MANAGING WATER BALANCE

Using LSI to preserve an Arizona treatment plant's distribution systems

By Heather Rekalske

The first thing anyone who manages water and wastewater learns is that water is the universal solvent. Because of the unique properties of that dihydrogen monoxide molecule, owing to the extreme electronegativity of the oxygen atom, water is highly polarized and dissolves almost everything with which it comes into contact. This fact is important when one has to maintain equipment and structures that process and distribute water because what the water has dissolved in it can cause it to be corrosive or scaling. What water generally has dissolved in it is at least some carbon dioxide and some calcium carbonate.

Carbon dioxide is ubiquitous and dissolves at the surface of the water, forming carbonic acid in solution. Calcium carbonate, dissolved by the carbonic acid, is globally present in rock formations (limestone), as well as in the physiological structures of organisms (particularly oceanic organisms) that excrete it. Calcium carbonate in its various forms is also used to buffer pH and stabilize solution in process control. Managing the calcium carbonate equilibrium becomes critical to managing any water and wastewater treatment process.

Too little calcium carbonate yields water that is not saturated and may cause corrosion and deteriorate equipment and structures. A supersaturated solution will likely precipitate calcium carbonate, causing scale, reducing efficiency and eventually leading to system failure.

Gary Lyons manages LSI at an Arizona water treatment facility using the Ultrameter II 6Psi.

LSI in AZ

One method for analyzing and managing corrosion and scale deposition of water is to use the Langelier Saturation Index (LSI). In Scottsdale, Ariz., Gary Lyons is managing LSI at his water treatment facility using the Ultrameter II 6Psi by Myron L. Co.

His drinking water treatment plant takes 70 million gal per day (mgd) of water from the Central Arizona Project canal and treats it for residential and commercial use. Within the 143-acre campus, the plant processes 20 mgd to of wastewater from the city of Scottsdale collection system using microfiltration and reverse osmosis (RO). Water coming from the RO treatment process is acidic around pH 5.5. It is then moved to decarbonation towers and lime is added to bring the LSI value close to zero. The water reclamation plant features 8 mgd of storage capacity. Recycled water treated by the plant is used for the irrigation of 20 Scottsdale golf courses.

There is great concern about how the water balance will affect this distribution system over time, especially due to higher total dissolved solids values. Plant technicians compute LSI values in the field with the 6Psi hand-held to determine what adjustments should be made and how in real time. The LSI calculator allows them to perform what-if scenarios on changes in pH, alkalinity, hardness and temperature. They are able to measure the effects of changes immediately as well in the facility and at distribution points.

Hardness and alkalinity are variables in the LSI calculation because they account for the availability of calcium in various forms in the water. Variables such as temperature and pH contribute to the likelihood of the formation of calcium carbonate.

The version of the LSI calculation used by the 6Psi LSI calculator is:

LSI = pH + TF + CF + AF – 12.1

In this calculation, pH = the measured value of pH in pH units; TF = 0.0117 x temperature – 0.4116; CF = 0.4341 x ln(Hrd) – 0.3926; and AF = 0.4341 x ln(AL) – 0.0074.

Indicator Analysis

LSI has been useful as a scaling/corrosion indicator in municipal water treatment for more than 70 years. The original Langelier Saturation (or Stability) Index calculation was developed by Dr. Wilfred Langelier in 1936 to be used as a tool to develop strategies to counteract corrosion of plumbing in municipal water distribution systems. It is a statement about the change in pH required to bring the calcium carbonate in water to equilibrium. LSI is a measure of the disparity between the pH of the system and the pH at which the system is saturated with calcium carbonate: LSI = pH – pH of saturation.

As such, the LSI indicates the change in pH required to bring water to equilibrium. If the LSI is +1, then the pH needs to be lowered by one unit to bring the water to equilibrium. If the LSI is -1, the pH needs to be raised by one unit to bring the water to equilibrium.

A positive saturation index means that the pH of the water is above equilibrium. The water is scaling because as pH increases, total alkalinity concentration increases. This is due to an increase in the carbonate ion, which bonds with calcium ions present in solution to form calcium carbonate (reference the carbonic acid equilibrium, in which hydrogen ions bond with carbonate ions to form bicarbonate and hydrogen ions bond with bicarbonate to form carbonic acid). Thus, any positive value for LSI is scaling.

If the pH is less than the pH of saturation, the index will be negative, which is corrosive. This means that the water is more acidic than it would be at equilibrium. There are less carbonate ions present, according to the carbonic acid equilibrium. The water will be aggressive because it has room for more ions in solution. Thus, any negative value for LSI indicates that the water may tend to be corrosive.

The use of LSI as an indicator is well documented and time-tested. Managing water balance through LSI analysis will prevent loss of efficiency and failure of equipment and structures, saving time and money. MT

Heather Rekalske is technical writer for Myron L Co. Rekalske can be reached at hrekalske@myronl.com.

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