D.
Engineering data

Fractions, decimals and millimeters equivilants

Fraction	Decimal	MM	Fraction	Decimal	MM	Fraction	Decimal	MM
1/64	.0156	0.396	21/64	.3281	8.334	41/64	.6406	16.271
1/32	.0312	0.793	11/32	.3437	8.731	21/32	.6562	16.668
3/64	.0468	1.190	23/64	.3593	9.128	43/64	.6718	17.065
1/16	.0625	1.587	3/8	.375	9.525	11/16	.6875	17.462
5/64	.0781	1.984	25/64	.3906	9.921	45/64	.7031	17.859
3/32	.0937	2.381	13/32	.4062	10.318	23/32	.7187	18.256
7/64	.1093	2.778	27/64	.4218	10.715	47/64	.7343	18.653
1/8	.125	3.175	7/16	.4375	11.112	3/4	.750	19.050
9/64	.1406	3.571	29/64	.4531	11.509	49/64	.7656	19.446
5/32	.1562	3.968	15/32	.4687	11.906	25/32	.7812	19.843
11/64	.1718	4.365	31/64	.4843	12.303	51/64	.7968	20.240
3/16	.1875	4.762	1/2	.500	12.700	13/16	.8125	20.637
13/64	.2031	5.159	33/64	.5256	13.096	53/64	.8281	21.034
7/32	.2187	5.556	17/32	.5312	13.493	27/32	.8437	21.431
15/64	.2343	5.953	35/64	.5468	13.890	55/64	.8593	21.828
1/4	.250	6.350	9/16	.5625	14.287	7/8	.875	22.225
17/64	.2656	6.746	37/64	.5781	14.684	57/64	.8906	22.621
9/32	.2812	7.143	19/32	.5937	15.081	29/32	.9062	23.018
19/64	.2968	7.540	39/64	.6093	15.478	59/64	.9218	23.415
5/16	.3125	7.937	5/8	.625	15.875	15/16	.9375	23.812
						61/64	.9531	24.209
						31/32	.9687	24.606
						63/64	.9843	25.003
						1	1.000	25.400

Useful formulas

Circumference of a circle = 3.1416 x diameter = 6.2832 x radius
Area of a circle = .7854 x $(\text{diameter})^2 = 3.1416 \times (\text{radius})^2$
Area of a sphere = 3.1416 x $(\text{diameter})^2$
Volume of a sphere = .5236 x $(\text{diameter})^3$
Area of a triangle = 0.5 x base x height
Area of a trapezoid = 0.5 x sum of the two parallel sides x height
Area of a square, a rectangle, or a parallelogram = base x height
Volume of a pyramid = area of base x 1/3 height
Volume of a cone = 0.2618 x $(\text{diameter of base})^2$ x height
Volume of a cylinder = 0.7854 x height x diameter

Metric Prefixes

Mega	= 1,000,000
Kilo	= 1,000
Hecto	= 100
Deca	= 10
Deci	= .1
Centi	= .01
Milli	= .001
Micro	= .000,001

Area conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
sq. inches	sq. cm	6.49	sq. yards	acres	.000207
sq. inches	sq. ft	.00694	acres	sq. feet	43,560
sq. inches	sq. yards	.000772	acres	sq. yards	4840
sq. ft	sq. cm	929	sq. cm	sq. inches	.155
sq. ft	sq. inches	144	sq. cm	sq. ft	.0011
sq. ft	sq. yards	.111	sq. m	sq. inches	1550
sq. yards	sq. inches	1296	sq. m	sq. ft	10.76
sq. yards	sq. feet	9			

Energy conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
BTU	foot pounds	778.3	joules	BTU	.000948
BTU	gram-calories	252.0	joules	foot pounds	.7376
BTU	horsepower-hrs	.000393	joules	watt/hrs	.0002778
BTU	joules	1054.8	kilogram-calories	BTU	3.968
BTU	kilocalories	.252	kilogram-calories	foot pounds	3.088
BTU/hr	watts	.2931	kilogram-calories	joules	4186
BTU/min	horsepower	.02358	kilogram-calories	kilowatt-hrs	.00163
BTU/min	kilowatts	.01757	kilowatts	BTU/min	56.92
BTU/min	watts	17.57	kilowatts	foot pounds/min	.0004426
boiler horsepower	BTU/hr	33479	kilowatts	horsepower	1.341
foot pounts	BTU	.001285	kilowatts	kg calories/min	14.34
foot pounds	joules	1.3558	kilowatt/hrs	BTU	3413
horsepower	BTU/hr	2546.4	kilowatt/hrs	horsepower/hrs	1.341
horsepower	kilocalories/hr	641.1	kilowatt/hrs	joules	3600000
horsepower	watts	745.7	watts	BTU/hr	3412
Refrigeration					
1 ton	BTU/hr	12000			
1 ton	kilocalories/hr	3025			
1 ton	watts	3517			

Flow conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
(Cv	Kv	.86)	(Kv	Cv	1.16)
Gallon US	Gallons Imp	.83267	Gallons Imp	Gallon US	1.20095
Gallon US	liters	3.785	Gallons Imp	liters	4.546
Gallon US	cubic meters	.003785	Gallons Imp	cubic meters	.004546
lbs H_20/hr	gallons min	.002	liter	Gallon US	.2642
Gallons min	lbs H_20 hr	500	liter/min	Gallon US/min	.26418
Gallons min	m^3/hr	.227	liter/sec	Gallon US/min	15.85
			m^3/hr	Gallon US/min	4.4

Length conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
feet	inches	12	miles	kilometers	1.609
feet	meters	.3048	yards	feet	3
feet	millimeters	304.8	centimeters	inches	.3937
feet	miles	.0001894	kilometers	feet	3281
feet	yards	.3333	kilometers	meters	1000
inches	yards	.0278	kilometers	miles	.6214
inches	feet	.0833	meters	feet	3.281
inches	centimeters	2.540	meters	inches	39.37
inches	meters	.02540	meters	millimeters	1000
miles	feet	5280	millimeters	inches	.0394

Pressure conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
atmospheres	kilopascals	101.325	bars	kgs/sq. meter	10195
atmospheres	pounds sq. inch	14.6963	bars	kilopascals	100
inches Hg (32°F)	bars	.033864	bars	millimeters CW	10200
inches Hg (32°F)	inches CW	13.6185	bars	feet CW	33.50
inches Hg (32°F)	pounds sq. inch	.491154	bars	pounds/sq. inch	14.50
inches Hg (32°F)	millimeters HG	25.4005	kilogram/cu. meter	pounds/cu. foot	.062428
feet CW	kilopascals	2.99	kilopascals	bar	.01
feet CW	millimeters CW	305	kilopascals	foot CW	.335
feet CW	pounds sq. inch	.4329	kilopascals	millimeters CW	102
pounds sq. inch	kilopascals	6.895	kilopascals	pounds/sq. inch	.14504
pounds sq. inch	millimeters CW	704	kilograms/meter	pounds/foot	.6720
pounds sq. inch	pascals	6895	meters CW	kilopascals	9.8
pounds/sq. inch	feet CW	2.31	meters CW	millimeters CW	1000
			meters CW	feet CW	3.281
			meters CW	pounds sq. inch	1.42
			millimeters at		
			Hg (32°F - 4°C)	bars	.001333
			Hg (32°F - 4°C)	feet CW	.044680
			Hg (32°F - 4°C)	pounds/sq. inch	.0193368
			pascals	bar	.00001
			pascals	pounds/sq. inch	.000145

