Testing & Control Of Bromine-Based Biocides

TT-030-0898

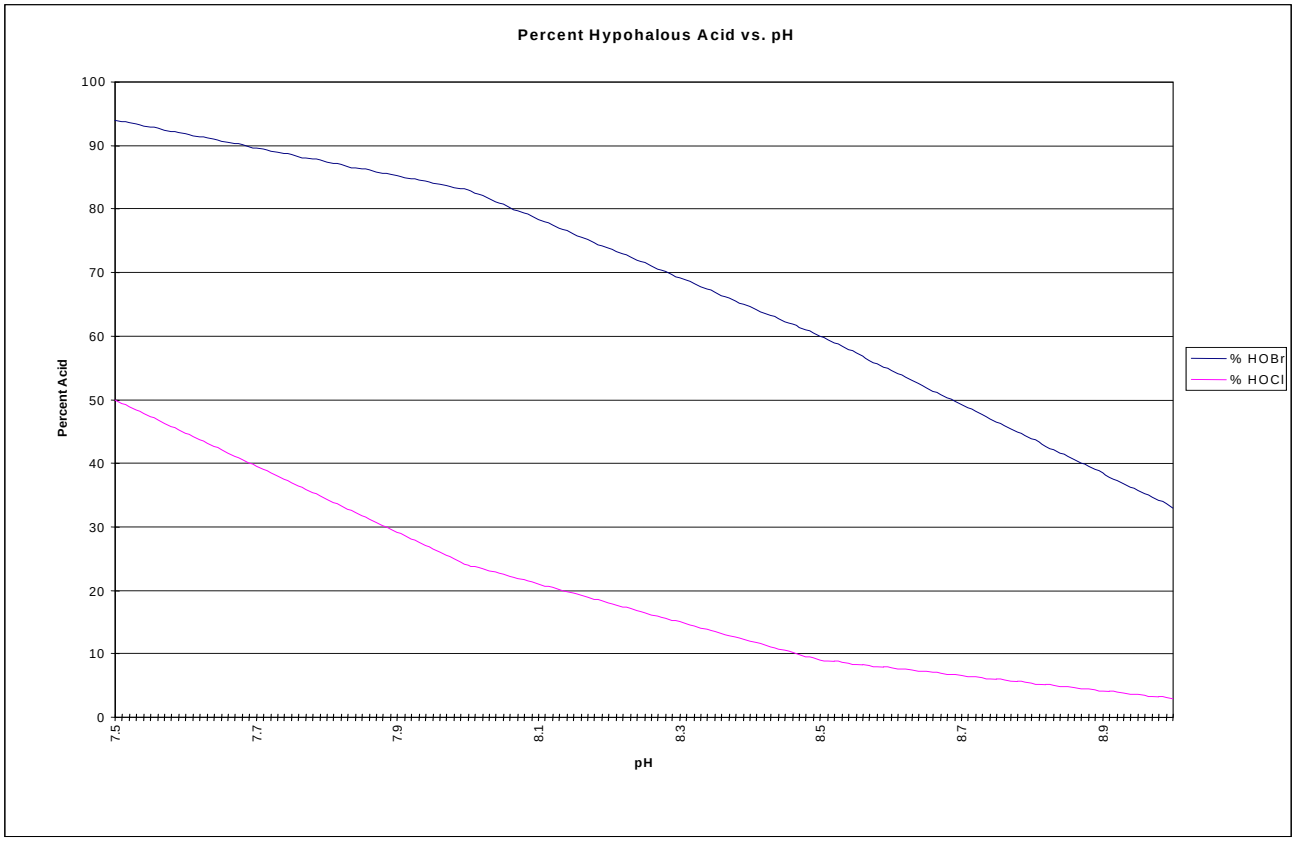
Halogen-based compounds have long been utilized for microbiological growth control in a wide array of water treatment and process applications. The halogens (chlorine and bromine) provide several distinct advantages as microbial growth control agents, including low use cost, quick kill rate, broad spectrum of effectiveness and very low occurrence of resistance.

Traditionally, chlorine in various forms (gas, liquid and dry) was the most commonly used of the halogens in cooling water applications. When introduced into water, chlorine in any of its forms hydrolyzes to produce hypochlorous acid, HOCl, which is a powerful microbial oxidant. In programs where chromate and acid were used for scale and corrosion control, chlorine was the biocide of choice.

In recent years, however, chromate has been banned from use in comfort cooling systems. Where the chromate-based programs were operated in an acidic water chemistry environment, the technologies which replaced chromate required a much more alkaline range, with pHs typically being maintained between 8.0 and 9.0 in the recirculating water. In this environment, chlorine loses most of its biocidal properties, and is rendered ineffective as a microbial growth control agent.

The ineffectiveness of chlorine in alkaline conditions necessitated the change to bromine as the oxidizing biocide in cooling water treatment programs. Bromine works in the same manner as chlorine in killing micro-organisms - it hydrolyzes in water to form hypobromous acid, HOBr. HOBr provides the same quick kill as HOCl, is effective at killing most cooling water microbes, and offers low occurrence of resistance. In addition, bromine is generally less corrosive than chlorine, and the compounds it forms with certain organics present in the cooling water - bromamines and bromophenols - are less toxic to the environment than their chlorine equivalents.

The most important advantage bromine has over chlorine in alkaline systems is that it retains more of its effectiveness at elevated pHs. Figure 1 shows the relationship of HOCl and HOBr to cooling water pH. At pH 9.0, there is virtually no HOCl available; at the same pH, there is still well over 30% of the HOBr left. This makes bromine a good choice as an alkaline program oxidizing biocide.



Bromine is available in liquid and dry form. The liquid form, an aqueous solution of sodium bromide, is seldom used in cooling water applications, as it requires supplemental feed of chlorine for activation. The most commonly used form is bromo-chloro dimethyl hydantoin (BCDMH) tablets.

The preferred method of feeding BCDMH tablets is by means of a bromine feeder located on the cooling system make-up water line. This method allows the greatest degree of control over feed rates and program economics.

The bromine feeder can also be located on a by-pass piped around the recirculating pump, but the operator should be aware that phosphonate in the cooling inhibitor passing through the feeder in the recirculating water can be degraded by contact with the concentrated HOBr in the feeder. It should also be noted that the rate of dissolution of bromine tablets is affected by water temperature. The tablets will dissolve more quickly at higher temperatures, thus, the HOBr concentration leaving the feeder will vary in proportion to the temperature of the water passing through it, and feed rates will need to be adjusted accordingly.

Whether feed is into the make-up water line or into the recirculating water, proper safety procedures must be followed when feeding bromine tablets through a bromine feeder.

Bromine tablets may also be fed by using a floating flow-through feeder or in a nylon mesh bag suspended in the tower basin.

Maintenance of proper BCDMH feed rates is accomplished by testing the recirculating water for free and total chlorine concentrations. The Hach #2231-01 DPD method for determining free and total chlorine is relatively accurate and easy to perform. For greater accuracy, use of a colorimeter is recommended. A Hach #46700-12 colorimeter for free and total chlorine is a good choice for this use alone. If a multi-use colorimeter is desired, the Hach DR 890 is recommended.

When BCDMH is used in conjunction with a suitable non-oxidizing biocide as part of a comprehensive microbiological growth control program, its feed rate should be adjusted to maintain a maximum of 0.2 ppm free chlorine or a maximum of 1.5 ppm total chlorine. In a clean system with little organic material in the recirculating water, the limit for free chlorine will likely be reached first. In a dirtier system with high organic loading, the inverse would likely be true. Feed should be controlled to maintain whichever limit is reached first.