Hitchins 1932 TECHNOLOGIES

Performance Through Technology and Service

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INFO SHEET

Langelier Saturation Index (LSI) for pool water –

All You Need to Know to Calculate it.

Introduction:

In the 1930`s, Professor Wilfred F.Langelier was commissioned to discover how to lay down a thin layer of scale on the distribution piping of a Large City. Such a thin layer of scale would protect the cast iron pipes from corrosion. About 40 years ago this calculation was adjusted and amended to suit swimming pool water conditions and made into a calculation that determines whether the water is neutral, balanced or unbalanced (corrosive or scale forming)

The **Langelier Saturation Index**, often called the **"LSI,"** the "saturation index," or the "stability index," is a numerical value indicating whether or not water is balanced. It is calculated using the formula shown below.

SI = pH + TF + logCH + logALK – CONSTANT, where:

SI = saturation index
pH = measured pH
TF = temperature factor
CH = measured calcium hardness
ALK = measured alkalinity minus cyanurate alkalinity
CONSTANT = combined factor for temperature and ionic strength correction, and concentration conversions

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An SI value of **zero** means water is properly balanced. No chemical adjustment is necessary if the SI is within ±0.5 units of zero; however, conditions producing a value greater than 0.5 may lead to cloudiness and scaling, while conditions producing a value less than -0.5 may cause corrosion of concrete or metal surfaces. (Note: While the cited SI range is commonly taught, the trend now in the pool/spa industry is to recommend a more restrictive range of -0.3 to 0.5 or even **-0.3 to 0.3.**)

The Langelier Index is used to determine the tendencies of water toward corrosion or scaling based upon the pH (potential of hydrogen) of calcium carbonate (CaCO3). In other words, The Langelier Saturation Index is used as a guide to achieve stable water. Several factors: pH, total alkalinity, total hardness, total dissolved solids and temperature are calculated to

determine the potential “aggressiveness” or scale forming potential of the water. The LSI is used to pinpoint water balancing problems.

Corrosive water will dissolve the surface composites in the structure of the pool and scale forming water will precipitate hard water salts causing cloudy water and eventually will deposit scale on pool walls and other surfaces as it attempts to correct imbalances.

Because of the relation to the swimming pool and spa industry the LSI was accepted and used as an index in correcting the chemistry of these recreational bodies of water.

The LSI is used worldwide in the water treatment industry and civil engineering worldwide. The saturation index written by Professor Langelier is relevant currently in the swimming pool and spa industry although it has been disputed, modified and adjusted.

During the beginning of the swimming pool era the LSI was accepted because of the correlation to swimming pool and spa plumbing and for the lack of a better reference in determining the quality of water. The Langelier Index was expanded on by the Ryzner Index, to better predict scale thickness observed in municipal water systems and the index used to monitor swimming pool and spa water was modified by a modern leader in chemistry Jock Hamilton.

Jock Hamilton was raised in southern California. In 1961 Jock started a pool company under the name of “Allied Pool Service & Engineering”. Eleven years later Mr. Hamilton expanded his business to include water chemistry and formed the United Chemical Corporation. Known as a maverick he is quoted refuting the Langelier Saturation Index as it pertains to pool and spa chemistry and offering an alternative of his own.

Hamilton slightly modifies the LSI increasing recommended alkalinity to 100 to 200 ppm rather than the previously outlined 60-80 ppm, pH between, 7.6 to 8.2, with a variable sanitizer maintained at 1ppm. According to Hamilton this decreased the maintenance in chemical adjustments and accounted for water with a temperature over 100 degrees and recycled/reused water with high bather load not only in pools but spas as well.

The following charts have been set forth to help achieve “perfect” water balance.
The formula is “SI = pH + TF + CF + AF – 12.1.” To calculate the Saturation Index, test the water for pH, temperature, calcium hardness, and total alkalinity.

Temperature F ° = **TF**	Calcium Hardness = **CF**	Total Alkalinity = **AF**
0° = **0.0**	5 = **0.3**	5 = **0.7**
3° = **0.1**	25 = **1.0**	25 = **1.4**
8° = **0.2**	50 = **1.3**	50 = **1.7**
12° = **0.3**	75 = **1.5**	75 = **1.9**
16° = **0.4**	100 = **1.6**	100 = **2.0**
19° = **0.5**	150 = **1.8**	150 = **2.2**
24° = **0.6**	200 = **1.9**	200 = **2.3**
29° = **0.7**	300 = **2.1**	300 = **2.5**
34° = **0.8**	400 = **2.2**	400 = **2.6**
40° = **0.9**	800 = **2.5**	800 = **2.9**
53° = **1.0**	1000 = **2.6**	1000 = **3.0**
Saturation Index = pH + TF + CF + AF – 12.1		

HITCHINS TECHNOLOGIES PTY LTD **ACN** 119 448 501, **Postal:** PO Box 3186, Bonnells Bay NSW 2264, Australia
Phone: 1300 8879 20 Fax: 1300 8879 21 **web: www.poolpaint.com.au** **Email: info@poolpaint.com.au**

Example:
Test results:
pH reading is 7.0
Water Temperature is 29c° (TF is .7 from chart)
Calcium Hardness reading is 300 ppm (CF is 2.1 from chart)
Alkalinity reading is 25 ppm (AF is 1.4 from chart)
Saturation Index =
(pH) 7.0 + (TF) 0.7 + (CF) 2.1 + (AF) 1.4 – 12.1 = ***-0.9***
Since the equation solution equals –0.9, this indicates a corrosive water condition.