Temperature conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
Fahreinheit°	Celcius	1.8 (C + 32)	Celcius°	Fahreinheit	5/9 (F° - 32°)
Fahreinheit°	Kelvin	(F° + 459.67) 1.8	Celcius°	Kelvin	C + 273.15°

Velocity conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
feet/min	feet/sec	.0167	kilometers/hr	feet/min	54.68
feet/min	kilometers/hr	.01829	kilometers/hr	miles/hr	.6214
feet/min	meters/sec	.00508	meters/sec	feet/min	196.8
feet/min	miles/hr	.01136	meters/sec	feet/sec	3.2808
feet/sec	meters/sec	.3048			
miles/hr	feet/min	88			
miles/hr	kilometers/hr	1.609			

Volume conversion formulas

English			S.I. Units		
To Convert From	To	Multiply By	To Convert From	To	Multiply By
cubic feet	cubic inches	1728	cubic centimeters	cubic feet	.00003531
cubic feet	cubic meters	.02832	cubic centimeters	cubic inches	0.6102
cubic feet	cubic yards	.03704	cubic centimeters	gallons	.0002642
cubic feet	gallons U.S.	7.48052	cubic centimeters	liters	.001
cubic feet	liters	28.32	cubic meters	cubic feet	35.31
cubic inches	cubic centimeters	16.39	cubic meters	cubic inches	61,023.0
cubic inches	cubic feet	.0005787	cubic meters	cubic yards	1.308
cubic inches	cubic meters	.00001639	cubic meters	gallons U.S.	264.2
cubic inches	gallons U.S.	.004329	cubic meters	liters	1000.0
cubic inches	liters	.01639	gallons imp.	gallons U.S.	1.20095
cubic yards	cubic feet	27.0	liters	cubic centimeters	1000
cubic yards	cubic inches	46,656.0	liters	cubic feet	.03531
cubic yards	cubic meters	0.7646	liters	cubic inches	61.02
cubic yards	gallons U.S.	202.0	liters	cubic meters	.0001
cubic yards	liters	764.6	liters	cubic yards	.001308
gallons U.S.	cubic feet	0.1337	liters	gallons U.S.	.2642
gallons U.S.	cubic inches	231.0	liters	ounce (fluid)	33.818
gallons U.S.	cubic meters	.003785			
gallons U.S.	cubic yards	.004951			
gallons U.S.	liters	3.785			
gallons U.S.	gallons imp.	.83267			
ounce (fluid)	liter	.02957			

Weight conversion formulas

English			S. I. Units		
To Convert From	Into	Multiply By	To Convert From	Into	Multiply By
ounces (Avoir)	grains	437.5	grains	grams	.06480
	grams	28.3495		ounces (Avoir)	.002286
	pounds	.0625	grams	grains	15.43
pounds (Avoir)	grains	7000		kilograms	.001
	grams	453.592		milligrams	1.000
	kilograms	.4536		ounces (Avoir)	.03527
	ounces	16.0		pounds	.002205
	ounces (troy)	14.5833	kilograms	grams	1,000
	pounds (troy)	1.2153		pounds	2.205
	tons (short)	.0005		tons (long)	.000984
	tons (long)	.000446		tons (short)	.001102
tons (long)	kilograms	1016	tons (metric)	kilograms	1,000
	pounds	2240		pounds	2205
	tons (short)	1.120		tons (long)	1.016
tons (short)	kilograms	907.1848		tons (short)	1.1056
	ounces	32,000			
	pounds	2,000			
	tons (long)	.8929			
	tons(metric)	.9078			

Friction head loss for water

Fittings			Pipe size									
			1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3
 **Regular 90° ell**	Screwed	Steel	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11
		C.I.	-	-	-	-	-	-	-	-	-	9.0
	Flanged	Steel	-	-	.92	1.2	1.6	2.1	2.4	3.1	36	4.4
		C.I.	-	-	-	-	-	-	-	-	-	3.6
 **Long radius 90° ell**	Screwed	Steel	1.5	2.0	2.2	2.3	2.7	3.2	3.4	3.6	3.6	4.0
		C.I.	-	-	-	-	-	-	-	-	-	3.3
	Flanged	Steel	-	-	1.1	1.3	1.6	2.0	2.3	2.7	2.9	3.4
		C.I.	-	-	-	-	-	-	-	-	-	2.8
 **Regular 45° ell**	Screwed	Steel	.34	.52	.71	.92	1.3	1.7	2.1	2.7	3.2	4.0
		C.I.	-	-	-	-	-	-	-	-	-	3.3
	Flanged	Steel	-	-	.45	.59	.81	1.1	1.3	1.7	2.0	2.6
		C.I.	-	-	-	-	-	-	-	-	-	2.1
 **Tee-line flow**	Screwed	Steel	.79	1.2	1.7	2.4	3.2	4.6	5.6	7.7	9.3	12
		C.I.	-	-	-	-	-	-	-	-	-	9.9
	Flanged	Steel	-	-	.69	.82	1.0	1.3	1.5	1.8	1.9	2.2
		C.I.	-	-	-	-	-	-	-	-	-	1.9
 **Tee-branch flow**	Screwed	Steel	2.4	3.5	4.2	5.3	6.6	8.7	9.9	12	13	17
		C.I.	-	-	-	-	-	-	-	-	-	14
	Flanged	Steel	-	-	2.0	2.6	3.3	4.4	5.2	6.6	7.5	9.4
		C.I.	-	-	-	-	-	-	-	-	-	7.7
 **180° return bend**	Screwed	Steel	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11
		C.I.	-	-	-	-	-	-	-	-	-	9.0
	Reg. Flanged	Steel	-	-	.92	1.2	1.6	2.1	2.4	3.1	3.6	4.4
		C.I.	-	-	-	-	-	-	-	-	-	3.6
	Long rad Flanged	Steel	-	-	1.1	1.3	1.6	2.0	2.3	2.7	2.9	3.4
		C.I.	-	-	-	-	-	-	-	-	-	2.8
 **Globe valve**	Screwed	Steel	21	22	22	24	29	37	42	54	62	79
		C.I.	-	-	-	-	-	-	-	-	-	65
	Flanged	Steel	-	-	38	40	45	54	59	70	77	94
		C.I.	-	-	-	-	-	-	-	-	-	77
 **Gate valve**	Screwed	Steel	.32	.45	.56	.67	.84	1.1	1.2	1.5	1.7	1.9
		C.I.	-	-	-	-	-	-	-	-	-	1.6
	Flanged	Steel	-	-	-	-	-	-	-	2.6	2.7	2.8
		C.I.	-	-	-	-	-	-	-	-	-	2.3
 **Angle valve**	Screwed	Steel	12.8	15	15	15	17	18	18	18	18	18
		C.I.	-	-	-	-	-	-	-	-	15	15
	Flanged	Steel	-	-	15	15	17	18	18	21	22	28
		C.I.	-	-	-	-	-	-	-	-	-	23
 **Swing check valve**	Screwed	Steel	7.2	7.3	8.0	8.8	11	13	15	19	22	27
		C.I.	-	-	-	-	-	-	-	-	-	22
	Flanged	Steel	-	-	3.8	5.3	7.2	10	12	17	21	27
		C.I.	-	-	-	-	-	-	-	-	-	22
Coupling or union	Screwed	Steel	.14	.18	.21	.24	.29	.36	.39	.45	.47	.53
		C.I.	-	-	-	-	-	-	-	-	-	.44
	Bell mouth inlet	Steel	.04	.07	.10	.13	.18	.26	.31	.43	.52	.67
		C.I.	-	-	-	-	-	-	-	-	-	.55
	Square mouth inlet	Steel	.44	.68	.96	1.3	1.8	2.6	3.1	4.3	5.2	6.7
		C.I.	-	-	-	-	-	-	-	-	-	5.5
	Re-entrant pipe	Steel	.88	1.4	1.9	2.6	3.6	5.1	6.2	8.5	10	13
		C.I.	-	-	-	-	-	-	-	-	-	11
	Y-strainer			4.6	5.0	6.6	7.7	18	20	27	29	34
	Sudden enlargement		$h = \frac{(V1 - V2)^2}{2g}$ feet of liquid; if V2 = 0, then $h = \frac{V1^2}{2g}$ feet of liquid									

