PoolCo USA

Pool Chemistry

SATURATION INDEX GUIDE

Definitions

- **pH** - on a scale from 0 to 14, the degree of acidity (below pH 7), or "basicness" (above pH 7) of the pool water - 7 being neutral.
  Typical pH range: 7.2 to 7.8.
- **Temperature (T)** - degrees farenheight of the water.
  Typical T range: 75 to 82 degrees F.
- **Total Alkalinity (TA)** - an index of pool water's resistance to pH change.
  Typical TA range: 80 ppm to 120 ppm.
- **Calcium Hardness (CH)** - calcium content of pool water.
  Typical CH range: 250 ppm to 350 ppm.
- **Total Dissolved Solids (TDS)** - dissolved solids content of pool water, mostly sodium (salt), calcium, and manganese.
  Typical TDS range: 300 ppm to 1000 ppm. Ignored in calculations unless over 1000 ppm, where .1 is subtracted for each 1000 ppm.
- **Calcium Saturation Index (CSI)** - the index of pool water's tendency to scale (positive values) or corrode (negative values), with zero a neutral.
  Typical (acceptable) CSI range: -.5 to +.5.

EXAMPLES
(Calculated on Circular Slide Rule)

	pH	T	TA	CH	TDS	CSI	NOTES
POOL 1:	7.2	75	50	120	200	-1.2	Very corrosive
POOL 2:	7.8	80	140	400	800	+.6	Scaling
POOL 3:	7.4	80	120	320	2000	0	Excellent

Note: TDS is ignored in the first two. It reduces the third by .1. Pools with heaters have .2 or more rise in the core or panels and should be adjustable for -.1 to -.2 CSI in the pools.

FORMULAS & MIXTURES

Commonly Used In Swimming Pool Operation

- **Raising Total Alkalinity . 15** lbs. of Sodium Bicarbonate, added to 100,000 gallons of pool water, will raise the total alkalinity 10 ppm.
- **Raising Calcium Hardness** - 11 lbs. of calcium chloride, added to 100,000 gallons of pool water, will raise the calcium hardness 10 ppm.
- **Raising Chlorine Residual** - 1 lb. of chlorine gas, or 1-1/2 lbs. of c alcium hypochlorite, or 1 U.S. gallon of sodium hypochlorite, added to 120,000 gallons (1,000,000 lbs.) of pool water, will raise the chlorine residual 1.0 ppm.
- **Lowering Chlorine Residual** - 1 lb. of sodium thiosulphate, added to 100,000 gallons of pool water, will lower the chlorine residual 1.0 ppm. NOTE: pH value will also be lowered slightly.
- **Maintaining pH While Adding Gas Chlorine to Pool Water** - 1-1/2 lb. of soda ash, or 1/2 lb. of caustic soda (about 1/3 quart of 50 % strength caustic solution), will maintain existing pH value for each pound of gas chlorine added to the pool.
- **Soda Ash & Water Mixture** (For chemical of water) - Maximum of 40 lbs. of soda ash per 100 gallons of water.
- **Muriatic Acid & Water Mixture** (For chemical feeder) - Maximum 1 gallon of muriatic acid per 4 gallons of water.
- **Diatomaceous Earth Precoat Mixture** - .1 lb. of diatomite per square foot of filter area.

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Engineering Data *Units of Measure*

UNITS OF PRESSURE

UNIT	Inches of water	Feet of water	Pounds per square inch	Inches of Mercury
Inches of water	1.0	.0833	.0361	.0736
Feet of water	12.0	1.0	.433	.883
Pounds per square inch	27.72	2.31	1.0	2.04
Inches of Mercury	13.596	1.133	.4906	1.0

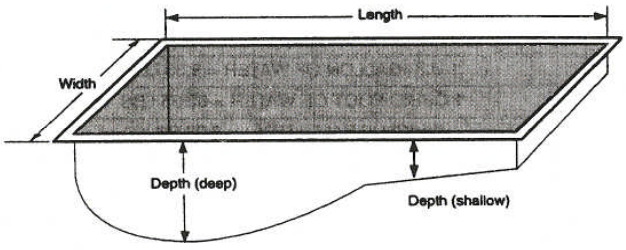
EQUIVALENT VALUES OF PRESSURE

Inches of Mercury	Feet of water	Pounds per Sq. In.	Inches of Mercury	Feet of water	Pounds per Sq. In.	Inches of Mercury	Feet of water	Pounds per Sq. In.
1	1.13	0.49	11	12.45	5.39	21	23.78	10.3
2	2.26	0.98	12	13.57	5.87	22	24.88	10.8
3	3.39	1.47	13	14.70	6.37	23	26.00	11.28
4	4.52	1.95	14	15.82	6.86	24	27.15	11.75
5	5.65	2.44	15	16.96	7.35	25	28.26	12.25
6	6.78	2.93	16	18.09	7.84	26	29.40	12.73
7	7.91	3.42	17	19.22	8.33	27	30.52	13.23
8	9.04	3.91	18	20.35	8.82	28	31.65	13.73
9	10.17	4.40	19	21.75	9.31	29	32.80	14.22
10	11.30	4.89	20	22.60	9.80	29.929	33.947	14.6969

