



Armstrong® Useful Engineering Tables

Table CG-29. Schedule 40 Pipe, Standard Dimensions

Size (in)	Diameters		Nominal Thickness (in)	Circumference		Transverse Areas			Length of Pipe Per sq ft		Length of Pipe Containing One Cubic Foot	Nominal Weight Per Foot		Number of Threads Per Inch of Screw
	External (in)	Approximate Internal (in)		External (in)	Internal (in)	External (sq in)	Internal (sq in)	Metal (sq in)	External Surface	Internal Surface				
									Feet	Feet	Feet	Plain Ends	Threaded and Coupled	
1/8	0.405	0.269	0.068	1.272	0.845	0.129	0.057	0.072	9.431	14.199	2533.775	0.244	0.245	27
1/4	0.540	0.364	0.088	1.696	1.114	0.229	0.104	0.125	7.073	10.493	1383.789	0.424	0.425	18
3/8	0.675	0.493	0.091	2.121	1.549	0.358	0.191	0.167	5.658	7.747	754.360	0.567	0.568	18
1/2	0.840	0.622	0.109	2.639	1.954	0.554	0.304	0.250	4.547	6.141	473.906	0.850	0.852	14
3/4	1.050	0.824	0.113	3.299	2.589	0.866	0.533	0.333	3.637	4.635	270.034	1.130	1.134	14
1	1.315	1.049	0.133	4.131	3.296	1.358	0.864	0.494	2.904	3.641	166.618	1.678	1.684	11-1/2
1-1/4	1.660	1.380	0.140	5.215	4.335	2.164	1.495	0.669	2.301	2.767	96.275	2.272	2.281	11-1/2
1-1/2	1.900	1.610	0.145	5.969	5.058	2.835	2.036	0.799	2.010	2.372	70.733	2.717	2.731	11-1/2
2	2.375	2.067	0.154	7.461	6.494	4.430	3.355	1.075	1.608	1.847	42.913	3.652	3.678	11-1/2
2-1/2	2.875	2.469	0.203	9.032	7.757	6.492	4.788	1.704	1.328	1.547	30.077	5.793	5.819	8
3	3.500	3.068	0.216	10.996	9.638	9.621	7.393	2.228	1.091	1.245	19.479	7.575	7.616	8
3-1/2	4.000	3.548	0.226	12.566	11.146	12.566	9.886	2.680	0.954	1.076	14.565	9.109	9.202	8
4	4.500	4.026	0.237	14.137	12.648	15.904	12.730	3.174	0.848	0.948	11.312	10.790	10.889	8
5	5.563	5.047	0.258	17.477	15.856	24.306	20.006	4.300	0.686	0.756	7.198	14.617	14.810	8
6	6.625	6.065	0.280	20.813	19.054	34.472	28.891	5.581	0.576	0.629	4.984	18.974	19.185	8
8	8.625	7.981	0.322	27.096	25.073	58.426	50.027	8.399	0.442	0.478	2.878	28.554	28.809	8
10	10.750	10.020	0.365	33.772	31.479	90.763	78.855	11.908	0.355	0.381	1.826	40.483	41.132	8
12	12.750	11.938	0.406	40.055	37.699	127.640	111.900	15.740	0.299	0.318	1.288	53.600	—	—
14	14.000	13.125	0.437	43.982	41.217	153.940	135.300	18.640	0.272	0.280	1.069	63.000	—	—
16	16.000	15.000	0.500	50.265	47.123	201.050	176.700	24.350	0.238	0.254	0.817	78.000	—	—
18	18.000	16.874	0.563	56.548	52.998	254.850	224.000	30.850	0.212	0.226	0.643	105.000	—	—
20	20.000	18.814	0.593	62.831	59.093	314.150	278.000	36.150	0.191	0.203	0.519	123.000	—	—
24	24.000	22.626	0.687	75.398	71.063	452.400	402.100	50.300	0.159	0.169	0.358	171.000	—	—