Fittings			Pipe size 4	5	6	8	19	12	14	16	18	20	24
	Screwed	Steel	13	-	-	-	-	-	-	-	-	-	-
		C.I.	11	-	-	-	-	-	-	-	-	-	-
Regular 90° ell	Flanged	Steel	5.9	7.3	8.9	12	14	17	18	21	23	25	30
		C.I.	4.8	-	7.2	9.8	12	15	17	19	22	24	28
	Screwed	Steel	4.6	-	-	-	-	-	-	-	-	-	-
		C.I.	3.7	-	-	-	-	-	-	-	-	-	-
Long radius 90° ell	Flanged	Steel	4.2	5.0	5.7	7.0	8.0	9.0	9.4	10	11	12	14
		C.I.	3.4	-	4.7	5.7	6.8	7.8	8.6	9.6	11	11	13
	Screwed	Steel	5.5	-	-	-	-	-	-	-	-	-	-
		C.I.	4.5	-	-	-	-	-	-	-	-	-	-
Regular 45° ell	Flanged	Steel	3.5	4.5	5.6	7.7	9.0	11	13	15	16	18	22
		C.I.	2.9	-	4.5	6.3	8.1	9.7	12	13	15	17	20
	Screwed	Steel	17	-	-	-	-	-	-	-	-	-	-
		C.I.	14	-	-	-	-	-	-	-	-	-	-
Tee-line flow	Flanged	Steel	2.8	3.3	3.8	4.7	5.2	6.0	6.4	7.2	7.6	8.2	9.6
		C.I.	2.2	-	3.1	3.9	4.6	5.2	5.9	6.5	7.2	7.7	8.8
	Screwed	Steel	21	-	-	-	-	-	-	-	-	-	-
		C.I.	17	-	-	-	-	-	-	-	-	-	-
Tee-branch flow	Flanged	Steel	12	15	18	24	30	34	37	43	47	52	62
		C.I.	10	-	15	20	25	30	35	39	44	49	57
	Screwed	Steel	13	-	-	-	-	-	-	-	-	-	-
		C.I.	11	-	-	-	-	-	-	-	-	-	-
	Reg. Flanged	Steel	5.9	7.3	8.9	12	14	17	19	21	23	25	30
		C.I.	4.8	-	7.2	9.8	12	15	17	19	22	24	28
	Long rad Flanged	Steel	4.2	5.0	5.7	7.0	8.0	9.0	9.4	10	11	12	14
180° return bend		C.I.	3.4	-	4.7	5.7	6.8	7.8	8.6	9.6	11	11	13
	Screwed	Steel	110	-	-	-	-	-	-	-	-	-	-
		C.I.	86	-	-	-	-	-	-	-	-	-	-
Globe valve	Flanged	Steel	120	150	190	260	310	390	-	-	-	-	-
		C.I.	99	-	150	210	270	330	-	-	-	-	-
	Screwed	Steel	2.5	-	-	-	-	-	-	-	-	-	-
		C.I.	2.0	-	-	-	-	-	-	-	-	-	-
Gate valve	Flanged	Steel	2.9	3.1	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
		C.I.	2.4	-	2.6	2.7	2.8	2.9	2.9	3.0	3.0	3.0	3.0
	Screwed	Steel	18	-	-	-	-	-	-	-	-	-	-
		C.I.	15	-	-	-	-	-	-	-	-	-	-
Angle valve	Flanged	Steel	38	50	63	90	120	140	160	190	210	240	300
		C.I.	31	-	52	74	98	120	150	170	200	230	280
	Screwed	Steel	38	-	-	-	-	-	-	-	-	-	-
		C.I.	31	-	-	-	-	-	-	-	-	-	-
Swing check valve	Flanged	Steel	38	50	63	90	120	140	-	-	-	-	-
		C.I.	31	-	52	74	98	120	-	-	-	-	-
Coupling or union	Screwed	Steel	.65	-	-	-	-	-	-	-	-	-	-
		C.I.	.52-	-	-	-	-	-	-	-	-	-	-
	Bell mouth inlet	Steel	.95	1.3	1.6	2.3	2.9	3.5	4.0	4.7	5.3	6.1	7.6
		C.I.	.77	-	1.3	1.9	2.4	3.0	3.6	4.3	5.0	5.7	7.0
	Square mouth inlet	Steel	9.5	13	16	23	29	35	40	47	53	61	79
		C.I.	7.7	-	13	19	24	30	36	43	50	57	70
	Re-entrant pipe	Steel	19	25	32	45	58	70	80	95	110	120	150
		C.I.	15	-	26	37	49	61	73	86	100	110	140
	Y-strainer		42	53	61	-	-	-	-	-	-	-	-

Equivalent length in feet of new straight pipe for valves and fittings for turbulent flow only.

Pressure drop per 100 feet & velocity in schedule 40 pipe for water at 60°F.

