Why We Call it "Total"

onBalance – Que Hales, Doug Latta and Kim Skinner

At this point in our swimming pool water chemistry careers, we experienced service techs are pretty solid in understanding some applications of the word "total." For instance, when we talk about total chlorine we understand that there are components – free chlorine and combined chlorine – that together make up the total. That is important because combined chlorine is part of the total chlorine, but it is something that we want to get rid of. A long time ago the pool industry only used one test for chlorine (OTO), which only read the total chlorine, and we had to guess if there was combined chlorine present. Fortunately, the DPD method is now common, and it can distinguish between the free and the total so we can see into the components of the species. This is especially important because the APSP standard calls for specific remedial action if too much combined chlorine is present.

We all may even be familiar at this point in our careers with the concept of total hardness, and its component, calcium hardness. Total hardness includes both the calcium portion and the magnesium hardness. This is useful because comparing the ratio of calcium hardness to total hardness in water can in some situations give us a rough read on the age of the water, since the percentage of total hardness that is calcium tends to increase over time. However, when calculating Saturation Index (SI) values on water it is important to use only the calcium hardness portion of total hardness, since that is the portion that plays a role in calcium carbonate solubility. Again, fortunately, there are separate testing methods for total hardness and for calcium hardness. Those who prefer to use both tests, may. But most of us will test only the calcium version, because it is the value used in the SI calculation. It is also the value in the APSP standard, which calls for a minimum and maximum calcium hardness content in pool and spa water.

We have also been taught that the alkalinity value we test and record in our chemical logbooks is total alkalinity. What does that mean? Well, similar to total chlorine and total hardness, total alkalinity is made of several sub-components. In pool/spa water, the components we are concerned with are carbonate-species and cyanurate-species alkalinity. And although even the carbonate is subdivided (carbonate and bicarbonate) and the cyanurate is subdivided, we use the words carbonate and cyanurate to describe the groupings. In pools where borax is added, a third type of alkalinity may be present in significant concentrations – borate alkalinity. Unfortunately, unlike chlorine and hardness, we only have one test for alkalinity, and that is for the total alkalinity. The APSP standard calls for minimum and maximum amounts of alkalinity, and this indeed refers to the total alkalinity. However, the standard also calls for balanced water, and when we calculate SI values, the value we input is carbonate-species alkalinity, not total alkalinity, just as we input calcium hardness, not total hardness.

This is a problem, since we do not have a test method that reads only the carbonate-species alkalinity. So, when significant non-carbonate alkalinity is present in water, we must isolate the carbonate species alkalinity before going on with the SI calculation, and that involves a separate mathematical step. Fortunately, at pool pH the portion of cyanurate species that is present as alkalinity is roughly a nice round 1/3. That varies slightly with varying pH, but not enough to get hung up over. So the subcalculation is that the carbonate-species alkalinity is equal to the total (measured) alkalinity minus 1/3 of the measured cyanuric acid content. The formula for isolating carbonate from total looks like this:

$$AlkTOT - 1/3(CyA) = AlkCARB$$

where AlkCARB is the carbonate-species alkalinity, AlkTOT is the titrated or measured total alkalinity, and CyA is the measured cyanuric acid species. For example, in pool water containing 100ppm of measured total alkalinity and 90ppm measured cyanuric acid, the carbonate-species alkalinity is 70ppm:

$$100 - 1/3(90) = 70 \quad \text{or} \quad 100 - 30 = 70$$

Remember that this is only important in terms of saturation chemistry calculations. If the total titrated alkalinity is 100ppm, then the TA is 100, not 70. And the APSP standard is for TA, not carbonate alkalinity only. Why? Because cyanurate (and borate, for that matter) are alkalinity, and perform as buffers in water, which is the reason for minimum and maximum alkalinity in water – to buffer or hold the pH steady. (The percentage of boron that is present as borate alkalinity is small enough that at pool pH we can safely ignore its contribution to alkalinity.)

Unfortunately, some pool industry chemistry texts refer to the calculated carbonate-species alkalinity as the “corrected” alkalinity value. This has led some to conclude that cyanurate and borate alkalinity are somehow unwanted, bogus, or unreal. This is far from the truth – cyanurate alkalinity and borate alkalinity actually buffer pH at different pH ranges than carbonate alkalinity, and this concept is used to advantage by some maintenance systems. It is simply important to make the isolation calculation in SI determinations.

On another topic, there are even implications on the subject of total dissolved solids vs. the individual components of the dissolved solids, such as with chlorinated by-products and with salt. But that is a different discussion only worth mentioning now to point out that when we go to the trouble of calling something “total” we do so because we are differentiating between components that in some contexts make a difference – and we do well to explore what those differences are.

A free version of the Saturation Index Calculator shown in this class is available at sic.poolhelp.com Downloadable versions are available on our Facebook page for both Android and Apple devices.

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