Table CG-30. Equivalent Length of Pipe to Be Added for Fittings—Schedule 40 Pipe

Pipe Size (in)	Length in Feet to Be Added Run				
	Standard Elbow	Side Outlet Tee	Gate Valve*	Globe Valve*	Angle Valve*
1/2	1.3	3	0.3	14	7
3/4	1.8	4	0.4	18	10
1	2.2	5	0.5	23	12
1-1/4	3.0	6	0.6	29	15
1-1/2	3.5	7	0.8	34	18
2	4.3	8	1.0	46	22
2-1/2	5.0	11	1.1	54	27
3	6.5	13	1.4	66	34
3-1/2	8.0	15	1.6	80	40
4	9.0	18	1.9	92	45
5	11.0	22	2.2	112	56
6	13.0	27	2.8	136	67
8	17.0	35	3.7	180	92
10	21.0	45	4.6	230	112
12	27.0	53	5.5	270	132

*Valve in full open position

Table CG-32. Diameters and Areas of Circles and Drill Sizes

Drill Size	Diameter	Area	Drill Size	Diameter	Area	Drill Size	Diameter	Area	Drill Size	Diameter	Area
3/64	.0469	.00173	27	.1440	.01629	C	.2420	.04600	27/64	.4219	.13920
55	.0520	.00212	26	.1470	.01697	D	.2460	.04753	7/16	.4375	.15033
54	.0550	.00238	25	.1495	.01705	1/4	.2500	.04909	29/64	.4531	.16117
53	.0595	.00278	24	.1520	.01815	E	.2500	.04909	15/32	.4688	.17257
1/16	.0625	.00307	23	.1540	.01863	F	.2570	.05187	31/64	.4844	.18398
52	.0635	.00317	5/32	.1562	.01917	G	.2610	.05350	1/2	.5000	.19635
51	.0670	.00353	22	.1570	.01936	17/64	.2656	.05515	33/64	.5156	.20831
50	.0700	.00385	21	.1590	.01986	H	.2660	.05557	17/32	.5312	.22166
49	.0730	.00419	20	.1610	.02036	I	.2720	.05811	9/16	.5625	.24850
48	.0760	.00454	19	.1660	.02164	J	.2770	.06026	19/32	.5937	.27688
5/64	.0781	.00479	18	.1695	.02256	K	.2810	.06202	5/8	.6250	.30680
47	.0785	.00484	11/64	.1719	.02320	9/32	.2812	.06213	21/32	.6562	.33824
46	.0810	.00515	17	.1730	.02351	L	.2900	.06605	11/16	.6875	.37122
45	.0820	.00528	16	.1770	.02461	M	.2950	.06835	23/32	.7187	.40574
44	.0860	.00581	15	.1800	.02545	19/64	.2969	.06881	3/4	.7500	.44179
43	.0890	.00622	14	.1820	.02602	N	.3020	.07163	25/32	.7812	.47937
42	.0935	.00687	13	.1850	.02688	5/16	.3125	.07670	13/16	.8125	.51849
3/32	.0938	.00690	3/16	.1875	.02761	O	.3160	.07843	27/32	.8437	.55914
41	.0960	.00724	12	.1890	.02806	P	.3230	.08194	7/8	.8750	.60132
40	.0980	.00754	11	.1910	.02865	21/64	.3281	.08449	29/32	.9062	.64504
39	.0995	.00778	10	.1935	.02941	Q	.3320	.08657	15/16	.9375	.69029
38	.1015	.00809	9	.1960	.03017	R	.3390	.09026	31/32	.9687	.73708
37	.1040	.00850	8	.1990	.03110	11/32	.3438	.09281	1	1.0000	.78540
36	.1065	.00891	7	.2010	.03173	S	.3480	.09511	1-1/16	1.0625	.88664
7/64	.1094	.00940	13/64	.2031	.03241	T	.3580	.10066	1-1/8	1.1250	.99402
35	.1100	.00950	6	.2040	.03268	23/64	.3594	.10122	1-3/16	1.1875	1.1075
34	.1110	.00968	5	.2055	.03317	U	.3680	.10636	1-1/4	1.2500	1.2272
33	.1130	.01003	4	.2090	.03431	3/8	.3750	.11045	1-5/16	1.3125	1.3530
32	.1160	.01039	3	.2130	.03563	V	.3770	.11163	1-3/8	1.3750	1.4849
31	.1200	.01131	7/32	.2188	.03758	W	.3860	.11702	1-7/16	1.4375	1.6230
1/8	.1250	.01227	2	.2210	.03836	25/64	.3906	.11946	1-1/2	1.5000	1.7671
30	.1285	.01242	1	.2280	.04083	X	.3970	.12379	1-5/8	1.6250	2.0739
29	.1360	.01453	A	.2340	.04301	Y	.4040	.12819	1-3/4	1.7500	2.4053
28	.1405	.01550	15/64	.2344	.04314	13/32	.4062	.12962	1-7/8	1.8750	2.7612
9/64	.1406	.01553	B	.2380	.04449	Z	.4130	.13396	2	2.0000	3.1416

