.0	10.2	3.92	6.49	1.31					1,600
1,800							20.0	18.5	11.5	4.99	7.30	1.60					1,800
2,000									12.8	5.96	8.11	1.97					2,000
2,500									16.0	9.00	10.2	2.95					2,500
3,000									19.2	12.5	12.2	4.15					3,000
3,500									22.4	16.6	14.2	5.60					3,500
4,000											16.2	6.90					4,000
4,500											18.3	8.80					4,500
5,000											20.3	10.8					5,000
5,500											22.3	13.0					5,500
6,000											24.4	15.3					6,000

[a] 1 gpm = 6.31×10^{-5} m^3/s = 0.227 m^3/h = 0.0631 liters/s
[b] Velocity, in feet per second. 1 ft/s = 0.305 m/s
[c] Frictional head loss, in feet of water per 100 feet of pipe. 1 ft = 0.305 m. Friction values apply to pipe carrying water at 60°F (15.6°C).
[d] 1 in = 25.4 mm

TABLE 6 Viscosity of common liquids
Typical SSU values as standardized by reputable authorities are shown in boldface type.

Liquid	Sp. gr. at 60°F (15.6°C)[a]	Viscosity			
		SSU	Centistokes	At °F	At °C
Freon	1.37 to 1.49 @ 70°F (21°C)		0.27–0.32	70	21
Glycerine (100%)	1.26 @ 68°F (20°C)	2950	648	68.6	20.3
		813	176	100	38
Glycol					
Propylene	1.038 @ 68°F (20°C)	240.6	52	70	21
Triethylene	1.125 @ 68°F (20°C)	185.7	40	70	21
Diethylene	1.12	149.7	32	70	21
Ethylene	1.125	88.4	17.8	70	21
Hydrochloric acid (31.5%)	1.05 @ 68°F (20°C)		1.9	68	20
Mercury	13.6		0.118	70	21
			0.11	100	38
Phenol (carbolic acid)	0.95 to 1.08	65	11.7	65	18
Silicate of soda	40 Baumé	365	79	100	38
	42 Baumé	637.6	138	100	38
Sulfuric acid (100%)	1.83	75.7	14.6	68	20
		Fish and animal oils			
Bone oil	0.918	220	47.5	130	54
		65	11.6	212	100
Cod oil	0.928	**150**	32.1	100	38
		95	19.4	130	54
Lard	0.96	**287**	62.1	100	38
		160	34.3	130	54
Lard oil	0.912 to 0.925	**190** to **220**	41 to 47.5	100	38
		112 to 128	23.4 to 27.1	130	54

TABLE 6 Continued.

Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Fish and animal oils					
Menhaden oil	0.933	**140**	29.8	100	38
		90	18.2	130	54
Neatsfoot oil	0.917	**230**	49.7	100	38
		130	27.5	130	54
Sperm oil	0.883	**110**	23.0	100	38
		78	15.2	130	54
Whale oil	0.925	**163** to **184**	35 to 39.6	100	38
		97 to 112	19.9 to 23.4	130	54
Mineral oils					
Automobile crankcase oils (average mid-continent paraffin base):					
SAE 10	0.880 to 0.935[b]	165 to 240	35.4 to 51.9	100	38
		90 to **120**	18.2 to 25.3	130	54
SAE 20	0.880 to 0.935[b]	240 to 400	51.9 to 86.6	100	38
		120 to **185**	25.3 to 39.9	100	54
SAE 30	0.880 to 0.935[b]	400 to 580	86.6 to 125.5	100	38
		185 to **255**	39.9 to 55.1	130	54
SAE 40	0.880 to 0.935[b]	580 to 950	125.5 to 205.6	100	38
		255 to	55.1 to	130	54
		80	15.6	210	99
SAE 50	0.880 to 0.935[b]	950 to 1600	205.6 to 352	100	38
		80 to **105**	15.6 to 21.6	210	99
SAE 60	0.880 to 0.935[b]	1600 to 2300	352 to 507	100	38
		105 to **125**	21.6 to 26.2	210	99
SAE 70	0.880 to 0.935[b]	2300 to 3100	507 to 682	100	38
		125 to **150**	26.2 to 31.8	210	99
SAE 10W	0.880 to 0.935[b]	**5000** to **10,000**	1100 to 2200	0	−18
SAE 20W	0.880 to 0.935[b]	**10,000** to **40,000**	2200 to 8800	0	−18

TABLE 6 Continued.

Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Mineral oils					
Automobile transmission lubricants					
SAE 80	0.880 to 0.935[b]	**100,000** max	22,000 max	0	−18
SAE 90	0.880 to 0.935[b]	**800** to **1500**	173.2 to 324.7	100	38
		300 to 500	64.5 to 108.2	130	54
SAE 140	0.880 to 0.935[b]	950 to 2300	205.6 to 507	130	54
		120 to **200**	25.1 to 42.9	210	99
SAE 250	0.880 to 0.935[b]	Over 2300	Over 507	130	54
		Over 200	Over 42.9	210	99
Crude oils					
Texas, Oklahoma	0.81 to 0.916	40 to 783	4.28 to 169.5	60	16
		34.2 to 210	2.45 to 45.3	100	38
Wyoming, Montana	0.86 to 0.88	74 to 1215	14.1 to 263	60	16
		46 to 320	6.16 to 69.3	100	38
California	0.78 to 0.92	40 to 4840	4.28 to 1063	60	16
		34 to 700	2.4 to 151.5	100	38
Pennsylvania	0.8 to 0.85	46 to 216	6.16 to 46.7	60	16
		38 to 86	3.64 to 17.2	100	38
Diesel engine lubricating oils (based on average mid-continent paraffin base)					
Federal specification no. 9110	0.880 to 0.935[b]	165 to 240	35.4 to 51.9	100	38
		90 to **120**	18.2 to 25.3	130	54
Federal specification no. 9170	0.880 to 0.935[b]	300 to 410	64.5 to 88.8	100	38
		140 to **180**	29.8 to 38.8	130	54
Federal specification no. 9250	0.880 to 0.935[b]	470 to 590	101.8 to 127.8	100	38
		200 to **255**	43.2 to 55.1	130	54
Federal specification no. 9370	0.880 to 0.935[b]	800 to 1100	173.2 to 238.1	100	38
		320 to **430**	69.3 to 93.1	130	54

TABLE 6 Continued.

Mineral oils					
Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Federal specification no. 9500	0.880 to 0.935[b]	490 to 600 **92** to **105**	106.1 to 129.9 18.54 to 21.6	130 210	54 99
Diesel fuel oils					
No. 2 D	0.82 to 0.95[b]	32.6 to 45.5 39	2 to 6 1 to 3.97	100 130	38 54
No. 3 D	0.82 to 0.95[b]	**45.5** to **65** 39 to 48	6 to 11.75 3.97 to 6.78	100 130	38 54
No. 4 D	0.82 to 0.95[b]	**140** max 70 max	29.8 max 13.1 max	100 130	38 54
No. 5 D	0.82 to 0.95[b]	**400** max 165 max	86.6 max 35.2 max	122 160	50 71
Fuel oils					
No. 1	0.82 to 0.95[b]	34 to 40 **32** to **35**	2.39 to 4.28 2.69	70 100	21 38
No. 2	0.82 to 0.95[b]	36 to 50 **33** to **40**	3.0 to 7.4 2.11 to 4.28	70 100	21 38
No. 3	0.82 to 0.95[b]	**35** to **45** 32.8 to 39	2.69 to 0.584 2.06 to 3.97	100 130	38 54
No. 5A	0.82 to 0.95[b]	**50** to **125** 42 to 72	7.4 to 26.4 4.91 to 13.73	100 130	38 54
No. 5B	0.82 to 0.95[b]	125 to **400** 72 to 310	26.4 to 86.6 13.63 to 67.1	100 122 130	38 50 54
No. 6	0.82 to 0.95[b]	**450** to **3000** 175 to 780	97.4 to 660 37.5 to 172	122 160	50 71

TABLE 6 Continued.

Mineral oils					
Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Fuel oil, navy specification	0.989 max[b]	**110** to **225**	23 to 48.6	122	50
		63 to 115	11.08 to 23.9	160	71
Fuel oil, navy II	1.0 max	**1500** max	324.7 max	122	50
		480 max	104 max	60	71
Gasoline	0.68 to 0.74		0.46 to 0.88	60	16
			0.40 to 0.71	100	38
Gasoline (natural)	76.5 degrees API		0.41	68	20
Gas oil	28 degrees API	73	13.9	70	21
		50	7.4	100	38
Insulating oil					
Transformer, switches, and circuit breakers		115 max	24.1 max	70	21
		65 max	11.75 max	100	38
Kerosene	0.78 to 0.82	35	2.69	68	20
		32.6	2	100	38
Machine lubricating oil (average Pennsylvania paraffin base)					
Federal specification no. 8	0.880 to 0.935[b]	112 to 160	23.4 to 34.3	100	38
		70 to **90**	13.1 to 18.2	130	54
Federal specification no. 10	0.880 to 0.935[b]	160 to 235	34.3 to 50.8	100	38
		90 to **120**	18.2 to 25.3	130	54
Federal specification no. 20	0.880 to 0.935[b]	235 to 385	50.8 to 83.4	100	38
		120 to **185**	25.3 to 39.9	130	54
Federal specification no. 30	0.880 to 0.935[b]	385 to 550	83.4 to 119	100	38
		185 to 255	39.9 to 55.1	130	54

TABLE 6 Continued.

Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Mineral oils					
Mineral lard cutting oil					
Federal specification grade 1		**140** to **190**	29.8 to 41	100	38
		86 to 110	17.22 to 23	130	54
Federal specification grade 2		**190** to **220**	41 to 47.5	100	38
		110 to 125	23 to 26.4	130	54
Petrolatum	0.825	100	20.6	130	54
		77	14.8	160	71
Turbine lubricating oil					
Federal specification (penn base)	0.91 average	400 to 440	86.6 to 95.2	100	38
		185 to **205**	39.9 to 44.3	130	54
Vegetable oils					
Castor oil	0.96 @ 68°F (20°C)	1200 to 1500	259.8 to 324.7	100	38
		450 to 600	97.4 to 129.9	130	54
China wood oil	0.943	**1425**	308.5	69	21
		580	125.5	100	38
Coconut oil	0.925	**140** to **148**	29.8 to 31.6	100	38
		76 to 80	14.69 to 15.7	130	54
Corn oil	0.924	135	28.7	130	54
		54	8.59	212	100
Cotton seed oil	0.98 to 0.925	**176**	37.9	100	38
		100	20.6	130	54
Linseed oil, raw	0.925 to 0.939	**143**	30.5	100	38
		93	18.94	130	54
Olive oil	0.912 to 0.918	**200**	43.2	100	38
		115	24.1	130	54

TABLE 6 Continued.

Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Vegetable oils					
Palm oil	0.924	**221**	47.8	100	38
		125	26.4	130	54
Peanut Oil	0.920	**221**	47.8	100	38
		125	26.4	130	54
Rape seed oil	0.919	**250**	54.1	100	38
		145	31	130	54
Rosin oil	0.980	**1500**	324.7	100	38
		600	129.9	130	54
Rosin (wood)	1.09 avg.	500 to **20,000**	108.2 to 4,400	200	93
		1,000 to 50,000	216.4 to 11,000	190	88
Sesame oil	0.923	**184**	39.6	100	38
		110	23	130	54
Soybean oil	0.927 to 0.98	**165**	35.4	100	38
		96	19.64	130	54
Turpentine	0.86 to 0.87	33	2.11	60	16
		32.6	2.0	100	38
Sugar, syrups, molasses, and so on					
Corn syrups	1.4 to 1.47	5,000 to 500,000	1,100 to 110,000	100	38
		1,500 to 60,000	324.7 to 13,200	130	54
Glucose	1.35 to 1.44	35,000 to 100,000	7,700 to 22,000	100	38
		4,000 to 11,000	880 to 2,420	150	66
Honey (raw)		340	73.6	100	38
Molasses “A” (first)	1.40 to 1.46	1,300 to 23,000	281.1 to 5,070	100	38
		700 to 8,000	151.5 to 1,760	130	54
Molasses “B” (second)	1.43 to 1.48	6,400 to 60,000	1,410 to 13,200	100	38
		3,000 to 15,000	660 to 3,300	130	54
Molasses “C” (blackstrap or final)	1.46 to 1.49	17,000 to 250,000	2,630 to 5,500	100	38
		6,000 to 75,000	1,320 to 16,500	130	54

TABLE 6 Continued.

Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Sugar, syrup, molasses, and so on					
Sucrose solutions (sugar syrups)					
60 Brix	1.29	230	49.7	70	21
		92	18.7	100	38
62 Brix	1.30	310	67.1	70	21
		111	23.2	100	38
64 Brix	1.31	440	95.2	70	21
		148	31.6	100	38
66 Brix	1.326	650	140.7	70	21
		195	42.0	100	38
68 Brix	1.338	1,000	216.4	70	21
		275	59.5	100	38
70 Brix	1.35	1,650	364	70	21
		400	86.6	100	38
72 Brix	1.36	2,700	595	70	21
		640	138.6	100	38
74 Brix	1.376	5,500	1,210	70	21
		1,100	238	100	38
76 Brix	1.39	10,000	2,200	70	21
		2,000	440	100	38
Tars					
Tar, coke oven	1.12+	**3,000** to **8,000**	600 to 1,760	71	21
		650 to 1,400	140.7 to 308	100	38
Tar, gas house	1.16 to 1.30	**15,000** to **300,000**	3,300 to 66,000	70	21
		2,000 to 20,000	440 to 4,400	100	38

TABLE 6 Continued.

Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Tars					
Road tar					
Grade RT-2	1.07+	**200** to **300**	43.2 to 64.9	122	50
		55 to 60	8.77 to 10.22	212	100
Grade RT-4	1.08+	**400** to **700**	86.6 to 154	122	50
		65 to 75	11.63 to 14.28	212	100
Grade RT-6	1.09+	**1,000** to **2,000**	216.4 to 440	122	50
		85 to 125	16.83 to 26.2	212	100
Grade RT-8	1.13+	**3,000** to **8,000**	660 to 1,760	122	50
		150 to 225	31.8 to 48.3	212	100
Grade RT-10	1.14+	**20,000** to **60,000**	4,400 to 13,200	122	50
		250 to 400	53.7 to 86.6	212	100
Grade RT-12	1.15+	114,000 to 456,000	25,000 to 75,000	122	50
		500 to **800**	108.2 to 173.2	212	100
Pine tar	1.06	2,500	559	100	38
		500	108.2	132	56
Miscellaneous					
Corn starch solutions					
22 Baumé	1.18	150	32.1	70	21
		130	27.5	100	38
24 Baumé	1.20	600	129.8	70	21
		440	95.2	100	38
25 Baumé	1.21	1,400	303	70	21
		800	173.2	100	38
Ink, printers	1.00 to 1.38	2,500 to 10,000	550 to 2,200	100	38
		1,100 to 3,000	238.1 to 660	130	54
Tallow	0.918 avg.	56	9.07	212	100
Milk	1.02 to 1.05		1.13	68	20

TABLE 6 Continued.

