replacement is a good management tool to use to maintain proper TDS levels in pools and spas. Some facilities develop a daily water replacement based on average user load. See the Spa & Therapy Operations chapter for more discussion concerning the water replacement interval.

Saturation Index

Wilfred F. Langelier, a professor of Civil Engineering at the University of California–Berkeley, developed a method of coating water distribution piping with a thin layer of scale. His published paper "The Analytical Control of Anti-Corrosive Water Treatment" quantified the corrosive potential of water. The index developed in this paper is called the Langelier Index.

The Langelier Index has been adopted by many industries and has spread to industrial water treatment as well as domestic drinking water treatment. The swimming pool industry developed a modified version of the Langelier Index in the 1970s. This index was adjusted for pool/spa water conditions and provides a method for determining whether the water is balanced with regard to calcium carbonate equilibrium.

The Saturation Index (SI) is a method of determining whether water will deposit calcium carbonate or maintain it in solution. The SI incorporates the five balance factors discussed in this chapter: pH, total alkalinity, calcium hardness, temperature, and total dissolved solids. Sequestering agents used to prevent scale, staining, or discoloration in water can improve the solubility characteristics of calcium carbonate, reducing the formation of scale. As a result, the balance point (0) of the SI can shift to a more positive number.

When higher cyanuric acid levels are present in water, the contribution of cyanuric acid should be removed from the total alkalinity since the saturation index uses the alkalinity due to carbonate, or total carbonate alkalinity, to determine the water balance. The cyanuric acid concentration should be divided by 3 to give the contribution to total alkalinity. For example, if the total alkalinity reading was 90 ppm (mg/L) and the cyanuric acid level is 60 ppm (mg/L), the total carbonate alkalinity would be 70 ppm (mg/L), since 20 ppm (mg/L) of the total alkalinity reading was due to the cyanuric acid interference (60 ppm (mg/L) ÷ 3 = 20 ppm (mg/L)).

Temperature, calcium hardness, total alkalinity, and total dissolved solids are expressed in the SI as factors Tf, Cf, Af, and TDSf respectively, as shown in Illustration 6-7. The pH of the water is substituted directly into the index.

For pool and spa waters, the ideal result of performing this index is to have a result of zero, i.e., SI = 0. Balanced water is between – 0.3 and + 0.5. Corrosive water is – 0.4 and lower. Scaling water is + 0.6 and higher.

Calculating the Saturation Index

To determine whether pool or spa water is properly balanced, a full water chemistry analysis is necessary. When calculating the SI, use the factors in Illustration 6-7. If an actual measurement is not found in the chart, use the next greatest value. The measured pH value is used directly in the formula. The Saturation Index formula is as follows:

SI	=	pH	+	Tf	+	Cf	+	Af	–	TDSf
Saturation Index		pH as tested		Temperature factor		Calcium factor		Alkalinity factor		TDS factor

If the water is not balanced, adjustments must be made to bring the water back into balance. The sequence of adding chemicals to make the adjustment should be total alkalinity first, followed by pH, and calcium hardness third. Temperature is not normally adjusted for water balance as most of the time it is not a controllable factor.

Example 6.1

Your pool water test readings are as follows:

pH	7.2
Temperature	84°F (28.9°C)
Calcium Hardness	200 ppm or mg/L
Total Alkalinity	100 ppm or mg/L
TDS	2,250 ppm or mg/L

Using the Saturation Index formula, the following results are obtained:

SI = pH + Tf + Cf + Af - TDSf
SI = 7.2 + 0.7 + 1.9 + 2.0 - 12.3
SI = - 0.5

The water is corrosive.

Example 6.2

Your spa water test readings are as follows:

pH	7.7
Temperature	104°F (40°C)
Calcium Hardness	400 ppm or mg/L
Total Alkalinity	100 ppm or mg/L
TDS	3,500 ppm or mg/L

Using the Saturation Index formula, the following results are obtained:

SI = pH + Tf + Cf + Af - TDSf
SI = 7.7 + 0.9 + 2.2 + 2.0 - 12.4
SI = + 0.4

The water is balanced.