Discharge		1/8"		1/4"		3/8"		1/2"		3/4"		1"		1 1/4"		1 1/2"	
Gallons per Minute	Cubic Ft. per Sec	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.	Velocity Lbs./ Sec.	Press. Drop Feet/ Sq.In.
.2	0.000446	1.13	1.86	0.616	0.359												
.3	0.000668	1.69	4.22	0.924	0.903	0.504	0.159	0.317	0.061								
.4	0.000891	2.26	6.98	1.23	1.61	0.672	0.345	0.422	0.086								
.5	0.00111	2.82	10.5	1.54	2.39	0.840	0.539	0.528	0.167	0.301	0.033						
.6	0.00134	3.39	14.7	1.85	3.29	1.01	0.751	0.633	0.240	0.361	0.041						
.8	0.00178	4.52	25.0	2.46	5.44	1.34	1.25	0.844	0.408	0.481	0.102						
1	0.00223	5.65	37.2	3.08	8.28	1.68	1.85	1.06	0.600	0.602	0.155	0.371	0.048				
2	0.00446	11.29	134.4	6.16	30.1	3.36	6.58	2.11	2.10	1.2	0.526	0.743	0.164	0.429	0.044		
3	0.00668			9.25	64.1	5.04	13.9	3.17	4.33	1.81	1.09	1.114	0.336	0.644	0.090	0.473	0.043
4	0.00891			12.33	111.2	6.72	23.9	4.22	7.42	2.41	1.83	1.49	0.565	0.858	0.150	0.630	0.071
5	0.01114	2"				8.40	36.7	5.28	11.2	3.01	2.75	1.86	0.835	1.073	0.223	0.788	0.104
6	0.01337	0.574	0.044	2 1/2"		10.08	51.9	6.33	15.8	3.61	3.84	2.23	1.17	1.29	0.309	0.946	1.145
8	0.01782	0.765	0.073			13.44	91.1	8.45	27.7	4.81	6.60	2.97	1.99	1.72	0.518	1.26	0.241
10	0.02228	0.956	0.108	0.670	0.046			10.56	42.4	6.02	9.99	3.71	2.99	2.15	0.774	1.58	0.361
15	0.03342	1.43	0.224	1.01	0.094	3"			9.03	21.6	5.57	6.36	3.22	1.63	2.37	0.755	
20	0.04456	1.91	0.375	1.34	0.158	0.868	0.056	3 1/2"		12.03	37.8	7.43	10.9	4.29	2.78	3.16	1.28
25	0.05570	2.39	0.561	1.68	0.234	1.09	0.083	0.812	0.041	4"		9.28	16.7	5.37	4.22	3.94	1.93
30	0.06684	2.87	0.786	2.01	0.327	1.30	0.114	0.974	0.056			11.14	23.8	6.44	5.92	4.73	2.72
35	0.07798	3.35	1.05	2.35	0.436	1.52	0.151	1.14	0.071	0.882	0.041	12.99	32.2	7.51	7.90	5.52	3.64
40	0.08912	3.83	1.35	2.68	0.556	1.74	0.192	1.30	0.095	1.01	0.052	14.85	41.5	8.59	10.24	6.30	4.65
45	0.1003	4.30	1.67	3.02	0.668	1.95	0.239	1.46	0.117	1.13	0.064			9.67	12.80	7.09	5.85
50	0.1114	4.78	2.03	3.35	0.839	2.17	0.288	1.62	0.142	1.26	0.076	5"		10.74	15.66	7.88	7.15
60	0.1337	5.74	2.87	4.02	1.18	2.60	0.406	1.95	0.204	1.51	0.107			12.89	22.2	9.47	10.21
70	0.1560	6.70	3.84	4.69	1.59	3.04	0.540	2.27	0.261	1.76	0.143	1.12	0.047			11.05	13.71
80	0.1782	7.65	4.97	5.36	2.03	3.47	0.687	2.60	0.334	2.02	0.180	1.28	0.060			12.62	17.59
90	0.2005	8.60	6.20	6.03	2.53	3.91	0.861	2.92	0.416	2.27	0.224	1.44	0.074	6"		14.20	22.0
100	0.2228	9.56	7.59	6.70	3.09	4.34	1.05	3.25	0.509	2.52	0.272	1.60	0.090	1.11	0.036	15.78	26.9
125	0.2785	11.97	11.76	8.38	4.71	5.43	1.61	4.06	0.769	3.15	0.415	2.01	0.135	1.39	0.055	19.72	41.4
150	0.3342	14.36	16.70	10.05	6.69	6.51	2.24	4.87	1.08	3.78	0.580	2.41	0.190	1.67	0.077		
175	0.3899	16.75	22.3	11.73	8.97	7.60	3.00	5.68	1.44	4.41	0.774	2.81	0.253	1.94	0.102		
200	0.4456	19.14	28.8	13.42	11.68	8.68	3.87	6.49	1.85	5.04	0.985	3.21	0.323	2.22	0.130	8"	
225	0.5013	...	...	15.09	14.36	9.77	4.83	7.30	2.32	5.67	1.23	3.61	0.401	2.50	0.162	1.44	0.043
250	0.557	...	...	...	...	10.85	5.93	8.12	2.84	6.30	1.46	4.01	0.495	2.78	0.195	1.60	0.051
275	0.6127	...	...	...	...	11.94	7.14	8.93	3.40	6.93	1.79	4.41	0.583	3.05	0.234	1.76	0.061
300	0.6684	...	...	...	...	13.00	8.36	9.74	4.02	7.56	2.11	4.81	0.683	3.33	0.275	1.92	0.072
325	0.7241	...	...	...	...	14.12	9.89	10.53	4.09	8.19	2.47	5.21	0.797	3.61	0.320	2.08	0.083

