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Date Issued	Feb 22
Replaces	

INFO SHEET

Understanding LSI: Langelier Saturation Index

November 16, 2016/by Orenda Technologies+

The Langelier Saturation Index (LSI) is a formula developed from studies conducted by Dr. Wilfred Langelier in the early 20th century. The LSI is the basis for water balance and saturation, and this article will try to explain how it works in a simplified way. This is complex science, but very helpful to know as a pool owner or operator.

Think of the LSI as a scale with a fulcrum

A perfect score on the LSI is zero (0.0). Zero is perfectly balanced water; saturated with the perfect amount of calcium and dissolved solids, and has a stable pH. Being the universal solvent, if water is out of balance, it will naturally try to find its own balance and equilibrium, because it wants to be at 0.0 LSI. For instance, if there is not enough calcium, water will dissolve and extract it from the plaster walls of the pool (etching).

Calcium carbonate, metals and other dissolved solids must all be saturated and balanced to attain zero LSI.

The Langelier saturation index is basically a way to determine if water is **corrosive** (negative LSI) or **scale-forming** (positive LSI). LSI between -0.3 and +0.3 is the widely accepted range, though 0.0 is the ideal.
The key word here is **saturation.** Ideal saturation is 0.0 LSI. Under-saturation is corrosive, and over-saturation is scale-forming. Water can only hold so much calcium in suspension. Once the water is saturated to where it wants to be, the etching stops. In this instance, as pool professionals, our goal is to properly balance water up front (and maintain it) so that neither etching nor scaling occur.
Low LSI does not just etch plaster, it can corrode metal too. This is part of the reason why metal sequests are so important to use in pools, especially during start up. Like calcium, water will dissolve metals and keep them in suspension…until the water is oversaturated. At that point, metals (most commonly copper, aluminum or magnesium from common pool products such as algaecides) will fall out of solution and stain pool surfaces. An effective sequestering product can prevent that from happening.

How to calculate LSI: it is an equation with six variables

The six variables you need to calculate the Langelier Saturation Index:

- pH
- Temperature (ºF)
- Calcium Hardness (ppm)
- Alkalinity (ppm)
- Cyanuric Acid/Stabilizer (If applicable, correction based on pH)
- Total Dissolved Solids (ppm)

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These variables are given numerical equivalent "factors", as assigned in The Langelier Numerical Equivalents Table. See the chart below.

Equivalent Factors - Langelier Saturation Index (LSI)

Temperature (ºF)	Temperature Factor	Calcium Hardness (PPM)	Calcium Hardness Factor	Alkalinity (PPM)	Alkalinity Factor	Cyanuric Acid (if present)	Cyanurate Correction Factor	Total Dissolved Solids	TDS Factor
32	0.0	5	0.3	5	0.7	**pH**	**Factor**	< 1000 ppm	12.10
37	0.1	25	1.0	25	1.4	7.0	0.23	1000 ppm	12.19
46	0.2	50	1.3	50	1.7	7.2	0.27	2000 ppm	12.29
53	0.3	75	1.5	75	1.9	7.4	0.31	3000 ppm	12.35
60	0.4	100	1.6	100	2.0	7.6	0.33	4000 ppm	12.41
66	0.5	150	1.8	150	2.2	7.8	0.35		
76	0.6	200	1.9	200	2.3	8.0	0.36		
84	0.7	300	2.1	300	2.5	Note: Only use if CYA is used in your pool. Only applies to >7.0pH. If so, select correction factor based on pool pH.		Note: most calculators assume **12.1** for under 1000ppm, or **12.2** for anything over 1000.	
94	0.8	400	2.2	500	2.6				
105	0.9	800	2.5	800	2.9				

The LSI Equation

(pH) + (Temperature ºF) + (Calcium Hardness) + [(Total Alkalinity) – (CYA correction factor @ current pH)] – (TDS factor) = **LSI**

Let's use an example.

You manage a pool that has the following chemistry:

- ph: **(7.4)**
- temperature: 84ºF **(0.7)**
- calcium hardness: 300 **(2.1)**
- alkalinity: 100 **(2.0)**
- cyanuric acid: **(Yes)**
- total dissolved solids < 1000 **(12.1)**

Let's calculate.

[(7.4) + (0.7) + (2.1) + [(2.0)-(0.31)] – (12.1) = X **LSI**
[(10.2) + (1.69)] – (12.1) = X **LSI**
[11.89] – (12.1) = **-0.21 LSI**

This is well balanced water (within acceptable range), but errs to the side of corrosive. Ideally, this water could be balanced by increasing the factors in the equation by 0.21. For example, an operator can increase the calcium hardness from 300 to 400, which would add 0.1…which gets closer to perfect balance. Play with the numbers on your own to find the balance that works for you and your pool(s).

More about the LSI factors

pH: this variable is the most likely to shift up and down, as pool operators already know. In the LSI calculation, it has no factor, just the pH value itself (example: 7.2). The lower the pH, the more acidic, and the higher the pH, the more alkaline.
Temperature (ºF): Temperature affects the speed of chemical reactions in water. The lower the temperature, the easier it is for corrosive reactions to occur. The higher the temperature, the easier it is for calcium to come out of suspension. This explains why salt cells often have calcium carbonate scale on them (heat).
Calcium Hardness: This is a measurement of how much calcium is dissolved in the water. Water that is over-saturated with calcium is likely to be more scale forming, but only if the pH and total alkalinity allow for it to come out of solution. Calcium hardness—like total alkalinity—serves as a buffer for pH.
Alkalinity: In the original Langelier Saturation Index formula, Dr. Langelier used **total alkalinity.** Over time, however, it became evident that swimming pool chemistry is different from other types of

water; therefore it is more accurate to use **carbonate alkalinity**. The reason for this change is because many pools use cyanuric acid as a stabilizer. Because of this, alkalinity requires a mathematical correction when CYA is involved. You can find this in the chart above.

Cyanuric Acid (stabilizer): If CYA is present, adjust total alkalinity with the cyanurate correction factor in the chart above to find the carbonate alkalinity. The CYA correction factor is about 1/3, if you're rounding. To find it exactly, you need to know the pH of the water and follow the chart.

Total Dissolved Solids (TDS): TDS is a measurement of everything that is dissolved in the water, floating around in suspension. It is measured in parts-per-million, and can include anything from calcium to metals and other chemicals. Most often, LSI calculations assume either less than 1000ppm or more. But if you want to be exact, follow the chart above.

Things the Langelier Saturation Index teaches us

If you look at the schedule of values, you will see that calcium hardness and total alkalinity have a similar impact on LSI. This is important, because it means total alkalinity is not alone in its ability to buffer/stabilize pH. Calcium hardness does too. The higher the hardness, the more stable the pH. Additionally, the LSI offers a different way of looking at water chemistry. By understanding how **saturated** the water is with metals and calcium, it is a strong predictor of damage to gunite/plaster before it gets bad. And on the other hand, if the LSI is positive, the water is likely to form scale, even if not seen. So as owners and operators, the LSI offers a broader view of water chemistry beyond just pH and chlorine levels. At Orenda, we believe two measurements—LSI and ORP—will be the future standard of measurement in pool chemistry.

Added Notes from PNF:

We recommend you have your pool's LSI calculated every time you do a water test at the pool shop. This can be done by them., Then keep a written record of the results inc date. Then watch trends and you can see in advance any upcoming problems. Meaning you can just the pool chemistry before they happen. This will save you money.