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Conversion Factors



Power		
Multiply	By	To Get
Boiler hp	33 472	Btu/hr
Boiler hp	34.5	lbs H ₂ O evap. at 212°F
Horsepower	2 540	Btu/hr
Horsepower	550	ft-lbs/sec
Horsepower	33 000	ft-lbs/min
Horsepower	42.42	Btu/min
Horsepower	0.7457	Kilowatts
Kilowatts	3 415	Btu/hr
Kilowatts	56.92	Btu/min
Watts	44.26	ft-lbs/min
Watts	0.7378	ft-lbs/sec
Watts	0.05692	Btu/min
Tons refriger.	12 000	Btu/hr
Tons refriger.	200	Btu/min
Btu/hr	0.0002986	Boiler hp
lbs H ₂ O evap. at 212°F	0.0290	Boiler hp
Btu/hr	0.000393	Horsepower
ft-lbs/sec	0.00182	Horsepower
ft-lbs/min	0.0000303	Horsepower
Btu/min	0.0236	Horsepower
Kilowatts	1.341	Horsepower
Btu/hr	0.000293	Kilowatts
Btu/min	0.01757	Kilowatts
ft-lbs/min	0.02259	Watts
ft-lbs/sec	1.355	Watts
Btu/min	1.757	Watts
Btu/hr	0.0000833	Tons Refriger.
Btu/min	0.005	Tons Refriger.

Energy		
Multiply	By	To Get
Btu	778	ft-lbs
Btu	0.000393	hp-hrs
Btu	0.000293	kw-hrs
		{lbs H ₂ O evap.}
Btu	0.0010307	at 212°F
Btu	0.293	Watt-hrs
ft-lbs	0.3765	Watt-hrs
latent heat} of ice	143.33	Btu/lb H ₂ O
lbs H ₂ O evap.} at 212°F	0.284	kw-hrs
lbs H ₂ O evap.} at 212°F	0.381	hp-hrs
ft-lbs	0.001287	Btu
hp-hrs	2 540	Btu
kw-hrs	3 415	Btu
lbs H ₂ O evap.} at 212°F	970.4	Btu
Watt-hrs	3.415	Btu
Watt-hrs	2 656	ft-lbs
Btu/lb H ₂ O	0.006977	{Latent heat of ice}
kw-hrs	3.52	{lbs H ₂ O evap. at 212°F}
hp-hrs	2.63	{lbs H ₂ O evap. at 212°F}

Pressure		
Multiply	By	To Get
atmospheres	29.92	{in Mercury (at 62°F)}
atmospheres	406.8	{in H ₂ O (at 62°F)}
atmospheres	33.90	{ft. H ₂ O (at 62°F)}
atmospheres	14.70	lbs/in ²
atmospheres	1.058	ton/ft ²
in. H ₂ O} (at 62°F)	0.0737	{in. Mercury (at 62°F)}
ft H ₂ O} (at 62°F)	0.881	{in. Mercury (at 62°F)}
ft H ₂ O} (at 62°F)	0.4335	lbs/in ²
ft H ₂ O} (at 62°F)	62.37	lbs/ft ²
in. Mercury} (at 62°F)	70.73	lbs/ft ²
in. Mercury} (at 62°F)	0.4912	lbs/in ²
in. Mercury} (at 62°F)	0.03342	atmospheres
in. H ₂ O} (at 62°F)	0.002458	atmospheres
ft. H ₂ O} (at 62°F)	0.0295	atmospheres
lbs/in ²	0.0680	atmospheres
ton/ft ²	0.945	atmospheres
in. Mercury} (at 62°F)	13.57	{in. H ₂ O (at 62°F)}
in. Mercury} (at 62°F)	1.131	{ft H ₂ O (at 62°F)}
{ft H ₂ O (at 62°F)	2.309	lbs/in ²
lbs/in ²	0.01603	(at 62°F)
lbs/ft ²	0.014138	(at 62°F)
{in. Mercury (at 62°F)	2.042	(at 62°F)
lbs/in ²	0.0689	Barg
lbs/in ²	0.0703	kg/cm ²