350	0.7798	...	...	...	...	...	...	11.36	5.41	8.82	2.84	5.62	0.919	3.89	0.367	2.24	0.095
375	0.8355	...	...	...	...	...	...	12.17	6.18	9.45	3.25	6.02	1.05	4.16	0.416	2.40	0.108
400	0.8912	...	...	...	...	...	...	12.98	7.03	10.08	3.68	6.42	1.19	4.44	0.471	2.56	0.121
425	0.9469	...	...	...	...	...	...	13.80	7.89	10.71	4.12	6.82	1.33	4.72	0.529	2.73	0.136
450	1.003		10"	...	...	...	...	14.61	8.80	11.34	4.60	7.22	1.48	5.00	0.590	2.89	0.151
475	1.059	1.93	0.054	...	...	...	...	...	...	11.97	5.12	7.62	1.64	5.27	0.653	3.04	0.166
500	1.114	2.03	0.059	...	...	...	...	...	...	12.60	5.65	8.02	1.81	5.55	0.720	3.21	0.182
550	1.225	2.24	0.071	...	...	...	...	...	...	13.85	6.79	8.82	2.17	6.11	0.861	3.53	0.219
600	1.337	2.44	0.083			...	...	...	...	15.12	8.04	9.63	2.55	6.66	1.02	3.85	0.258
650	1.448	2.64	0.097		12"	...	...	...	...	...	...	10.43	2.98	7.22	1.18	4.17	0.301
700	1.560	2.85	0.112	2.01	0.047			...	...	...	...	11.23	3.43	7.78	1.35	4.49	0.343
750	1.671	3.05	0.127	2.15	0.054	14"		...	...	...	...	12.03	3.92	8.33	1.55	4.81	0.392
800	1.782	3.25	0.143	2.29	0.061			...	...	...	...	12.83	4.43	8.88	1.75	5.13	0.443
850	1.894	3.46	0.160	2.44	0.068	2.02	0.042	...	...	...	...	13.64	5.00	9.44	1.96	5.45	0.497
900	2.005	3.66	0.179	2.58	0.075	2.13	0.047	...	...	...	...	14.44	5.58	9.99	2.18	5.77	0.554
950	2.117	3.86	0.198	2.72	0.083	2.25	0.052			...	...	15.24	6.21	10.55	2.42	6.09	0.613
1,000	2.228	4.07	0.218	2.87	0.091	2.37	0.057	16"		...	...	16.04	6.84	11.10	2.68	6.41	0.675
1,100	2.451	4.48	0.260	3.15	0.110	2.61	0.068			...	...	17.65	8.23	12.22	3.22	7.05	0.807
1,200	2.674	4.88	0.306	3.44	0.128	2.85	0.080	2.18	0.042	...	...	...	...	13.33	3.81	7.70	0.948
1,300	2.896	5.29	0.355	3.73	0.150	3.08	0.093	2.36	0.048	...	...	...	...	14.43	4.45	8.33	1.11
1,400	3.119	5.70	0.409	4.01	0.171	3.32	0.107	2.54	0.055					15.55	5.13	8.98	1.28
1,500	3.342	6.10	0.466	4.30	0.195	3.56	0.122	2.72	0.063	18"				16.66	5.85	9.62	1.46
1,600	3.565	6.51	0.527	4.59	0.219	3.79	0.138	2.90	0.071					17.77	6.61	10.26	1.65
1,800	4.010	7.32	0.663	5.16	0.276	4.27	0.172	3.27	0.088	2.58	0.050			19.99	8.37	11.54	2.08
2,000	4.456	8.14	0.808	5.73	0.339	4.74	0.209	3.63	0.107	2.87	0.060	20"		22.21	10.3	12.82	2.55
2,500	5.570	10.17	1.24	7.17	0.515	5.93	0.321	4.54	0.163	3.59	0.091					16.03	3.94
3,000	6.684	12.20	1.76	8.60	0.731	7.11	0.451	5.45	0.232	4.30	0.129	3.46	0.075	24"		19.24	5.59
3.500	7.798	14.24	2.38	10.03	0.982	8.30	0.607	6.35	0.312	5.02	0.173	4.04	0.101			22.44	7.56
4,000	8.912	16.27	3.08	11.47	1.27	9.48	0.787	7.26	0.401	5.74	0.222	4.62	0.129	3.19	0.052	25.65	9.80
4,500	10.03	18.31	3.87	12.90	1.60	10.67	0.990	8.17	0.503	6.46	0.280	5.20	0.162	3.59	0.065	28.87	12.2
5,000	11.14	20.35	4.71	14.33	1.95	11.85	1.21	9.08	0.617	7.17	0.340	5.77	0.199	3.99	0.079	...	...
6,000	13.37	24.41	6.74	17.20	2.77	14.23	1.71	10.89	0.877	8.61	0.483	6.93	0.280	4.79	0.111	...	...
7,000	15.60	28.49	9.11	20.07	3.74	16.60	2.31	12.71	1.18	10.04	0.652	8.08	0.376	5.59	0.150	...	...
8,000	17.82	...	...	22.93	4.84	18.96	2.99	14.52	1.51	11.47	0.839	9.23	0.488	6.38	0.192	...	...
9,000	20.05	...	...	25.79	6.09	21.34	3.76	16.34	1.90	12.91	1.05	10.39	0.608	7.18	0.242	...	...
10,000	22.28	...	...	28.66	7.46	23.71	4.61	18.15	2.34	14.34	1.28	11.54	0.739	7.98	0.294	...	...
12,000	26.74	...	...	34.40	10.7	28.45	6.59	21.79	3.33	17.21	1.83	13.85	1.06	9.58	0.416	...	...
14,000	31.19	...	...	...	...	33.19	8.89	25.42	4.49	20.08	2.45	16.16	1.43	11.17	0.562	...	...
16,000	35.65	...	...	...	...	...	...	29.05	5.83	22.95	3.18	18.47	1.85	12.77	0.723	...	...
18,000	40.10	...	...	...	...	...	...	32.68	7.31	25.82	4.03	20.77	2.32	14.36	0.907	...	...
20,000	44.56	...	...	...	...	...	...	36.31	9.03	28.69	4.93	23.08	2.86	15.96	1.12	...	...

For pipe lengths other than 100 Feet, the pressure drop is proportional to the lengths. Thus, for 50 feet of pipe, the pressure drop is approximately one-half the value given in the table; for 300 feet, three times the given value, etc.

Velocity is a function of the cross sectional flow area; thus, it is constant for a given flow rate and is independent of pipe length.

Power required for pumping

Theoretical horsepower required to raise water at 60°F to different heights

USGPM	5 feet	10 feet	15 feet	20 feet	25 feet	30 feet	35 feet	40 feet	45 feet	50 feet	60 feet	70 feet
5	0.006	0.013	0.019	0.025	0.032	0.038	0.044	0.051	0.057	0.063	0.076	0.088
10	0.013	0.025	0.038	0.051	0.063	0.076	0.088	0.101	0.114	0.126	0.152	0.177
15	0.019	0.038	0.057	0.076	0.095	0.114	0.133	0.152	0.171	0.190	0.227	0.265
20	0.025	0.051	0.076	0.101	0.126	0.152	0.177	0.202	0.227	0.253	0.303	0.354
25	0.032	0.063	0.095	0.126	0.158	0.191	0.221	0.253	0.284	0.316	0.379	0.442
30	0.038	0.076	0.114	0.152	0.190	0.227	0.265	0.303	0.341	0.379	0.445	0.531
35	0.044	0.088	0.133	0.177	0.221	0.265	0.310	0.354	0.398	0.442	0.531	0.619
40	0.051	0.101	0.152	0.202	0.253	0.303	0.354	0.404	0.455	0.505	0.606	0.707
45	0.057	0.114	0.171	0.227	0.284	0.341	0.398	0.445	0.512	0.568	0.682	0.796
50	0.063	0.126	0.190	0.253	0.316	0.379	0.442	0.505	0.568	0.632	0.758	0.884
60	0.076	0.152	0.227	0.303	0.379	0.445	0.531	0.606	0.682	0.758	0.910	1.061
70	0.088	0.177	0.265	0.354	0.442	0.531	0.619	0.707	0.796	0.884	1.061	1.238
80	0.101	0.202	0.303	0.404	0.505	0.606	0.707	0.808	0.910	1.011	1.213	1.415
90	0.114	0.227	0.341	0.455	0.568	0.682	0.796	0.910	1.023	1.137	1.364	1.592
100	0.126	0.253	0.379	0.505	0.632	0.758	0.884	1.011	1.137	1.263	1.516	1.768
125	0.158	0.316	0.474	0.632	0.790	0.947	1.105	1.263	1.421	1.579	1.895	2.211
150	0.190	0.379	0.568	0.758	0.947	1.137	1.326	1.516	1.705	1.895	2.274	2.653
175	0.221	0.442	0.663	0.884	1.105	1.326	1.547	1.768	1.990	2.211	2.653	3.095
200	0.253	0.505	0.758	1.011	1.263	1.516	1.768	2.021	2.274	2.526	3.032	3.537
250	0.316	0.632	0.947	1.263	1.579	1.895	2.211	2.526	2.842	3.158	3.790	4.421
300	0.379	0.758	1.137	1.516	1.895	2.274	2.653	3.032	3.411	3.790	4.548	5.305
350	0.442	0.884	1.326	1.768	2.211	2.653	3.095	3.537	3.979	4.421	5.305	6.190
400	0.505	1.011	1.516	2.021	2.526	3.032	3.537	4.042	4.548	5.053	6.063	7.074
500	0.632	1.263	1.895	2.526	3.158	3.790	4.421	5.053	5.684	6.316	7.579	8.842