Miscellaneous					
Liquid	Sp. gr. at 60°F (15.6°C)[a]	SSU	Centistokes	At °F	At °C
Varnish, spar	0.9	1425	313	68	20
		650	143	100	38
Water, fresh	1.0		1.123	60	16
			0.516	130	54

[a]Unless otherwise noted

[b]Depends on origin or percent and type of solvent

Source: *Hydraulic Institute Engineering Data Book,* 2nd Edition, 1990, Hydraulic Institute, Parsippany, NJ

TABLE 7 Viscosity Conversion Table

This table gives an approximate comparison of ratings so that, if a viscosity is given in terms other than Saybolt seconds universal, it can be translated quickly by following horizontally to the SSU column.

Saybolt universal seconds SSU	Kinematic viscosity, cSt[a]	Approx. seconds, Mac Michael	Approx. Gardner Holt bubble	Seconds, Zahn cup 1	Seconds, Zahn cup 2	Seconds, Zahn cup 3	Seconds, Zahn cup 4	Seconds, Zahn cup 5	Seconds, Demmler cup 1	Seconds, Demmler cup 10	Approx. seconds, Stormer 100–g load	Seconds, Pratt and Lambert "F"
31	1.00	—	—	—	—	—	—	—	—	—	—	—
35	2.56	—	—	—	—	—	—	—	—	—	—	—
40	4.30	—	—	—	—	—	—	—	1.3	—	—	—
50	7.40	—	—	—	—	—	—	—	2.3	—	2.6	—
60	10.3	—	—	—	—	—	—	—	3.2	—	3.6	—
70	13.1	—	—	—	—	—	—	—	4.1	—	4.6	—
80	15.7	—	—	—	—	—	—	—	4.9	—	5.5	—
90	18.2	—	—	—	—	—	—	—	5.7	—	6.4	—
100	20.6	125	—	38	18	—	—	—	6.5	—	7.3	—
150	32.1	145	—	47	20	—	—	—	10.0	1.0	11.3	—
200	43.2	165	A	54	23	—	—	—	13.5	1.4	15.2	—
250	54.0	198	A	62	26	—	—	—	16.9	1.7	19	—
300	65.0	225	B	73	29	—	—	—	20.4	2.0	23	—
400	87.0	270	C	90	37	—	—	—	27.4	2.7	31	7
500	110.0	320	D	—	46	—	—	—	34.5	3.5	39	8
600	132	370	F	—	55	—	—	—	41	4.1	46	9
700	154	420	G	—	63	22.5	—	—	48	4.8	54	9.5
800	176	470	—	—	72	24.5	—	—	55	5.5	62	10.8
900	198	515	H	—	80	27	18	—	62	6.2	70	11.9
1000	220	570	I	—	88	29	20	138	69	6.9	77	12.4
1500	330	805	M	—	—	40	28	18	103	10.3	116	16.8
2000	440	1070	Q	—	—	51	34	24	137	13.7	154	22
2500	550	1325	T	—	—	63	41	29	172	17.2	193	27.6
3000	660	1690	U	—	—	75	48	33	206	20.6	232	33.7
4000	880	2110	V	—	—	—	63	43	275	27.5	308	45
5000	1100	2635	W	—	—	—	77	50	344	34.4	385	55.8
6000	1320	3145	X	—	—	—	—	65	413	41.3	462	65.5

TABLE 7 Continued.

Saybolt universal seconds SSU	Kinematic viscosity, cSt[a]	Approx. seconds, Mac Michael	Approx. Gardner Holt bubble	Seconds, Zahn cup 1	Seconds, Zahn cup 2	Seconds, Zahn cup 3	Seconds, Zahn cup 4	Seconds, Zahn cup 5	Seconds, Demmler cup 1	Seconds, Demmler cup 10	Approx. seconds, Stormer 100–g load	Seconds, Pratt and Lambert "F"
7000	1540	3670	—	—	—	—	—	75	481	48	540	77
8000	1760	4170	Y	—	—	—	—	86	550	55	618	89
9000	1980	4700	—	—	—	—	—	96	620	62	695	102
10,000	2200	5220	Z	—	—	—	—	—	690	69	770	113
15,000	3300	7720	Z2	—	—	—	—	—	1030	103	1160	172
20,000	4400	10500	Z3	—	—	—	—	—	1370	137	1540	234

[a]Kinematic viscosity (in centistokes) = $\dfrac{\text{absolute viscosity (in centipoises)}}{\text{density}}$

When the SI units centistokes and centipoises are used, the density is numerically equal to the specific gravity. Therefore, the following will be sufficiently accurate for most calculations:

Kinematic viscosity (in centistokes) = $\dfrac{\text{absolute viscosity (in centipoises)}}{\text{specific gravity}}$

When USCS units are used, the density must be used rather than the specific gravity.

Note: For values of 70 cSt and above, use the conversion

$$\text{SSU} = \text{centistokes} \times 4.635$$

Above the range of this table and within the range of the viscosimeter, multiply the particular value by the following approximate factors to convert to SSU:

Viscosimeter	Factor
Mac Michael	1.92 (approx.)
Demmler 1	14.6
Demmler 10	146
Stormer	13 (approx.)

Source: *Hydraulic Institute Engineering Data Book,* 2nd Edition, 1990, Hydraulic Institute, Parsippany, NJ

TABLE 7 Viscosity conversion table, (cont.)
This table gives an approximate comparison of ratings so that, if a viscosity is given in terms other than Saybolt seconds universal, it can be translated quickly by following horizontally to the SSU column.

