WATER TREATMENT NEWS

Don't Let "Cancer" Destroy Your Cooling Tower System

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Cancer is the second leading cause of death in the United States (heart disease is number one). The effects of cancer are devastating both to those afflicted and to their friends and loved ones, but the fight against this dreaded disease presents a good news/bad news scenario.

First, the bad news – over 560,000 people in the United States are expected to die of cancer in 2009. A staggering number, to be sure, but the good news is that the number represents a continuing downward trend in the U.S. cancer death rate over the past 20 years. During the 15-year period from 1990 to 2005, the cancer mortality rate among men fell by 19.2%, while the women's cancer death rate declined by 11.4% over the same period.

The reason? The general population is better informed as to the causes of cancer, and the medical community has made great strides in diagnosis and treatment. In the *Annual Report to the Nation on the Status of Cancer*, Otis W. Brawley, MD, chief medical officer of the American Cancer society, stated that the "continuing drop in mortality is evidence once again of real progress made against cancer, reflecting real gains in prevention, early detection, and treatment."

These principles – prevention, early detection and proper treatment – are not only key in the fight against cancer, they are also essential in minimizing or eliminating problems caused by the uncontrolled growth of microorganisms in cooling tower systems. Uncontrolled microbiological growth is responsible for a myriad of problems in cooling tower systems, including fouling of heat exchangers, piping, cooling tower fill and distribution decks, scale formation on heat exchange surfaces and even disease (Legionnaires disease). But arguably the most destructive and difficult-to-deal-with problem caused by microbial growth in cooling water systems is microbiologically induced corrosion (MIC).

MIC is a type of corrosion caused or contributed to by cooling water microorganisms, including bacteria and, in some cases, algae. The microbes attach to surfaces and, if conditions are favorable, replicate rapidly and begin forming a substance called biofilm. The biofilm, which consists of microbial waste products and debris that is collected from the flowing cooling water, has electrically charged sites that establish differential cells on the metal surface, initiating the corrosion process. In addition, many microbes produce acidic byproducts that accelerate corrosion rates.

MIC caused by one of a group of organisms referred to collectively as sulfate reducing bacteria (SRB) is particularly troublesome because of its severity and the difficulty of controlling it, especially if the SRB are allowed to become well-established in the cooling water system. Corrosion caused by SRB is arguably the most destructive of any type encountered in cooling water systems. Their destructiveness and persistence have led some water treatment professionals to refer to sulfate reducing bacteria as "cooling tower cancer."

SRB are anaerobic, meaning they require the lack of free oxygen to thrive. In a cooling tower system, SRB favor deposits of dirt and organic debris that collect near the edges of tower basins and other areas where water flow rates are low or stagnant. They form colonies in the anaerobic environment beneath the deposits and attach themselves to the metal surface.

SRB access the oxygen they require for their metabolic process by reducing sulfate, which is present in decaying organic matter in

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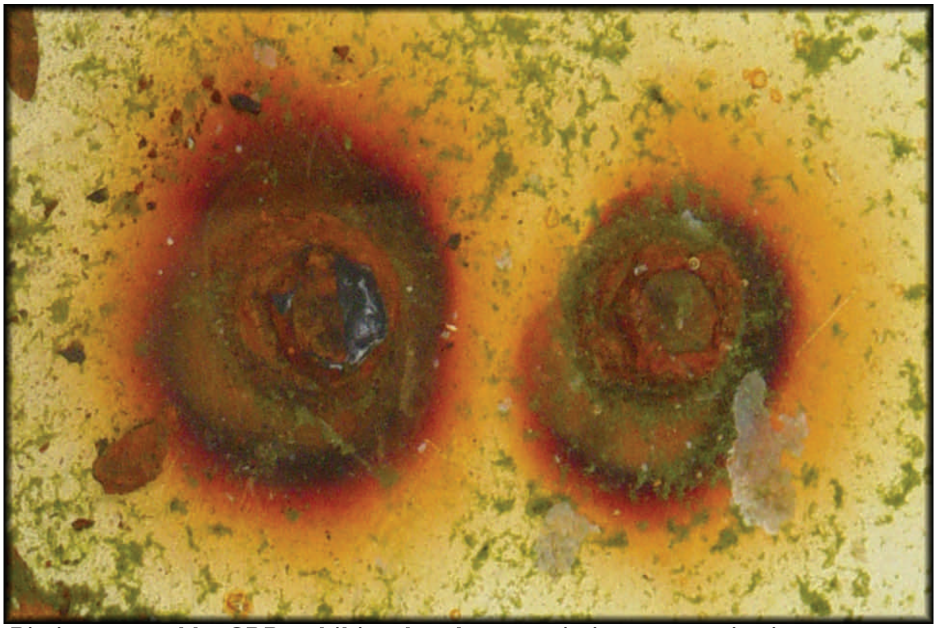
mud and dirt deposits, and is also available in contamination from oil, grease and automotive exhaust. Through the sulfate reduction process, SRB produce hydrogen sulfide (H_2S). In the aquatic environment of the cooling system, H_2S attacks system metals, especially mild and galvanized steels, severely damaging cooling tower basins, distribution decks, piping and other system components.

