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ORP and Disinfection: A Perspective

So OK, you want to kill bugs. That could be bacteria or algae, or most other microorganisms, in a cooling tower, industrial process, pool, spa, fountain, drinking water source, or even a wastewater stream. Today, the most common way to do that is with an oxygen-rich oxidizing chemical, such as hypochlorite, chlorine dioxide, hypobromite or ozone. Within limits, they all can do the job. Given that, the question becomes which to use and the degree of control you wish to maintain. In my opinion, given a few years of experience, the most reliable measure of having achieved that disinfection is done by Oxidation Reduction Potential, or ORP.

For the lower end of treatment, flowmeters, metering pumps and timers can be used to accomplish a minimum level of microorganism kill. At this level, the result is "spiky", meaning that the disinfection is reached and then not reached intermittently, but that bug growth is limited. The degree of treatment you need will determine how much and what type of equipment you have in your application. Drinking water, for example, would require a constantly maintained 100 % microorganism kill, while a cooling tower can usually be sustained quite adequately with a limited bacterial or algal growth. To achieve a high degree of reliable and repeatable treatment, more sophisticated equipment is called for. This could include controllers for ORP, pH and/or conductivity, along with metering pumps and other accessory equipment.

ORP control is currently the best available way to achieve and hold a desired level of disinfection. This is done by maintaining a constant ORP millivolt level in the water being treated, and the kill rate is independent of the particular type of oxidizing chemical selected. In fact, if the millivolt level is held, the kill will occur regardless of the significant variables like pH, conductivity, temperature, complexing ions or other organics. That's not to say you won't have to go from a teaspoonful to a bucketful of your oxidizing chemical to maintain that millivolt level, just that if you hold the same millivolt level you will achieve the same level of disinfection.

Of all the variables, pH is the most important. Interestingly enough, in the case of chlorine, the parts per million level of free chlorine is not particularly useful. This measurement does not distinguish between the presence of hypochlorous acid (HOCl) and the hypochlorite ion (OCl^-), even though hypochlorous acid is 80 to 100 times more effective in killing bacteria than hypochlorite. If the system pH is 7.5, then 75 % of the free chlorine exists as hypochlorous acid, and 25 % as hypochlorite. When the system pH rises to 9.0, then only 3 % of the free chlorine is HOCl. In short, if the pH is too high, then the free chlorine level is high, the hypochlorite ion level is high, and the kill rate is low. It's much more efficient to control the system pH (preferably between 7.0 and 7.5), select the millivolt level that maintains the degree of treatment you wish to have, and use less chlorine to achieve the same level of disinfection. It's possible, at a constant millivolt level, to need over four parts per million of free chlorine at a pH of 9.0, while you can reach the same degree of disinfection at a pH of 7.5 with only 0.4 ppm – a factor of more than ten!