PRESSURE AND EQUIVALENT FEET HEAD OF WATER

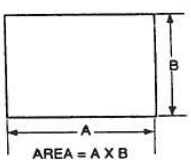
Lbs. per Sq. In.	Feat Head	Lbs. per Sq. In.	Feet Head	Lbs. per Sq. In.	Feed Head	Lbs. per Sq. In.	Feet Head
1	2.31	20	46.18	120	277.07	225	519.51
2	4.62	25	57.72	125	288.62	250	577.24
3	6.93	30	69.27	130	300.16	275	643.03
4	9.24	40	92.36	140	323.25	300	692.69
5	11.54	50	115.45	150	346.34	325	750.41

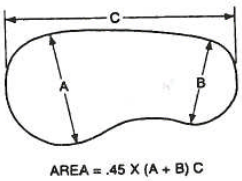
Engineering Data *Estimating Total Gallons in a Pool or Spa*

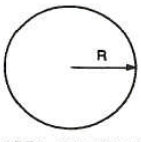


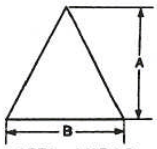
Formula A: Length x Width x Average Depth x7.5
Example: Pool Length = 40 ft.
Pool Width = 20 ft.
Shallow Depth = 3 ft.
Deep Depth = + 8 ft.
Total Depth = 11 ft.

Using formula A: 40 x 20 = 800 sq. ft., 800 x 5.5 = 4,400 cubic ft., 4,400 x 7.5 = 33,00 gallons.









The area in square feet for pools ans spas can be determined by using one or more of the above formulas.

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Engineering Data *Units of Measure*

UNITS OF LENGTH

Unit	Inch	Foot	Yard	Meter
Inch	1.0	.0833	.0278	.0254
Foot	12.0	1.0	.333	.305
Yard	36.0	3.0	1.0	.9144
Meter	39.37	3.281	1.094	1.0

UNITS OF AREA

Unit	Inch	Foot	Yard	Meter
Square inch	1.0	.00694	.000772	.000645
Square foot	144.0	1.0	.111	.0929
Square yard	1,296.0	9.0	1.0	.836
Square meter	1,550.0	10.76	1.196	1.0

UNITS OF VOLUME

Unit	U.S. Gallon	Imperial Gallon	Cubic feet	Pounds of water	Cubic meters
U.S. Gallon	1.0	.833	.1337	8.33	.003785
Imperial Gallon	1.2	1.0	.1605	10.0	.004546
Cubic feet	7.481	6.232	1.0	63.37	.0283
Pounds of water	.12		.0160	1.0	.00045
Cubic meters	264.2	220.0	35.31	2,204,0	1.0

UNITS OF FLOW

Unit	U.S. G.P.M.	Imperial G.P.M.	Cubic feet/second	Cubic feet/hour	Liters/second
U.S. G.P.M.	1.0	.833	.00223	8.02	.0631
Imperial G.P.M.	1.2	1.0	.00268	.272	.0757
Cubic feet per second	448.8	374.0	1.0	3.600	28.32
Cubic feet per hour	4.403	3.67	.00981	1.0	.2778
Liters per second	15.85	13.21	.0353	3.60	1.0

PRESSURE AND EQUIVALENT FEET HEAD OF WATER

Lbs. per Sq. In.	Feat Head	Lbs. per Sq. In.	Feet Head	Lbs. per Sq. In.	Feed Head	Lbs. per Sq. In.	Feet Head
6	13.85	60	138.54	160	369.43	350	808.13
7	16.16	70	161.63	170	392.52	375	865.89
8	18.47	80	184.72	180	415.61	400	922.58
9	20.78	90	207.81	190	438.90	500	1154.48
10	23.09	100	230.90	200	461.78	1000	2309.00
15	34.63	110	253.98				

CURRENT CAPACITY (AMPS) OF WIRE*

WIRE SIZE	AMPERES	
	COPPER	ALUMINUM
14	15	–
12	20	15
10	30	25
8	30	30
6	40	30
4	70	55
3	80	65
2	95	75
1	110	85
0	125	100

* Wire size is minimum for amperes listed.

