The Association of Pool & Spa Professionals®

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Fact Sheet

Total Dissolved Solids

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Brought to you by the APSP Recreational Water Quality (RWQ) Committee

I. INTRODUCTION

In understanding the necessary water chemistry parameters used to protect swimmers, bathers, interior finishes, and equipment, total dissolved solids (TDS) must not be overlooked. Its role in achieving "balanced" water is usually given less importance in comparison to pH, total alkalinity and calcium hardness levels. With the increased popularity of electrolytic chlorine generators (ECG) as well as drought conditions in many parts of the United States restricting the draining of pools, TDS levels have been steadily climbing. This bulletin will review the increasingly significant role TDS plays in today's residential and commercial pools, spas, and water features.

II. GENERAL DESCRIPTION

A. What is TDS

TDS is the total of all dissolved solid matter such as minerals, metals, salts and contaminants in the water.

B. How TDS is Determined

TDS is most often determined in pool and spa water by using a conductivity meter. These electronic meters measure the waters' ability to conduct an electric current. The greater the concentration of charged particles (to include both positive and negative ions), the more freely electric current can flow through the water. TDS concentrations can also be measured by other test means such as test kits and test strips. It is important to note that while testing methods measure charged particles in the water, true TDS also includes non-charged contaminants such as oils, lotions, cosmetics and other swimmer waste. Other tests will provide better information about organic contaminants in pools and spa, but are much more costly and time consuming to perform in comparison to the simple conductivity test.

In residential pools and spas, TDS testing should be performed monthly. In commercial pools, spas, and water features, testing should be performed several times a month as necessary.

C. TDS and the "Aging" of Water

Rising TDS levels have traditionally been used as an indicator of the accumulation of contaminates in the pool or spa water. Contamination may be in the form of un-oxidized or partially oxidized pollutants and include nitrogenous products from swimmer's waste. TDS concentration increases over time as dissolved materials are added to water from source or fill water, pool treatment chemicals, swimmer waste, and environmental contaminants. Evaporation increases TDS as water evaporates leaving behind dissolved solids.

D. Background-TDS and The Langelier Saturation Index (LSI)

Of the different water balance indices that are currently used in the swimming pool industry to help predict the scale forming or corrosive tendencies of pool and spa waters, the major index utilized today is the LSI. The LSI is a mathematical/chemical formula that considers five factors or properties of pool/spa water which include the following: pH, bicarbonate/carbonate alkalinity, calcium hardness, temperature and TDS. Traditionally in LSI calculations, carbonate alkalinity, calcium hardness, and temperature levels were assigned numerical factors while the TDS content was assigned a constant of 12.1, which reflected TDS levels from 0ppm to 1000 ppm.

Historically, the LSI was developed for use with closed systems, such as pipe lines, wherein the water balance remained relatively fixed for a given body of water. The system was later applied to swimming pools. Initially in pools, TDS was easily controlled by draining water when elevated TDS levels were reached. This solution is not always practical for open pool systems with many changes in the water caused by reactions with the atmosphere, additions of pool chemicals, evaporation, new replacement water, and other factors that cause TDS levels to rise well beyond the 1000 ppm level. The concept of trying to provide a better arithmetic formula to protect tile grout, equipment, and plaster surfaces resulted in adding the LSI TDS constant of 12.2 for the 1000-2000 ppm range.

For years, a level of 3000 ppm was considered the maximum allowable TDS for pools. In the early 1990s, electrolytic chlorine generators gained enough acceptance to have an impact on common TDS levels. The sodium chloride (salt) introduced into these pools causes TDS levels to exceed the 3000 ppm range. By the early 2000s, the NSPI (now APSP) adopted the additional TDS constant of 12.3 for levels from 2000 ppm to 3000 ppm. These TDS constants or factors were updated by APSP again in 2009 to cover TDS ranges from 0ppm up to 5000 ppm.

III. APPLICATION AND USE OF TDS DATA

A. The recommended maximum allowable TDS for pools and spas is 1500ppm greater than TDS at initial pool or spa start-up. Start-up TDS includes balanced water TDS as well as salt (sodium chloride) added at start-up.

B. This maximum allowable level can be used to prevent issues associated with the *aging* of pool/spa water which includes problems such as 1) reduced efficiency of disinfection/sanitizing chemicals due to elevated organic contaminants, 2) corrosion of fixtures as TDS increases due to the greater conductivity of the water, and 3) surface staining and/or etching may result from elevated TDS.