Velocity of Flow		
Multiply	By	To Get
ft/min	0.01139	miles/hr
ft/min	0.01667	ft/sec
cu ft/min	0.1247	gal/sec
cu ft/sec	448.8	gal/min
miles/hr	88	ft/min
ft/sec	60	ft/min
gal/sec	8.02	cu ft/min
gal/min	0.002228	cu ft/sec

Temperature		
°F = (°C x 1.8) + 32		
°C = (°F - 32) ÷ 1.8		

Weight		
Multiply	By	To Get
lbs	7 000	grains
lbs H ₂ O (60°F)	0.01602	cu ft H ₂ O
lbs H ₂ O (60°F)	0.1198	gal H ₂ O
tons (long)	2 240	lbs
tons (short)	2 000	lbs
grains	0.000143	lbs
lbs H ₂ O	62.37	(60°F)
cu ft H ₂ O	8.3453	(60°F)
lbs H ₂ O	0.000446	tons (long)
lbs	0.000500	tons (short)

Circular Measure		
Multiply	By	To Get
Degrees	0.01745	Radians
Minutes	0.00029	Radians
Diameter	3.142	Circumference
Radians	57.3	Degrees
Radians	3 438	Minutes
Circumference	0.3183	Diameter

Volume		
Multiply	By	To Get
Barrels (oil)	42	gal (oil)
cu ft	1 728	cu in
cu ft	7.48	gal
cu in	0.00433	gal
gal (oil)	0.0238	barrels (oil)
cu in	0.000579	cu ft
gal	0.1337	cu ft
gal	231	cu in

Heat Transmission		
Multiply	By	To Get
Btu/in		{Btu/ft
/sq ft	0.0833	/sq ft
/hr/°F		/hr/°F
Btu/ft		{Btu/in
/sq ft	12	/sq ft
/hr/°F		/hr/°F

Fractions and Decimals		
Multiply	By	To Get
Sixty-fourths	0.015625	Decimal
Thirty-seconds	0.03125	Decimal
Sixteenths	0.0625	Decimal
Eighths	0.125	Decimal
Fourths	0.250	Decimal
Halves	0.500	Decimal
Decimal	64	Sixty-fourths
Decimal	32	Thirty-seconds
Decimal	16	Sixteenths
Decimal	8	Eighths
Decimal	4	Fourths
Decimal	2	Halves

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Armstrong® Specific Heat—Specific Gravity

Table CG-33. Physical Properties of Liquids and Solids

	Liquid (L) or Solid (S)	sp gr @ 60-70°F	sp ht @ 60°F Btu/lb-°F
Acetic acid 100%	L	1.05	0.48
Acetic acid 10%	L	1.01	0.96
Acetone, 100%	L	0.78	0.514
Alcohol, ethyl, 95%	L	0.81	0.60
Alcohol, methyl, 90%	L	0.82	0.65
Aluminum	S	2.64	0.23
Ammonia, 100%	L	0.61	1.10
Ammonia, 26%	L	0.90	1.00
Aroclor	L	1.44	0.28
Asbestos board	S	0.88	0.19
Asphalt	L	1.00	0.42
Asphalt, solid	S	1.1-1.5	0.22-0.4
Benzene	L	0.84	0.41
Brickwork & Masonry	S	1.6-2.0	0.22
Brine - calcium chloride, 25%	L	1.23	0.689
Brine - sodium chloride, 25%	L	1.19	0.786
Clay, dry	S	1.9-2.4	0.224
Coal	S	1.2-1.8	0.26-0.37
Coal tars	S	1.20	0.35@40
Coke, solid	S	1.0-1.4	0.265
Copper	S	8.82	0.10
Cork	S	0.25	0.48
Cotton, cloth	S	1.50	0.32
Cottonseed oil	L	0.95	0.47
Dowtherm A	L	0.99	0.63
Dowtherm C	L	1.10	0.35-0.65
Ethylene glycol	L	1.11	0.58
Fatty acid - palmitic	L	0.85	0.653
Fatty acid - stearic	L	0.84	0.550
Fish, fresh, average	S		0.75-0.82
Fruit, fresh, average	S		0.80-0.88
Gasoline	L	0.73	0.53
Glass, Pyrex	S	2.25	0.20
Glass, wool	S	0.072	0.157
Glue, 2 parts water 1 part dry glue	L	1.09	0.89
Glycerol, 100% (glycerin)	L	1.26	0.58
Honey	L		0.34
Hydrochloric acid, 31.5% (muriatic)	L	1.15	0.60
Hydrochloric acid, 10% (muriatic)	L	1.05	0.75
Ice	S	0.90	0.50
Ice Cream	S		0.70
Lard	S	0.92	0.64
Lead	S	11.34	0.031
Leather	S	0.86-1.02	0.36
Linseed oil	L	0.93	0.44
Magnesia, 85%	L	0.208	0.27
Maple syrup	L		0.48
Meat, fresh, average	S		0.780
Milk	L	1.03	0.90-0.93
Nickel	S	8.90	0.11
Nitric acid, 95%	L	1.50	0.50
Nitric acid, 60%	L	1.37	0.64
Nitric acid, 10%	L	1.05	0.90
No. 1 Fuel Oil (kerosene)	L	0.81	0.47
No. 2 Fuel Oil	L	0.86	0.44
No. 3 Fuel Oil	L	0.88	0.43
No. 4 Fuel Oil	L	0.90	0.42
No. 5 Fuel Oil	L	0.93	0.41
No. 6 Fuel Oil	L	0.95	0.40