WEIGHT
1 U.S. GALLON OF WATER = 8.33 LBS.
1 CUBIC FOOT OF WATER = 62.35 LBS.
1 KILOGRAM (LITRE) = 2.2 LBS.
1 IMPERIAL GALLON = 10.0 LBS.

EFFICIENCY	
EFFICIENCY	$\frac{\text{POWER OUTPUT}}{\text{POWER INPUT}}$
MOTOR EFFICIENCY	$\frac{\text{H.P. OUTPUT}}{\text{K.W. INPUT}}$
PUMP EFFICIENCY	$\frac{\text{G.P.M. X TOTAL HEAD (F.T.)}}{3960 \times \text{B.H.P.}}$
PLANT EFFICIENCY	$\frac{\text{G.P.M. X TOTAL HEAD (F.T.)}}{5300 \times \text{K.W. INPUT}}$

Amperage = $\frac{\text{Watts}}{\text{Volts}}$

Watts = Volts x Amperage

FRICTION/FLOW CHART FOR SCHEDULE 40 RIGID PVC PIPE*

U.S. Gal. per min.	1/4" pipe		1" pipe		1 1/4" pipe		1-1/2" pipe		2" pipe		2-1/2" pipe		3" pipe		4" pipe		5" pipe		U.S. Gal. per min.
	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	Velocity feet per second	Loss in feet	
1	.60	.25	.37	.07															1
2	1.20	.90	.74	.28	.43	.07													2
3	1.80	1.92	1.11	.60	.64	.16	.47	.07											3
4	2.41	3.28	1.48	1.02	.86	.25	.63	.12											4
5	3.01	5.8	1.86	1.52	1.07	.39	.79	.18											5
6	3.61	7.0	2.23	2.15	1.29	.55	.95	.25	.57	.07									6
8	4.81	11.8	2.97	3.6	1.72	.97	1.25	.46	.76	.14	.54	.05							8
10	6.02	17.9	3.71	5.5	2.15	1.46	1.58	.69	.96	.21	.67	.09							10
15	9.02	37.8	5.57	11.7	3.22	3.07	2.36	1.45	1.42	.44	1.01	.18	.65	.07					15
20			7.42	19.9	4.29	4.2	3.15	2.47	1.91	.74	1.34	.30	.87	.12					20
25			9.28	30.0	5.36	7.9	3.94	3.8	2.39	1.11	1.67	.46	1.08	.16					25
30			11.14	42.0	6.43	11.1	4.73	5.2	2.87	1.55	2.01	.65	1.30	.23					30
35					7.51	14.7	5.52	7.0	3.35	2.06	2.35	.88	1.52	.30	.88	.07			35
40					8.58	18.9	6.30	8.9	3.82	2.63	2.64	1.11	1.73	.39	1.01	.09			40
45					9.65	23.5	7.09	11.1	4.30	3.28	3.01	1.39	1.95	.48	1.13	.12			45
50					10.72	28.5	7.88	13.5	4.78	4.0	3.35	1.69	2.17	.58	1.26	.16			50
60							9.466	18.9	5.74	5.6	4.02	2.36	2.60	.81	1.51	.21			60
70							11.03	25.1	6.69	7.4	4.69	3.14	3.04	1.09	1.76	.28			70
80									7.65	9.5	5.35	4.0	3.47	1.39	2.02	.37			80
90									8.60	11.8	6.03	5.0	3.91	1.73	2.27	.46			90
100									9.56	14.4	6.70	6.1	4.34	2.10	2.52	.55	1.11	.07	100
125									11.95	21.8	8.38	9.2	5.42	3.19	3.15	.85	1.39	.12	125
150											10.05	12.8	6.51	4.5	3.78	1.18	1.67	.16	150
175													7.59	5.9	4.41	1.57	1.94	.21	175
200													8.68	7.9	5.04	2.08	2.22	.28	200
225													9.76	9.4	5.67	2.52	2.50	.35	225
250													10.85	11.5	6.30	3.05	2.78	.42	250
275															6.93	3.6	3.05	.48	275
300															7.56	4.3	3.33	.58	300
325															8.19	5.0	3.61	.67	325
350															8.82	5.7	3.89	.79	350
375															9.45	6.5	4.17	.88	375
400															10.08	7.3	4.44	.99	400
425																	4.72	1.11	425
450																	5.00	1.22	450
475																	5.28	1.36	475
500																	5.55	1.50	500
550																	6.11	1.80	550
600																	6.67	2.10	600
650																	7.22	2.44	650
700																	7.78	2.79	700
750																	8.33	3.19	750
800																	8.89	3.6	800

* Friction loss of water in feet per 100 feet length of pipe. Based on Williams & Hazen formula using constant 150.