Horsepower = 33,000 ft-lb/min
= 550 ft-lb/sec
= 2544.48 Btu/hr
=745.7 watts

where: (Whp) = water horsepower
H = pump head in feet
(bhp) = brake horsepower
ep = pump efficiency

(whp) = QHp ÷ 247,000 = QP ÷ 1714
(bhp) = (whp) ÷ ep = QHp ÷ 247,000 ep
(ep) = QHp ÷ 247,000 (bhp)

Theoretical horsepower required to raise water at 60°F to different heights

USGPM	80 feet	90 feet	100 feet	125 feet	150 feet	175 feet	200 feet	250 feet	300 feet	350 feet	400 feet
5	0.101	0.114	0.126	0.158	0.190	0.221	0.253	0.316	0.379	0.442	0.505
10	0.202	0.227	0.253	0.316	0.379	0.442	0.505	0.632	0.758	0.884	1.011
15	0.303	0.341	0.379	0.474	0.568	0.663	0.758	0.947	1.137	1.326	1.516
20	0.404	0.455	0.505	0.632	0.758	0.884	1.011	1.263	1.516	1.768	2.021
25	0.505	0.568	0.632	0.790	0.947	1.105	1.263	1.579	1.895	2.211	2.526
30	0.606	0.682	0.758	0.947	1.137	1.326	1.516	1.895	2.274	2.653	3.032
35	0.707	0.796	0.884	1.105	1.326	1.547	1.768	2.211	2.653	3.095	3.537
40	0.808	0.910	1.011	1.263	1.516	1.768	2.021	2.526	3.032	3.537	4.042
45	0.910	1.023	1.137	1.421	1.705	1.990	2.274	2.842	3.411	3.979	4.548
50	1.011	1.137	1.263	1.579	1.895	2.211	2.526	3.158	3.790	4.121	5.053
60	1.213	1.364	1.516	1.895	2.274	2.653	3.032	3.790	4.548	5.305	6.063
70	1.415	1.592	1.768	2.211	2.653	3.095	3.537	4.421	5.305	6.190	7.074
80	1.617	1.819	2.021	2.526	3.032	3.537	4.042	5.053	6.063	7.074	8.084
90	1.819	2.046	2.274	2.842	3.411	3.979	4.548	5.684	6.821	7.958	9.095
100	2.021	2.274	2.526	3.158	3.790	4.421	5.053	6.316	7.579	8.842	10.11
125	2.526	2.842	3.158	3.948	4.737	5.527	6.316	7.895	9.474	11.05	12.63
150	3.032	3.411	3.790	4.737	5.684	6.632	7.579	9.474	11.37	13.26	15.16
175	3.537	3.979	4.421	5.527	6.632	7.737	8.842	11.05	13.26	15.47	17.68
200	4.042	4.548	5.053	6.316	7.579	8.842	10.11	12.63	15.16	17.68	20.21
250	5.053	5.684	6.316	7.895	9.474	11.05	12.63	15.79	18.95	22.11	25.26
300	6.063	6.821	7.579	9.474	11.37	13.26	15.16	18.95	22.74	26.53	30.32
350	7.074	7.958	8.842	11.05	13.26	15.47	17.68	22.11	26.53	30.95	35.37
400	8.084	9.095	10.11	12.63	15.16	17.68	20.21	25.26	30.32	35.37	40.42
500	10.11	11.37	12.63	15.79	18.95	22.11	25.26	31.58	37.90	44.21	50.53

Overall efficiency (e_o) takes into account all losses in the pump and driver

$e_o = e_P\ e_D\ e_T$

where: e_D = driver efficiency
e_T = transmission efficiency

e_V = volumetric efficiency

$$e_V(\%) = \frac{\text{actual pump displacement (Q) (100)}}{\text{theoretical pump displacement (Q)}}$$

To calculate for other fluids

For fluids other than water, multiply table values by specific gravity. In pumping liquids with a viscosity considerably higher than that of water, the pump capacity and head are reduced. To calculate the horsepower for such fluids, pipe friction head must be added to the elevation head to obtain the total head; this value is inserted in the first horsepower equation given above.

Properties of water at various temperatures

Temp. F	Temp. C	Specific Volume Cu Ft/Lb	SPECIFIC GRAVITY			Wt in Lb/Cu Ft	Vapor Pressure Psi Abs
			39.2 F Reference	60 F Reference	68 F Reference		
32	0	.01602	1.000	1.001	1.002	62.42	0.088
35	1.7	.01602	1.000	1.001	1.002	62.42	0.100
40	4.4	.01602	1.000	1.001	1.002	62.42	0.1217
50	10.0	.01603	.999	1.001	1.002	62.38	0.1781
60	15.6	.01604	.999	1.000	1.001	62.34	0.2563
70	21.1	.01606	.998	.999	1.000	62.27	0.3631
80	26.7	.01608	.996	.998	.999	62.19	0.5069
90	32.2	.01610	.995	.996	.997	62.11	0.6982
100	37.8	.01613	.993	.994	.995	62.00	0.9492
120	48.9	.01620	.989	.990	.991	61.73	1.692
140	60.0	.01629	.983	.985	.986	61.39	2.889
160	71.1	.01639	.977	.979	.979	61.01	4.741
180	82.2	.01651	.970	.972	.973	60.57	7.510
200	93.3	.01663	.963	.964	.966	60.13	11.526
212	100.0	.01672	.958	.959	.960	59.81	14.696
220	104.4	.01677	.955	.956	.957	59.63	17.186
240	115.6	.01692	.947	.948	.949	59.10	24.97
260	126.7	.01709	.938	.939	.940	58.51	35.43
280	137.8	.01726	.928	.929	.930	58.00	49.20
300	148.9	.01745	.918	.919	.920	57.31	67.01
320	160.0	.01765	.908	.909	.910	56.66	89.66
340	171.1	.01787	.896	.898	.899	55.96	118.01
360	182.2	.01811	.885	.886	.887	55.22	153.04
380	193.3	.01836	.873	.874	.875	54.47	195.77
400	204.4	.01864	.859	.860	.862	53.65	247.31
420	215.6	.01894	.846	.847	.848	52.80	308.83
440	226.7	.01926	.832	.833	.834	51.92	381.59
460	237.8	.0196	.817	.818	.819	51.02	466.9
480	248.9	.0200	.801	.802	.803	50.00	566.1
500	260.0	.0204	.785	.786	.787	49.02	680.8
520	271.1	.0209	.765	.766	.767	47.85	812.4
540	282.2	.0215	.746	.747	.748	46.51	962.5
560	293.3	.0221	.726	.727	.728	45.3	1133.1
580	304.4	.0228	.703	.704	.704	43.9	1325.8
600	315.6	.0236	.678	.679	.680	42.3	1542.9
620	326.7	.0247	.649	.650	.650	40.5	1786.6
640	337.8	.0260	.617	.618	.618	38.5	2059.7
660	348.9	.0278	.577	.577	.578	36.0	2365.4
680	360.0	.0305	.525	.526	.527	32.8	2708.1
700	371.1	.0369	.434	.435	.435	27.1	3093.7
705.4	374.1	.0503	.319	.319	.320	19.9	3206.2