Saybolt seconds universal SSU	Kinematic viscosity, cSt[a]	Saybolt seconds Furol SSF	Seconds, Redwood 1 (standard)	Seconds, Redwood 2 (admiralty)	Degrees, Engler	Degrees, Barbey	Seconds, Parlin cup 7	Seconds, Parlin cup 10	Seconds, Parlin cup 15	Seconds, Parlin 20	Seconds, Ford cup 3	Seconds, Ford cup 4
31	1.00	—	29	—	1.00	6200	—	—	—	—	—	—
35	2.56	—	32.1	—	1.16	2420	—	—	—	—	—	—
40	4.30	—	36.2	5.10	1.31	1440	—	—	—	—	—	—
50	7.40	—	44.3	5.83	1.58	838	—	—	—	—	—	—
60	10.3	—	52.3	6.77	1.88	618	—	—	—	—	—	—
70	13.1	12.95	60.9	7.60	2.17	483	—	—	—	—	—	—
80	15.7	13.70	69.2	8.44	2.45	404	—	—	—	—	—	—
90	18.2	14.44	77.6	9.30	2.73	348	—	—	—	—	—	—
100	20.6	15.24	85.6	10.12	3.02	307	—	—	—	—	—	—
150	32.1	19.30	128	14.48	4.48	195	—	—	—	—	—	—
200	43.2	23.5	170	18.90	5.92	144	40	—	—	—	—	—
250	54.0	28.0	212	23.45	7.35	114	46	—	—	—	—	—
300	65.0	32.5	254	28.0	8.79	95	52.5	15	6.0	3.0	30	20
400	87.60	41.9	338	37.1	11.70	70.8	66	21	7.2	3.2	42	28
500	110.0	51.6	423	46.2	14.60	56.4	79	25	7.8	3.4	50	34
600	132	61.4	508	55.4	17.50	47.0	92	30	8.5	3.6	58	40
700	154	71.1	592	64.6	20.45	40.3	106	35	9.0	3.9	67	45
800	176	81.0	677	73.8	23.35	35.2	120	39	98.8	4.1	74	50
900	198	91.0	762	83.0	26.30	31.3	135	41	10.7	4.3	82	57
1000	220	100.7	896	92.1	29.20	28.2	149	43	11.5	4.5	90	62
1500	330	150	1270	138.2	43.80	18.7	—	65	15.2	6.3	132	90
2000	440	200	1690	184.2	58.40	14.1	—	86	19.5	7.5	172	118
2500	550	250	2120	230	73.0	11.3	—	108	24	9	218	147
3000	660	300	2540	276	87.60	9.4	—	129	28.5	11	258	172
4000	880	400	3380	368	117.0	7.05	—	172	37	14	337	230
5000	1100	500	4230	461	146	5.64	—	215	47	18	425	290
6000	1320	600	5080	553	175	4.70	—	258	57	22	520	350

TABLE 7 Continued.

Saybolt seconds universal SSU	Kinematic viscosity, cSt[a]	Saybolt seconds Furol SSF	Seconds, Redwood 1 (standard)	Seconds, Redwood 2 (admiralty)	Degrees, Engler	Degrees, Barbey	Seconds, Parlin cup 7	Seconds, Parlin cup 10	Seconds, Parlin cup 15	Seconds, Parlin 20	Seconds, Ford cup 3	Seconds, Ford cup 4
7000	1540	700	5920	645	204.5	4.03	—	300	67	25	600	410
8000	1760	800	6770	737	233.5	3.52	—	344	76	29	680	465
9000	1980	900	7620	829	263	3.13	—	387	86	32	780	520
10,000	2200	1000	8460	921	292	2.82	—	430	96	35	850	575
15,000	3300	1500	13,700	—	438	2.50	—	650	147	53	1280	860
20,000	4400	2000	18,400	—	584	1.40	—	860	203	70	1715	1150

[a]Kinematic viscosity (in centistokes) $= \dfrac{\text{absolute viscosity (in centipoises)}}{\text{density}}$

When the SI units centistokes and centipoises are used, the density is numerically equal to the specific gravity. Therefore, the following will be sufficiently accurate for most calculations:

Kinematic viscosity (in centistokes) $= \dfrac{\text{absolute viscosity (in centipoises)}}{\text{specific gravity}}$

When USCS units are used, the density must be used rather than the specific gravity.

Note: For values of 70 cSt and above, use the conversion

$$\text{SSU} = \text{centistokes} \times 4.635$$

Above the range of this table and within the range of the viscosimeter, multiply the particular value by the following approximate factors to convert to SSU:

Viscosimeter	Factor	Viscosimeter	Factor
Saybolt Furol	10.	Parlin cup #15	98.2
Redwood Standard	1.095	Parlin cup #20	187.0
Redwood Admiralty	10.87	Ford cup #4	17.4
Engler, degrees	34.5		

Source: *Hydraulic Institute Engineering Data Book,* 2nd Edition, 1990, Hydraulic Institute, Parsippany, NJ

TABLE 8 Properties of water at temperatures from 40 to 705.4°F (4.4 to 374.1°C)