Calculating Surface Area

When calculating the surface area (SA) of a pool, use the following two formulas depending on shape.

Rectangular Formula:

Length = L, Width = W
SA = L x W

Example:

L = 60', W = 30'
SA = (60') x (30)
SA = 1,800 square feet

Round Formula:

Radius = R (which is 1/2 of diameter)
SA = R x R x 3.14

Example:

R = 18'
SA = (18') x (18') x (3.14)
SA = 1,017 square feet

SURFACE AREA CHART

Pool Size In Feet	Pool Area Square Feet	Gallons Needed Per Inch Depth
50 x25	1250	779
50 x 50	2500	1558
60 x 20	1200	0748
60 x 30	1800	1122
75 x 40	3000	1870
745 x 42	3150	1964
75 x 605	4500	2805
82 x 42	3444	2147
82 x 75	6150	3834
100 x 45	4500	2805
164 x 60	9840	6134
164 x 75	12,300	7667

Calculating Pool Volume

Gather the following information when determining pool volume (V).

Length = L, Width = W, Depth = D
V = L x W x D

Example:

L = 164', W = 75, D = 5'
V = (164') x (75') x (5')
V = 61,500 cubic feet (7.48 gal/cu. ft.)
V = 479,700 gallons

It's important to convert meters to feet prior to calculating volume.

1 meter = 3.28 feet.

EQUIVALENT DATA

- 1 Meter = 3.28 Feet
- 1 Cubic Foot = 7.48 Gallons
- 1 Cubic Foot of water = 62.4 lbs.
- 1 Gallon of Water = 8.3 lbs.
- 1 part per million (ppm) = 1 pound of chemical per million pounds of water.
- 1 ppm hardness = .058 grains per gallon hardness.
- 1 foot of water depth = .0433 P.S.I.
- 1 P.S.I. - 2.31 Feet of Head.
- For every 2.31 feet of water depth, water pressure increases 1 P.S.I.

Calculating Water Loss

The formula for make up water is important when refilling your pool.

Water loss occurs from evaporation, splashing, backwashing filters, and leaks.

You first need to know many inches of water are required to fill the pool.

The formula is:
(In. of water) x (SA) x (.63) = gallons needed

Example:
(6") x (1500) x (.63) = gallons needed
5670 = gallons needed

Calculation of Swimmer Loads

The formula for calculating maximum swimmer loas per day varies from state to state depending on health department requirements.

The formula listed below allows for one swimmer per 600 gallons of fresh water per 24 hour period.

[(Lowest Pump Rate in GPM) x (60) x (24)] – 600 = Load or Daily Pool Limit.

Flow Rate & Pump Curves

It is necessary to be able to calculate the flow rate of your pool based on turnover rate when sizing pumps.

During this process, the following two conversions will be used in order to effectively use the pump sizing curves.

The conversions are:

- Converting inches of Hg to P.S.I.

  Formula:
  (inches Hg) x (.49) = P.S.I.

- Converting P.S.I. to feet of head

  Formula:
  $\frac{(\text{P.S.I.}) \times (27.7)}{12} = \text{Ft. of Head}$

- Converting Ft. of Head to P.S.I.

  Formula:
  (Ft. of Head) x (.036) x (12) = P.S.I.

- Flow Rate

  PV = Pool Volume, TR = Turnover Rate Formula:
  PV = Pool Volume, TR = Turnover Rate Formula:
  (PV÷TR) ÷ 60 = Flow Rate
  Example: PV = 127,500, TR = 6
  (127,500 ÷ 6) ÷ 60 = 354.17 GPM.

FLOW RATE CHART

Pool Capacity (Gallons)	Flow Rates (GPM)	
	6-hour Turnover	8-hour Turnover
50,000	139	104
55	153	115
60	167	125
65	181	135
70	194	146
75,000	208	156
80	222	167
85	236	177
90	250	188
95	264	198
100,000	278	208
105	292	219
110	306	229
115	319	240
120	333	250
125,000	347	260

Flow Rate Formula:
Pool Volume ÷ 6 or 8 hours = GPH
GPH ÷ 60 = GPM