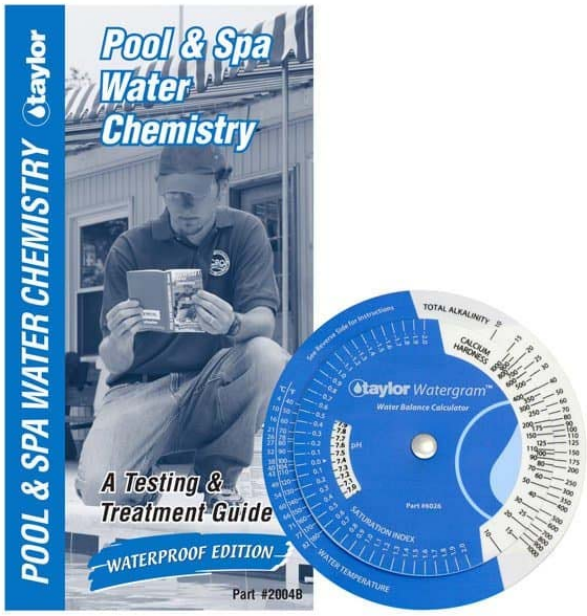
A result between -0.3 and +0.5 is said to indicate balanced water

The LSI and the modified Hamilton Saturation Index are not guaranteed; however, some readings for pH, calcium, and alkalinity which, if taken individually would be considered to be well beyond recommendations, can combine within the formula to produce "balanced water." Professor Langelier and Hamilton were both experts and pioneers in their respective fields. Their indexes continue to assist civil engineers as well as swimming pool professionals. The United Chemical Corporation founded by Jock Hamilton is still thriving in the pool industry.
Swimming pool and spa water chemistry is no doubt a science that can become very involved and somewhat complex. Don't let your water chemistry distract you from enjoying your pool. Do what works for you and your pool. Maintaining proper parameters is a must keeping in mind every pool is unique.

While the SI is a useful calculation, crunching it out poolside could prove troublesome. To simplify the process, Taylor developed the Watergram®, a sliderule-like device used to determine whether water is balanced without performing tedious calculations. Just follow these four simple steps:

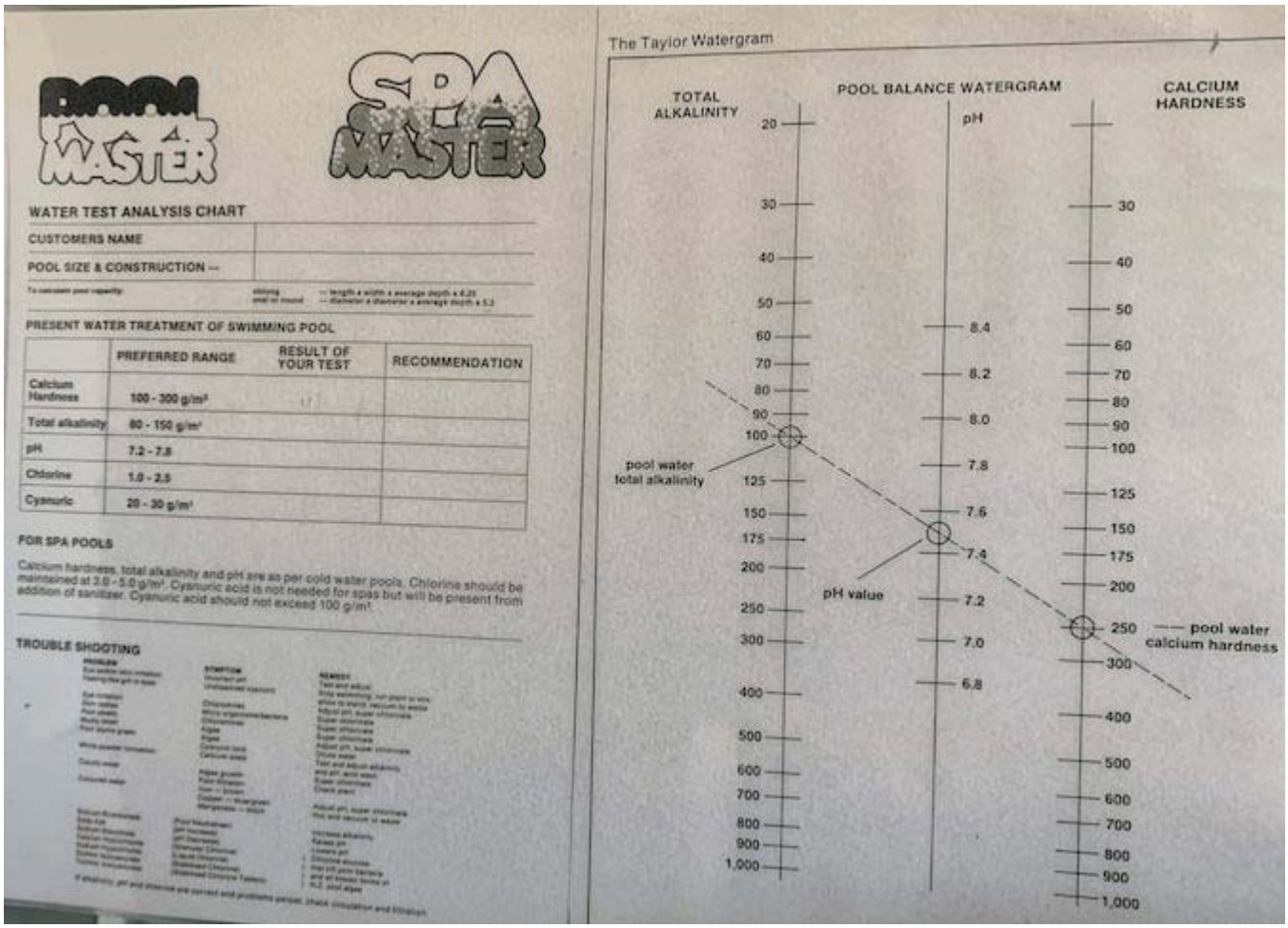
1. Using test kit, determine pH, Calcium Hardness, and Total Alkalinity of sample water.
2. Using *Watergram® Water Balance Calculator*, set **Calcium Hardness** opposite **Total Alkalinity**.
3. Hold Calcium Hardness against Total Alkalinity and set arrow to measured **pH** in window.
4. Read **Saturation Index** opposite **Water Temperature**. Note: If the temperature is not known, use 27°C (summer) or 15 C (winter) for pools or 38°C for spas and hot tubs. (However ALWAYS better to know the pool temperature for an accurate result)