Table CG-33. (cont.) Physical Properties of Liquids and Solids

	Liquid (L) or Solid (S)	sp gr @ 60-70°F	sp ht @ 60°F Btu/lb-°F
API Mid-continent crude	L	.085	0.44
API gas oil	L	0.88	0.42
Paper	S	1.7-1.15	0.45
Paraffin	S	0.86-0.91	0.62
Paraffin, melted	L	0.90	0.69
Phenol (carbolic acid)	L	1.07	0.56
Phosphoric acid, 20%	L	1.11	0.85
Phosphoric acid, 10%	L	1.05	0.93
Phthalic anhydride	L	1.53	0.232
Rubber, vulcanized	S	1.10	0.415
SAE - SW (#8 machine lube oil)	L	0.88	
SAE - 20 (#20 machine lube oil)	L	0.89	
SAE - 30 (#30 machine lube oil)	L	0.89	
Sand	S	1.4-1.76	0.19
Sea water	L	1.03	0.94
Silk	S	1.25-1.35	0.33
Sodium hydroxide, 50% (caustic acid)	L	1.53	0.78
Sodium hydroxide, 30%	L	1.33	0.84
Soybean oil	L	0.92	0.24-0.33
Steel, mild @ 70	S	7.90	0.11
Steel, stainless, 300 series	S	8.04	0.12
Sucrose, 60% sugar syrup	L	1.29	0.74
Sucrose, 40% sugar syrup	L	1.18	0.66
Sugar, cane & beet	S	1.66	0.30
Sulfur	S	2.00	0.203
Sulfuric acid, 110% (fuming)	L		0.27
Sulfuric acid, 98%	L	1.84	0.35
Sulfuric acid, 60%	L	1.50	0.52
Sulfuric acid, 20%	L	1.14	0.84
Titanium (commercial)	S	4.50	0.13
Toluene	L	0.86	0.42
Trichloroethylene	L	1.62	0.215
Tetrachloride carbon	L	1.58	0.21
Turpentine, spirits of	L	0.86	0.42
Vegetables, fresh, average	S		0.73-0.94
Water	L	1.00	1.00
Wines, table, dessert, average	L	1.03	0.90
Woods, vary from	S	0.35-0.9	0.90
Wool	S	1.32	0.325
Zinc	S	7.05	0.095

Table CG-34. Physical Properties of Gases

	sp gr @ 60-70°F	spht@60°F Btu/lb-°F
Air	1.00	0.24
Ammonia	0.60	0.54
Benzene		0.325
Butane	2.00	0.455
Carbon dioxide	1.50	0.21
Carbon monoxide	0.97	0.255
Chlorine	2.50	0.118
Ethane	1.10	0.50
Ethylene	0.97	0.45
Freon - 12		0.16
Hydrogen	0.069	3.42
Hydrogen sulfide	1.20	0.25
Methane	0.55	0.60
Nitrogen	0.97	0.253
Oxygen	1.10	0.225
Propane	1.50	0.46
Sulfur dioxide		0.162
Water vapor (steam)	2.30	0.453