°F	°C	Specific volume[a], ft³/lb	Specific gravity			Wt[b], lb/ft³	Vapor pressure[c], lb/in²abs
			39.2°F reference	60°F reference	70°F reference		
40	4.4	0.01602	1.000	1.001	1.002	62.42	0.1217
50	10.0	0.01603	0.999	1.001	1.002	62.38	0.1781
60	15.6	0.01604	0.999	1.000	1.001	62.34	0.2563
70	21.1	0.01606	0.998	0.999	1.000	62.27	0.3631
80	26.7	0.01608	0.996	0.998	0.999	62.19	0.5069
90	32.2	0.01610	0.995	0.996	0.997	62.11	0.6982
100	37.8	0.01613	0.993	0.994	0.995	62.00	0.9492
120	48.9	0.01620	0.989	0.990	0.991	61.73	1.692
140	60.0	0.01629	0.983	0.985	0.986	61.39	2.889
160	71.1	0.01639	0.977	0.979	0.979	61.01	4.741
180	82.2	0.01651	0.970	0.972	0.973	60.57	7.510
200	93.3	0.01663	0.963	0.964	0.966	60.13	11.526
212	100.0	0.01672	0.958	0.959	0.960	59.81	14.696
220	104.4	0.01677	0.955	0.956	0.957	59.63	17.186
240	115.6	0.01692	0.947	0.948	0.949	59.10	24.97
260	126.7	0.01709	0.938	0.939	0.940	58.51	35.43
280	137.8	0.01726	0.928	0.929	0.930	58.00	49.20
300	148.9	0.01745	0.918	0.919	0.920	57.31	67.01
320	160.0	0.01765	0.908	0.909	0.910	56.66	89.66
340	171.1	0.01787	0.896	0.898	0.899	55.96	118.01
360	182.2	0.01811	0.885	0.886	0.887	55.22	153.04
380	193.3	0.01836	0.873	0.874	0.875	54.47	195.77
400	204.4	0.01864	0.859	0.860	0.862	53.65	247.31
420	215.6	0.01894	0.846	0.847	0.848	52.80	308.83
440	226.7	0.01926	0.832	0.833	0.834	51.92	381.59
460	237.8	0.0196	0.817	0.818	0.819	51.02	466.0
480	248.9	0.0200	0.801	0.802	0.803	50.00	566.1
500	260.0	0.0204	0.785	0.786	0.787	49.02	680.8
520	271.1	0.0209	0.765	0.766	0.767	47.85	812.4
540	282.2	0.0215	0.746	0.747	0.748	46.51	962.5
560	293.3	0.0221	0.726	0.727	0.728	45.3	1133.1
580	304.4	0.0228	0.703	0.704	0.704	43.9	1325.8
600	315.6	0.0236	0.678	0.679	0.680	42.3	1542.9
620	326.7	0.0247	0.649	0.650	0.650	40.5	1786.6
640	337.8	0.0260	0.617	0.618	0.618	38.5	2059.7
660	348.9	0.0278	0.577	0.577	0.578	36.0	2365.4
680	360.0	0.0305	0.525	0.526	0.527	32.8	2708.1
700	371.1	0.0369	0.434	0.435	0.435	27.1	3093.7
705.4	374.1	0.0503	0.319	0.319	0.320	19.9	3206.2

[a] 1 m^3/kg = 16.02 ft^3/lb

[b] 1 kg/m^3 = 0.06243 lb/ft^3

[c] 1 kPa = 0.145 lb/in^2; 1 bar = 14.5 lb/in^2

Source: *Hydraulic Institute Engineering Data Book,* 2nd Edition, 1990, Hydraulic Institute, Parsippany, NJ

TABLE 9 Conversions of USCS to SI units

The first two digits of each numeral entry represent a power of 10. An asterisk follows each number that expresses an exact definition.

Acceleration

To convert from	to	multiply by
foot/second^2	meter/second^2	−01 3.048*
free fall, standard	meter/second^2	+00 9.806 65*
gal (galileo)	meter/second^2	−02 1.00*
inch/second^2	meter/second^2	−02 2.54*

Area

To convert from	to	multiply by
acre	meter^2	+03 4.046 856 4224*
circular mil	meter^2	−10 5.067 074 8
foot^2	meter^2	−02 9.290 304*
inch^2	meter^2	−04 6.4516*
mile^2 (U.S. statute)	meter^2	+06 2.589 988 110 336*
yard^2	meter^2	−01 8.361 273 6*

Density

To convert from	to	multiply by
gram/centimeter^3	kilogram/meter3	+03 1.00*
lbm/inch^3	kilogram/meter^3	+04 2.767 990 5
lbm/foot^3	kilogram/meter^3	+01 1.601 846 3
slug/foot^3	kilogram/meter^3	+02 5.153 79

Energy

To convert from	to	multiply by
British thermal unit (ISO/TC 12)	joule	+03 1.055 06
British thermal unit (International Steam Table)	joule	+03 1.055 04
British thermal unit (mean)	joule	+03 1.055 87
British thermal unit (thermochemical)	joule	+03 1.054 350 264 488
British thermal unit (39°F)	joule	+03 1.059 67
British thermal unit (60°F)	joule	+03 1.054 68
calorie (International Steam Table)	joule	+00 4.1868
calorie (mean)	joule	+00 4.190 02
calorie (thermochemical)	joule	+00 4.184*
calorie (15°C)	joule	+00 4.185 80