See our *Pool & Spa Water Chemistry* booklet (#2004B) for proper water-chemistry adjustment procedures when you discover scaling or corrosive tendencies.



The Taylor "Watergram"

Every swimming pool owner should have this very useful and informative tool at their finger tips. Is your pool shell showing early signs of corrosion or erosion?



WATER TEST ANALYSIS CHART

CUSTOMERS NAME

POOL SIZE & CONSTRUCTION —

PRESENT WATER TREATMENT OF SWIMMING POOL

	PREFERRED RANGE	RESULT OF YOUR TEST	RECOMMENDATION
Calcium Hardness	100 - 300 g/m³		
Total alkalinity	80 - 150 g/m³		
pH	7.2 - 7.8		
Chlorine	1.0 - 2.5		
Cyanuric	20 - 30 g/m³		

FOR SPA POOLS

Calcium hardness, total alkalinity and pH are as per cold water pools. Chlorine should be maintained at 3.0 - 5.0 g/m³. Cyanuric acid is not needed for spas but will be present from addition of sanitizer. Cyanuric acid should not exceed 100 g/m³.

TROUBLE SHOOTING

The Taylor Watergram

POOL BALANCE WATERGRAM

TOTAL ALKALINITY

pH

CALCIUM HARDNESS

20 30 40 50 60 70 80 90 100 125 150 175 200 250 300 400 500 600 700 800 900 1,000

8.4 8.2 8.0 7.8 7.6 7.4 7.2 7.0 6.8

30 40 50 60 70 80 90 100 125 150 175 200 250 300 400 500 600 700 800 900 1,000

pool water total alkalinity

pH value

pool water calcium hardness

Balanced water with these 3 readings / points intersecting

Every swimming pool owner should strive to get a straight line intersecting the 3 lines on the Watergram above. The readings/values can be different as long as they intersect in a straight line as shown above.

This indicates balanced water. Try to get to the industry standard readings as per the original Watergram

(Another version below)

Taylor Watergram

TOTAL ALKALINITY	Ph	CALCIUM HARDNESS
50	8.4	50
60		60
70	8.2	70
80		80
90	8.0	90
100		100
125	7.8	125
150		150
175	7.4	175
200		200
250	7.2	250
300		300
350	7.0	350
400		400
450	6.8	450

There is a relationship between levels the of Calcium Hardness and the Total Alkalinity of your pool called the "Water Balance". The pool is termed "Balanced" if the above values shown are true. The Watergram above shows TA 100, pH 7.6 and CH 200 as being ideal. The two elements CH & TA may vary, so long as the crossover point on the Taylor Watergram is within the specified pH range - the preferred pH value of home pools = 7.6 This "Balanced" pool will maintain the pH due to the "buffering" effects of the two compounds which are added to the pool Calcium Hypochlorite - which are related to "Baking Soda" and "Chalk". Maintaining the pH at the recommended level is the most important factor in keeping the pool clean and sterile, so always keep an eye on the pH of your swimming pool.

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