Example 6.3

You can also use the following SI Worksheet in order to calculate the SI value for your pool water. Using the factors chart in Illustration 6-7, insert the factors values for each measured variable. Note that in this example the water is not balanced with a Saturation Index value of -0.5, which means that the water is corrosive. The values given in red are possible adjustments that can be made to bring the water back into balance. These adjustments are not the only ones that can be made to bring the water back into balance.

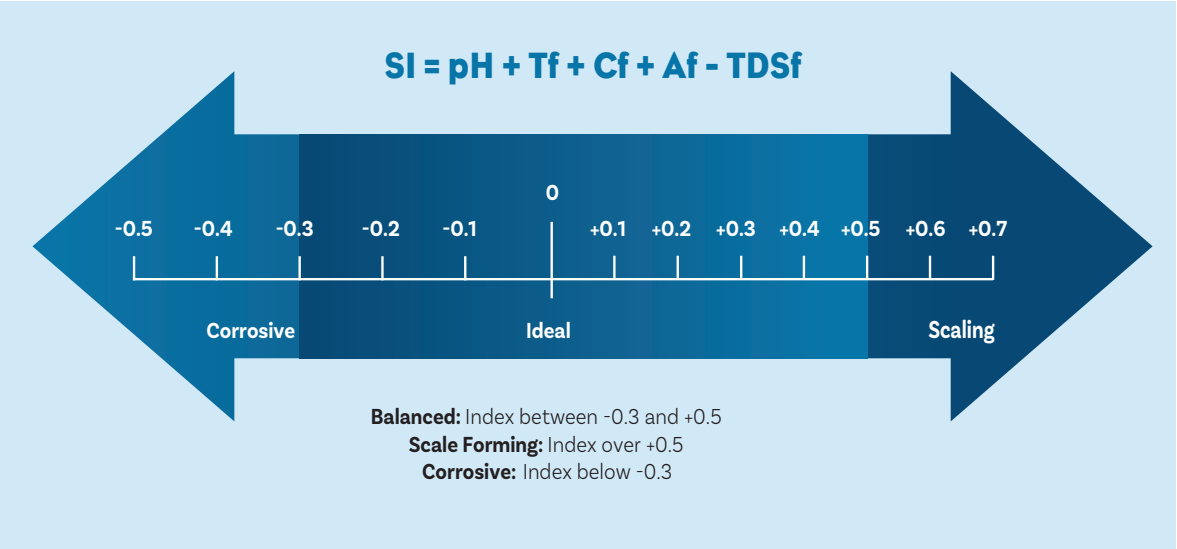
Saturation Index Factors

Temperature			Calcium Hardness expressed as $CaCO_3$		Total Carbonate Alkalinity	
°F	°C	Tf	ppm (mg/L)	Cf	ppm (mg/L)	Af
32	0.0	0.0	25	1.0	25	1.4
37	2.8	0.1	50	1.3	50	1.7
46	7.8	0.2	75	1.5	75	1.9
53	11.7	0.3	100	1.6	100	2.0
60	15.6	0.4	125	1.7	125	2.1
66	18.9	0.5	150	1.8	150	2.2
76	24.4	0.6	200	1.9	200	2.3
84	28.9	0.7	250	2.0	250	2.4
94	34.4	0.8	300	2.1	300	2.5
105	40.6	0.9	400	2.2	400	2.6
			800	2.5	800	2.9

Total Dissolved Solids Factors

TDS	Factor
≤800	12.1
801-1,500	12.2
1,501-2,900	12.3
2,901-5,500	12.4
>5,500	12.5

Illustration 6-7.



Balanced: Index between -0.3 and +0.5
Scale Forming: Index over +0.5
Corrosive: Index below -0.3

Illustration 6-8.