Length

To convert from	to	multiply by
fathom	meter	+00 1.8288*
foot	meter	−01 3.048*
foot (U.S. survey)	meter	+00 1200/3937*
foot (U.S. survey)	meter	−01 3.048 006 096
furlong	meter	+02 2.011 68*
inch	meter	−02 2.54*
league (U.K. nautical)	meter	03 5.559 552*
league (international nautical)	meter	+03 5.556*
league (statute)	meter	+03 4.828 032*
light-year	meter	+15 9.460 55
meter	wavelengths Kr 86	+06 1.650 763 73*
micron	meter	−06 1.00*
mil	meter	−05 2.54*
mile (U.S. statute)	meter	+03 1.609 344*
mile (U.K. nautical)	meter	+03 1.853 184*
mile (international nautical)	meter	+03 1.852*
mile (U.S. nautical)	meter	+03 1.852*
nautical mile (U.K.)	meter	+03 1.853 184*
nautical mile (international)	meter	+03 1.852*
nautical mile (U.S.)	meter	+03 1.852*
rod	meter	+00 5.0292*
statute mile (U.S.	meter	+03 1.609 344*
yard	meter	−01 9.144*

Mass

To convert from	to	multiply by
carat (metric)	kilogram	−04 2.00*
grain	kilogram	−05 6.479 891*
gram	kilogram	−03 1.00*
kgf second^2 meter (mass)	kilogram	+00 9.806 65*
kilogram mass	kilogram	+00 1.00*
lbm (pound mass, avoirdupois)	kilogram	−01 4.535 923 7*
ounce mass (avoirdupois)	kilogram	−02 2.834 952 312 5*
ounce mass (troy or apothecary)	kilogram	−02 3.110 347 68*
pennyweight	kilogram	−03 1.555 173 84*
pound mass, lbm (avoirdupois)	kilogram	−01 4.535 923 7*
pound mass (troy or apothecary)	kilogram	−01 3.732 417 216*
slug	kilogram	+01 1.459 390 29
ton (assay)	kilogram	−02 2.916 666 6
ton (long)	kilogram	+03 1.016 046 908 8*

TABLE 9 Continued.

Energy

To convert from	to	multiply by
calorie (20°C)	joule	+00 4.181 90
calorie (kilogram, International Steam Table)	joule	+03 4.1868
calorie (kilogram, mean)	joule	+03 4.190 02
calorie (kilogram, thermochemical)	joule	+03 4.184*
electronvolt	joule	−19 1.602 10
erg	joule	−07 1.00*
foot pound force (ft • lbf)	joule	+00 1.355 817 9
foot poundal	joule	−02 4.214 011 0
joule (international of 1948)	joule	+00 1.000 165
kilocalorie (International Steam Table)	joule	+03 4.1868
kilocalorie (mean)	joule	+03 4.190 02
kilocalorie (thermochemical)	joule	+03 4.184*
kilowatthour	joule	+06 3.60*
kilowatthour (international of 1948)	joule	+06 3.600 59
ton (nuclear equivalent of TNT)	joule	+09 4.20
watthour	joule	+03 3.60*

Energy/Area Time

To convert from	to	multiply by
Btu (thermochemical)/foot^2 second	watt/meter^2	+04 1.134 893 1
Btu (thermochemical)/foot^2 minute	watt/meter^2	+02 1.891 488 5
Btu (thermochemical)/foot^2 hour	watt/meter^2	+00 3.152 480 8
Btu (thermochemical)/inch^2 second	watt/meter^2	+06 1.634 246 2
calorie (thermochemical)/cm^2 minute	watt/meter^2	+02 6.973 333 3
erg/centimeter^2 second	watt/meter^2	−03 1.00*
watt/centimeter^2	watt/meter^2	+04 1.00*

Force

To convert from	to	multiply by
dyne	newton	−05 1.00*
kilogram force (kgf)	newton	+00 9.806 65*
kilopond force	newton	+00 9.806 65*
kip	newton	+03 4.448 221 615 260 5*
lbf (pound force, avoirdupois)	newton	+00 4.448 221 615 260 5*
ounce force (avoirdupois)	newton	−01 2.780 138 5
pound force lbf (avoirdupois)	newton	+00 4.448 221 615 260 5*
poundal	newton	−01 1.382 549 543 76*

Mass

To convert from	to	multiply by
ton (metric)	kilogram	+03 1.00*
ton (short, 2000 pound)	kilogram	+02 9.071 847 4*

Power

To convert from	to	multiply by
Btu (thermochemical)/second	watt	+03 1.054 350 264 488
Btu (thermochemical)/minute	watt	+01 1.757 250 4
calorie (thermochemical)/second	watt	+00 4.184*
calorie (thermochemical)/minute	watt	−02 6.973 333 3
foot lbf/hour	watt	−04 3.766 161 0
foot lbf/minute	watt	−02 2.259 696 6
foot lbf/second	watt	+00 1.355 817 9
horsepower (550 foot lbf/second)	watt	+02 7.456 998 7
horsepower (boiler)	watt	+03 9.809 50
horsepower (electric)	watt	+02 7.46*
horsepower (metric)	watt	+02 7.354 99
horsepower (U.K.)	watt	+02 7.457
horsepower (water)	watt	+02 7.460 43
kilocalorie (thermochemical)/minute	watt	+01 6.973 333 3
kilocalorie (thermochemical)/second	watt	+03 4.184*
watt (international of 1948)	watt	+00 1.000 165