Barometer reading, atmospheric pressure and boiling point of water

Altitude		Barometer Reading		Atmos. Press.		Boiling Pt. of Water
Feet	Meters	In. Hg.	Mm. Hg.	psia	Ft. Water	°F
— 1000	— 304.8	31.0	788	15.2	35.2	213.8
— 500	— 152.4	30.5	775	15.0	34.6	212.9
0	0.0	29.9	760	14.7	33.9	212.0
+ 500	+ 152.4	29.4	747	14.4	33.3	211.1
+ 1000	304.8	28.9	734	14.2	32.8	210.2
1500	457.2	28.3	719	13.9	32.1	209.3
2000	609.6	27.8	706	13.7	31.5	208.4
2500	762.0	27.3	694	13.4	31.0	207.4
3000	914.4	26.8	681	13.2	30.4	206.5
3500	1066.8	26.3	668	12.9	29.8	205.6
4000	1219.2	25.8	655	12.7	29.2	204.7
4500	1371.6	25.4	645	12.4	28.8	203.8
5000	1524.0	24.9	633	12.2	28.2	202.9
5500	1676.4	24.4	620	12.0	27.6	201.9
6000	1828.8	24.0	610	11.8	27.2	201.0
6500	1981.2	23.5	597	11.5	26.7	200.1
7000	2133.6	23.1	587	11.3	26.2	199.2
7500	2286.0	22.7	577	11.1	25.7	198.3
8000	2438.4	22.2	564	10.9	25.2	197.4
8500	2590.8	21.8	554	10.7	24.7	196.5
9000	2743.2	21.4	544	10.5	24.3	195.5
9500	2895.6	21.0	533	10.3	23.8	194.6
10000	3048.0	20.6	523	10.1	23.4	193.7
15000	4572.0	16.9	429	8.3	19.2	184.0

Steam data

Temp F t	Abs Press. Lb Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp F t
32	0.08854	0.01602	3306	3306	0.00	1075.8	1075.8	0.0000	2.1877	2.1877	32
35	0.09995	0.01602	2947	2947	3.02	1074.1	1077.1	0.0061	2.1709	2.1770	35
40	0.12170	0.01602	2444	2444	8.05	1071.3	1079.3	0.0162	2.1435	2.1597	40
45	0.14752	001602	2036.4	2036.4	13.06	1068.4	1081.5	0.0262	2.1167	2.1429	45
50	0.17811	0.01603	1703.2	1703.2	18.07	1065.6	1083.7	0.0361	2.0903	2.1264	50
60	0.2563	0.01604	1206.6	1206.7	28.06	1059.9	1088.0	0.0555	2.0393	2.0948	60
70	0.3631	0.01606	867.8	867.9	38.04	1054.3	1092.3	0.0745	1.9902	2.0647	70
80	0.5069	0.01608	633.1	633.1	48.02	1048.6	1096.6	0.0932	1.9428	2.0360	80
90	0.6982	0.01610	468.0	468.0	57.99	1042.9	1100.9	0.1115	1.8972	2.0087	90
100	0.9492	0.01613	350.3	350.4	67.97	1037.2	1105.2	0.1295	1.8531	1.9826	100
110	1.2748	0.01617	265.3	265.4	77.94	1031.6	1109.5	0.1471	1.8106	1.9577	110
120	1.6924	0.01620	203.25	203.27	87.92	1025.8	1113.7	0.1645	1.7694	1.9339	120
130	2.2225	0.01625	157.32	157.34	97.90	1020.0	1117.9	0.1816	1.7296	1.9112	130
140	2.8886	0.01629	122.99	123.01	107.89	1014.1	1122.0	0.1984	1.6910	1.8894	140
150	3.718	0.01634	97.06	97.07	117.89	1008.2	1126.1	0.2149	1.6537	1.8685	150
160	4.741	0.01639	77.27	77.29	127.89	1002.3	1130.2	0.2311	1.6174	1.8485	160
170	5.992	0.01645	62.04	62.06	137.90	996.3	1134.2	0.2472	1.5822	1.8293	170
180	7.510	0.01651	50.21	50.23	147.92	990.2	1138.1	0.2630	1.5480	1.8109	180
190	9.339	0.01657	40.94	40.96	157.95	984.1	1142.0	0.2785	1.5147	1.7932	190
200	11.526	0.01663	33.62	33.64	167.99	977.9	1145.9	0.2938	1.4824	1.7762	200
210	14.123	0.01670	27.80	27.82	178.05	971.6	1149.7	0.3090	1.4508	1.7598	210
212	14.696	0.01672	26.78	26.80	180.07	970.3	1150.4	0.3120	1.4446	1.7566	212
220	17.186	0.01677	23.13	23.15	188.13	965.2	1153.4	0.3239	1.4201	1.7440	220
230	20.780	0.01684	19.365	19.382	198.23	958.8	1157.0	0.3387	1.3901	1.7288	230
240	24.969	0.01692	16.306	16.323	208.34	952.2	1160.5	0.3531	1.3609	1.7140	240
250	29.825	0.01700	13.804	13.821	218.48	945.5	1164.0	0.3675	1.3323	1.6998	250
260	35.429	0.01709	11.746	11.763	228.64	938.7	1167.3	0.3817	1.3043	1.6860	260
270	41.858	0.01717	10.044	10.061	238.84	931.8	1170.6	0.3958	1.2769	1.6727	270
280	49.203	0.01726	8.628	8.645	249.06	924.7	1173.8	0.4096	1.2501	1.6597	280
290	57.556	0.01735	7.444	7.461	259.31	917.5	1176.8	0.4234	1.2238	1.6472	290
300	67.013	0.01745	6.449	6.466	269.59	910.1	1179.7	0.4369	1.1980	1.6350	300
320	89.66	0.01765	4.896	4.914	290.28	894.9	1185.2	0.4637	1.1478	1.6115	320
340	118.01	0.01787	3.770	3.788	311.13	879.0	1190.1	0.4900	1.0992	1.5891	340
360	153.04	0.01811	2.939	2.957	332.18	862.2	1194.4	0.5158	1.0519	1.5677	360
380	195.77	0.01836	2.317	2.335	353.45	844.6	1198.1	0.5413	1.0059	1.5471	380
400	247.31	0.01864	1.8447	1.8633	374.97	826.0	1201.0	0.5664	0.9608	1.5272	400
420	308.83	0.01894	1.4811	1.5000	396.77	806.3	1203.1	0.5912	0.9166	1.5078	420
440	381.59	0.01926	1.1979	1.2171	418.90	785.4	1204.3	0.6158	0.8730	1.4887	440
460	466.9	0.0196	0.9748	0.9944	441.4	763.2	1204.6	0.6402	0.8298	1.4700	460
480	566.1	0.0200	0.7972	0.8172	464.4	739.4	1203.7	0.6645	0.7868	1.4513	480
500	680.8	0.0204	0.6545	0.6749	487.8	713.9	1201.7	0.6887	0.7438	1.4325	500
520	812.4	0.0209	0.5385	0.5594	511.9	686.4	1198.2	0.7130	0.7006	1.4136	520
540	962.5	0.0215	0.4434	0.4649	536.6	656.6	1193.2	0.7374	0.6568	1.3942	540
560	1133.1	0.0221	0.3647	0.3868	562.2	624.2	1186.4	0.7621	0.6121	1.3742	560
580	1325.8	0.0228	0.2989	0.3217	588.9	588.4	1177.3	0.7872	0.5659	1.3532	580
600	1542.9	0.0236	0.2432	0.2668	617.0	548.5	1165.5	0.8131	0.5176	1.3307	600
620	1786.6	0.0247	0.1955	0.2201	646.7	503.6	1150.3	0.8398	0.4664	1.3062	620
640	2059.7	0.0260	0.1538	0.1798	678.6	452.0	1130.5	0.8679	0.4110	1.2789	640
660	2365.4	0.0278	0.1165	0.1442	714.2	390.2	1104.4	0.8987	0.3485	1.2472	660
680	2708.1	0.0305	0.0810	0.1115	757.3	309.9	1067.2	0.9351	0.2719	1.2071	680
700	3093.7	0.0369	0.0392	0.0761	823.3	172.1	995.4	0.9905	0.1484	1.1389	700
705.4	3206.2	0.0503	0	0.0503	902.7	0	902.7	1.0580	0	1.0580	705.4