C. Exceeding the maximum recommended level may indicate the need to partially or completely drain water, provided there are not local drought conditions or other prohibitions against draining. For spas, the TDS can be used to calculate the water replacement interval (WRI) or when the spa needs to be completely drained if either of the following conditions are met:

1. The Total Dissolved Solids (TDS) in the spa exceeds the source water TDS by 1500ppm or more,

Or

2. The Water Replacement Interval (WRI) is less than or equal to the number of days since the last time the water was drained. WRI is calculated as shown in the formula and examples below:

WRI = (0.33) (Spa Volume in gallons ÷ (Cumulative No. Bathers per day since last change)

Example 1:
The TDS of the original source water was measured and recorded to be 800ppm. The TDS of the spa water now reads 2500ppm. The difference is greater than 1500ppm (2500ppm 800ppm = 170Oppm). Therefore, the spa should be drained immediately.

Example 2:
Consider a 600-gallon spa last drained and refilled on Sunday evening, with the usage pattern outlined in the table below:

600 Gallon (2.3 cubic meter) Spa Usage Pattern								
	Sun	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
Bathers	Water changed at end of day	85	2	19	20	105	100	50

The WRI is computed in the table below and compared to the interval since the last change. If the Difference (WRI - Days since last change) is less than or equal to zero, the spa should be drained

600 Gallon Spa Usage Pattern								
	Sun	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
Bathers	Water changed at end of day	85	2	19	20	105	100	50
WRI	-	2	2	11	5	1	2	1
Difference (WRI minus Days since last change)	-	1	0	10	3	-2	1	-1
Change Water (Difference ≤ 0?)		No	Yes	No	No	Yes	No	Yes

[NOTE: Language and tables from ANSI/APSP ICC-5 2011, page A-S.]

D. Use the TDS numerical value to obtain the correct LSI factor to properly calculate the Langelier Saturation Index (LSI or SI).

E. For elevated TDS levels such as with pools and spas with salt chlorine generators, use the following table:

TDS	Factor
<800	-12.1
800-1,500	-12.2
1,500-2,900	-12.3
2,900-5,500	-12.4
>5,500	-12.5

[NOTE: Table taken from ANSVAPSP-II 2009, page 18. These factors can also be found in the APSP Service Tech Manual, 4th Edition, page 3-29, published in 2010.]

Use the reading closest to your actual reading in choosing the factor.

IV. PRECAUTIONS

A. Low TDS levels – Although there is not a minimum level in ANSI/APSP standards, source water TDS should always be checked before start-up of new pools, spas, and water features. Low TDS may be indicative of low calcium hardness and/or low total alkalinity levels that may produce corrosive conditions that could affect tile grout, surfaces, and equipment.

B. High or elevated TDS levels may be an indicator of high organic contamination that may influence the consumption of the sanitizer and its ability to properly disinfect and oxidize the pool or spa water, which can in turn, lead to swimmer or bather safety concerns.

C. Elevated TDS levels will increase the conductivity of the water and may lead to possible corrosion of fixtures, lights, and equipment, especially if any stray voltage is present in the water

D. Elevated TDS levels (which include elevated sodium chloride levels) can damage some ECGs and should be monitored to prevent problems. The individual manufacturer of the ECG should be consulted as to the levels that can create possible problems.

E. It has been known for years in industrial water treatment, that high mineral content of water increases the conductivity of water and thus possible corrosion if other factors favor corrosion. In, addition, high salt content or elevated TDS can increase the solubility of calcium carbonate and other calcium compounds. With elevated TDS and salt (NaCl) levels, there is an increase in ionic strength as salt and TDS concentrations increase. For cementitious interior finishes, this increase in the solubility of calcium components of the plaster and other cement-based surfaces can be offset/managed by adjustment of the other LSI water chemistry parameters (pH, total alkalinity, calcium hardness, and temperature) and use of the LSI to prevent corrosive conditions. This must include the correct factor for elevated TDS levels.

F. Elevated TDS levels (which include elevated sodium chloride levels and other salts) can cause problems with masonry materials used in pool/spa decks. Both natural and man-made products subjected to frequent wet/dry cycles with water containing high TDS can experience deterioration of these materials. Always consult with the installer/contractor to confirm the compatibility of these materials to be placed on and around pools/spas with elevated TDS and salt levels.

V. SUMMARY/CONCLUSIONS

With the increased popularity of ECGs as well as water restrictions, many pools, spas, and water features are running TDS levels in excess of 3000ppm. With this increase in TDS must come a heightened awareness of the potential problems associated with these elevated levels. Concerns with issues ranging from hazy "tired" water, improper LSI water balances, surface staining, decreased sanitizer efficiency, and deterioration of equipment must all be considered with performing a regimen of care to any pool, spa, or water feature. The simplest remedy to these problems is often to perform a partial or complete drain of a vessel and replace with fresh water having a lower TDS content. Monthly testing should be performed on residential pools and spas and more frequently on commercial vessels.

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