Pressure

To convert from	to	multiply by
atmosphere	newton/meter^2	+05 1.013 25*
bar	newton/meter^2	+05 1.00*
centimeter of mercury (0°C)	newton/meter^2	+03 1.333 22
centimeter of water (4°C)	newton/meter^2	+01 9.806 38
dyne/centimeter^2	newton/meter^2	−01 1.00*
foot of water (39.2°F)	newton/meter^2	+03 2.988 98
inch of mercury (32°F)	newton/meter^2	+03 3.386 389
inch of mercury (60°F)	newton/meter^2	+03 3.376 85
inch of water (39.2°F)	newton/meter^2	+02 2.490 82
inch of water (60°F)	newton/meter^2	+02 2.4884
kgf/centimeter^2	newton/meter^2	+04 9.806 65*
kgf/meter^2	newton/meter^2	+00 9.806 65*
lbf/foot^2	newton/meter^2	+01 4.788 025 8

TABLE 9 Continued.

Pressure

To convert from	to	multiply by
lbf/inch^2 (psi)	newton/meter^2	+03 6.894 757 2
millibar	newton/meter^2	+02 1.00*
millimeter of mercury (0°C)	newton/meter^2	+02 1.333 224
pascal	newton/meter^2	+00 1.00*
psi (lbf/inch^2)	newton/meter^2	+03 6.894 757 2

Speed

To convert from	to	multiply by
foot/hour	meter/second	−05 8.466 666 6
foot/minute	meter/second	−03 5.08*
foot/second	meter/second	−01 3.048*
inch/second	meter/second	−02 2.54*
kilometer/hour	meter/second	−01 2.777 777 8
knot (international)	meter/second	−01 5.144 444 444
mile/hour (U.S. statute)	meter/second	−01 4.4704*
mile/minute (U.S. statute)	meter/second	+01 2.682 24*
mile/second (U.S. statute)	meter/second	+03 1.609 344*

Temperature

To convert from	to	proceed as follows
Celsius	Kelvin	$t_K = t_C + 273.15$
Fahrenheit	Kelvin	$t_K = (\frac{5}{9})(t_F + 459.67)$
Fahrenheit	Celsius	$t_C = (\frac{5}{9})(t_F - 32)$
Rankine	Kelvin	$t_K = (\frac{5}{9})t_R$

Viscosity

To convert from	to	multiply by
centistoke	meter^2/second	−06 1.00*
stoke	meter^2/second	−04 1.00*
foot^2/second	meter^2/second	−02 9.290 304*
centipoise	newton second/meter^2	−03 1.00*
lbm/foot second	newton second/meter^2	+00 1.488 163 9
lbf second/foot^2	newton second/meter^2	+01 4.788 025 8

Viscosity

To convert from	to	multiply by
poise	newton second/meter^2	−01 1.00*
poundal second/foot^2	newton second/meter^2	+00 1.488 163 9
slug/foot second	newton second/meter^2	+01 4.788 025 8
rhe	meter^2/newton second	+01 1.00*

Volume

To convert from	to	multiply by
acre foot	meter^3	+03 1.233 481 9
barrel (petroleum, 42 gallons)	meter^3	−01 1.589 873
bushel (U.S.)	meter^3	−02 3.523 907 016 688*
cord	meter^3	+00 3.624 556 3
cup	meter^3	−04 2.365 882 365*
dram (U.S. fluid)	meter^3	−06 3.696 691 195 312 5*
fluid ounce (U.S.)	meter^3	−05 2.957 352 956 25*
foot^3	meter^3	−02 2.831 684 659 2*
gallon (U.K. liquid)	meter^3	−03 4.546 087
gallon (U.S. dry)	meter^3	−03 4.404 883 770 86*
gallon (U.S. liquid)	meter^3	−03 3.785 411 784*
gill (U.S.)	meter^3	−04 1.182 941 2
inch^3	meter^3	−05 1.638 706 4*
liter	meter^3	−03 1.00*
ounce (U.S. fluid)	meter^3	−05 2.957 352 956 25*
peck (U.S.)	meter^3	−03 8.809 767 541 72*
pint (U.S. dry)	meter^3	−04 5.506 104 713 575*
pint (U.S. liquid)	meter^3	−04 4.731 764 73*
quart (U.S. dry)	meter^3	−03 1.101 220 942 715*
quart (U.S. liquid)	meter^3	−04 9.463 529 5
tablespoon	meter^3	−05 1.478 676 478 125*
teaspoon	meter^3	−06 4.928 921 593 75*
ton (register)	meter^3	+00 2.831 684 659 2*
yard^3	meter^3	−01 7.645 548 579 84*

Volume/Unit Time

To convert from	to	multiply by
gallon/minute	meter^3/second	−05 6.309 020
gallon/minute	meter^3/hour	−01 2.271 247
gallon/minute	liter/second	−02 6.309 020