Valve coefficients

Valve Coefficients Cv and Kv

	ΔP in PSI	ΔP in Ft. hd	ΔP in bar	ΔP in kPa
Cv	$Cv = \frac{USGPM}{\sqrt{\Delta P(PSI)}}$	$Cv = 1.52 \times \frac{USGPM}{\sqrt{\Delta P(Ft.\ hd)}}$	$Cv = 1.16 \times \frac{m^3h}{\sqrt{\Delta P(bar)}}$	$Cv = 42 \times \frac{L/S}{\sqrt{\Delta P(kPa)}}$
Kv	$Kv = .86 \times \frac{USGPM}{\sqrt{\Delta P(PSI)}}$	$Kv = 1.32 \times \frac{USGPM}{\sqrt{\Delta P(Ft.\ hd)}}$	$Kv = 1.16 \times \frac{m^3h}{\sqrt{\Delta P(bar)}}$	$Kv = 36 \times \frac{L/S}{\sqrt{\Delta P(kPa)}}$
Pressure Drop	$\Delta P(PSI) = \left(\frac{USGPM}{Cv}\right)^2$	$\Delta P(Ft.\ hd) = \left(\frac{USGPM}{.658Cv}\right)^2$	$\Delta P(bar) = \left(1.16\frac{m^3h}{Cv}\right)^2$	$\Delta P(kPa) = \left(42 \times \frac{L/S}{Cv}\right)^2$
Flow	$USGPM = Cv \times \sqrt{\Delta P(PSI)}$	$USGPM = .658Cv \times \sqrt{\Delta P(Ft.\ hd)}$	$m^3h = .86Cv \times \sqrt{\Delta P(bar)}$	$L/S = \frac{Cv}{42} \times \sqrt{\Delta P(kPa)}$

$Cv = 1.16K$ $Kv = .86Cv$

Ethylene Glycol

°F °C	20° -7°				40° 4.5°				70° 21°				180° 82°				200° 93°			
W%	d	V	C	CG	d	V	C	CG	d	V	C	CG	d	V	C	CG	d	V	C	CG
0					1.00	1.59	1.06	1.00	1.00	1.00	1.00	1.00	0.97	0.36	.085	1.01	0.97	0.30	0.83	1.02
10					1.01	2.02	1.11	0.99	1.01	1.29	1.05	0.99	0.98	0.43	0.88	1.01	0.98	0.38	0.86	1.01
20					1.03	2.66	1.17	0.99	1.03	1.67	1.10	0.99	0.99	0.53	0.91	1.00	0.99	0.44	0.89	1.01
30	1.05	5.64	1.31	0.98	1.04	3.50	1.23	0.98	1.04	2.16	1.15	0.98	1.00	0.60	0.94	1.00	1.00	0.51	0.91	1.00
40	1.06	7.53	1.38	0.97	1.06	4.62	1.29	0.97	1.05	2.80	1.20	0.97	1.01	0.78	0.98	0.99	1.01	0.62	0.95	1.00
50	1.08	11.09	1.48	0.96	1.07	6.09	1.36	0.96	1.07	3.83	1.26	0.97	1.03	0.89	1.01	0.99	1.02	0.77	0.98	0.99
60	1.10	15.50	1.56	0.95	1.09	8.44	1.43	0.96	1.08	4.69	1.32	0.96	1.04	1.15	1.05	0.98	1.03	0.92	1.02	0.98

Propylene Glycol

°F °C	20° -7°				40° 4.5°				70° 21°				180° 82°				200° 93°			
W%	d	V	C	CG	d	V	C	CG	d	V	C	CG	d	V	C	CG	d	V	C	CG
0					1.00	1.69	1.07	1.00	1.00	1.00	1.00	1.00	0.97	0.39	0.86	1.01	0.97	0.33	0.84	1.02
10					1.01	2.48	1.14	1.00	1.01	1.47	1.06	1.00	0.98	0.46	0.88	1.01	0.97	0.39	0.86	1.01
20					1.02	3.53	1.20	0.99	1.02	2.16	1.12	0.99	0.98	0.57	0.91	1.01	0.98	0.47	0.88	1.01
30	1.04	9.18	1.38	0.98	1.03	5.04	1.27	0.98	1.02	2.84	1.17	0.99	0.99	0.67	0.94	1.01	0.98	0.54	0.90	1.01
40	1.05	16.70	1.51	0.98	1.04	7.87	1.36	0.98	1.03	3.97	1.24	0.98	0.99	0.82	0.96	1.01	0.98	0.69	0.93	1.01
50	1.06	24.60	1.60	0.97	1.05	12.38	1.46	0.98	1.04	5.78	1.30	0.98	0.99	1.01	1.00	1.00	0.99	0.81	0.96	1.01
60	1.06	40.57	1.72	0.97	1.05	18.99	1.52	0.97	1.04	8.16	1.37	0.98	1.00	1.40	1.04	1.00	0.99	1.01	0.99	1.01

W% = Weight proportion for glycol in %
d = density
V = viscosity in centistokes