WATER TREATMENT NEWS

# A New Population Bomb?

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In his 1968 book ***The Population Bomb***, Paul Ehrlich warned of an imminent world-wide disaster due to what he termed a coming "population explosion." In the book, Ehrlich predicted that in the 1970s and 1980s, over-population of the earth would lead to food shortages that would result in the starvation of hundreds of millions of people across the globe.

Fortunately, Ehrlich's predictions didn't come to pass. Technological advances in agriculture and food science allowed world food production to grow exponentially at a rate higher than the population growth. And, though areas of famine still exist, the world's population is better fed overall than it was in 1968.

Today, a new population explosion looms. While this new threat doesn't foretell dire consequences for the human race, it can wreak havoc on process and HVAC cooling water systems and destroy maintenance and engineering budgets. In this case the problem is not too many people, it is the uncontrolled growth of water-borne micro-organisms.

These "bugs", as they are often referred to by water treatment technicians, are bacteria, algae and fungi, and they inhabit cooling tower systems, where, because conditions are often ideal for their growth, they can multiply at an alarming rate. Most strains of bacteria, which are the most damaging of the micro-organisms, favor warm water and nutrients for proliferation—conditions most cooling tower systems provide. Water temperatures in typical systems range from $75^{\circ}$—$110^{\circ}$ F, and dust, dirt and other particulate matter constantly being scrubbed from the air passing through the tower provide a continuous feast for the "bugs".

Bacteria reproduce by a process called cell division, whereby one organism divides into two; two become four, four become eight, and so on. Since their reproductive cycle is measured in minutes, not months as with humans, bacteria can populate a cooling tower system at a staggering rate: one bacteria can produce over a billion off-spring in a single eight hour shift—a cooling system population bomb!

As bacteria and other micro-organisms multiply, they attach to cooling system surfaces and form masses called biofilm. These biofilm masses, commonly called slime, consist of exopolymer waste products produced by the micro-organisms, along with dirt, organic matter and other debris carried in the cooling water and trapped by the gooey slime. Under the right conditions, slime masses can grow rapidly and cause a myriad of problems.

Biofilm frequently forms in condensers or heat exchangers where water temperatures are elevated. As the slimey substance is highly insulating, even a thin layer will significantly reduce heat transfer through the exchanger, resulting in decreased system efficiency. In a centrifugal chiller, this translates to increased electrical consumption. The degree of increase can be astounding—a slime layer 0.03" thick on the condenser tubes of a typical 500 ton chiller can raise the electrical costs by over $47,000 per year!

Cooling water microbes cause other problems as well. Slime masses slough off and foul heat exchangers, piping and process equipment, often necessitating shut-down for cleaning. As bacterial waste products are usually acidic, microbiologically induced corrosion (MIC) can be severe and rapidly advancing. Sulfate reducing bacteria (SRB) cause a pitting type of corrosion that can eat through a cooling tower basin in a matter of weeks, causing what can amount to thousnands of dollars worth of damage. Biofilm can even serve as the formation site for scale.

Fortunately, just as advancements in agricultural science prevented the predicted effects of the human population explosion, water treatment science has provided the tools necessary to mitigate microbe-related cooling system problems. Over the past 20 years, researchers have developed a whole arsenal of weapons that can be used to attack and kill cooling system microbes and prevent the problems they cause.

*Continued*

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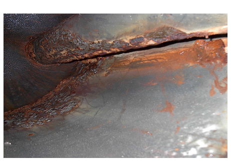
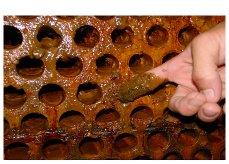
Oxidizing and non-oxidizing biocides are available in several forms and with varying delivery methods, enabling an expert water treatment technician to design a biological control program specific for both the system and the particular microbe population. New biodispersants and biofilm cleaners have the ability to strip slime and other microbial deposits from system surfaces, enabling the biocide to kill the remaining microbes and allowing scale and corrosion control chemicals to completely protect system metals.

SRB nodules and pits on chiller end bell

Active SRB nodules in cooling tower basin



SRB pitting in a carbon steel filter housing



Biofilm in a centrifugal chiller

Cooling water microbiocides, particularly some of the newer technologies, are water treatment's version of wonder drugs, but they come with a big caveat: they won't work if they aren't fed into the system at the correct dosage rate and maintained at this level in the water long enough to provide a complete kill. The "lethal dosage" of a biocide is calculated based on an accurate determination of the total volume of water in the system. Each biocide has a "contact time", which is the length of time a lethal dosage of the product must be in contact with microbes to effect their complete kill.

One of the most common mistakes made in the application of cooling water microbiocides is not feeding enough product to maintain a lethal dosage for the product's contact time. When this mistake is made, an incomplete kill occurs; over time, continuing this under-feed allows strains of micro-organisms to grow that are resistant to the biocide, rendering it ineffective.

Determining the correct biocide dosage is relatively easy. The first critical step involves an accurate determination of the total water volume in the system. System blueprints or plans, if available, may indicate system volume. Water meter readings taken during filling of the system are a good method. If neither of these methods is feasible, an estimate can be made from accurate measurements of tower basin length, width and depth. When this volume is determined, add 20—25% for piping depending on the distance from the chiller to the tower. The surest way to determine system volume is through a loop volume study, wherein a pre-weighed amount of a known salt is added to the system water. Water samples are collected before salt addition, and then approximately 30 minutes after salt addition. The samples are analyzed for salt concentrations before and after addition and, through a set of calculations, the system volume can be accurately determined.

When system volume is known, the next step is to refer to product literature or the biocide label for dosage information. The dosage will be in parts per million (ppm) or ounces per 1000 gallons, and will be expressed as a range, e.g., 100-300 ppm. The initial application of the product should be at or near the upper end of the range to assure a good kill; subsequent additions would typically be near mid-range. It is recommended to feed two biocides in this manner on an alternating basis to maintain good control and prevent development of resistant microbe strains.

The final step in this process is monitoring results. Various means of monitoring are available, including visual inspection, dipslides, specific bacteria tests and ATP analysis. Dipslides and other bacteria test methods require 2—8 days for development; ATP analysis, a method using an electronic instrument, gives instant results. Dipslides, which are easy to use and inexpensive, are the most frequently-used method. Based on this monitoring, the biocide dosages can be increased or decreased, as indicated. AN IMPORTANT POINT—if testing indicates an increase in biocide feed is required, the amount of product added per dose should be increased, not the frequency of application.

Dipslides

ATP Unit;
**Uni**-*Lite NG*

Uncontrolled microbiological growth and its attendant problems pose arguably the greatest challenge in the administration of a cooling water treatment program. A well-designed program using the right biocides at the correct dosages will help you meet this challenge and prevent a microbial population explosion.