SRB-caused corrosion is characterized by pits with concentric rings in the metal surface. As the corrosive energy is focused in relatively small areas, penetration of the metal can occur quickly, with leaks in tower basins or piping occurring within months or even weeks after the start of an SRB attack. If left unchecked, MIC caused by sulfate reducing bacteria can cost the owner of a cooling tower system tens or even hundreds of thousands of dollars in repair, replacement and downtime costs.

To avoid this type of budget-busting expense, cooling tower owners and operators would do well to follow the guidelines that oncologists and other medical professionals have used in bringing down cancer mortality rates. The principles of prevention, early detection and proper treatment – key in the fight against cancer – are *critical* in preventing SRB from establishing a foothold in a cooling tower system and causing unnecessary maintenance costs.

First, prevention. Tower operators should keep dirt and other debris from building up in tower basins. Periodic sweeping may be sufficient to keep basins free of



Pitting caused by SRB exhibits the characteristic concentric rings.

dirt build-up; in areas where dust, dirt or other airborne material causes heavy deposits, it may be necessary to install a filtration system to keep the tower and components clean. Eliminating habitat is an important first step in SRB prevention.

The next step in prevention is minimizing the amount of nutrients present for SRB growth. Removing organic debris is part of that effort; reducing or eliminating contamination of the cooling water with oil, grease and other hydrocarbon material is also an important part of keeping the system free of SRB. Care should be taken not to drip grease into the basin when lubricating tower fans, as even a small amount of grease in cooling water can promote heavy SRB growth.

If possible, prevent or limit the amount of automotive or diesel exhaust that enters the tower in the air stream. A suburban Minneapolis hospital experiences an SRB infestation in their tower system every summer when they exercise their diesel-powered generator, which is located adjacent to the bank of cooling towers. The infestation occurs every year, despite the fact that hospital engineering personnel maintain a rigorous program of tower hygiene

Tower basin with typical reddish to yellow growth.

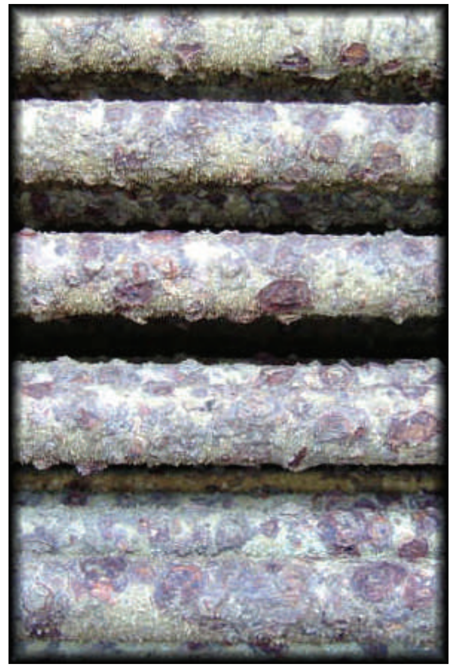
When nodules are removed, deep pits are revealed. If left unchecked, SRB-caused corrosion can penetrate a tower basin in months or even weeks

coupled with a highly effective dual biocide program that maintains outstanding overall system microbial growth control. The engineering staff minimizes the degree of SRB infestation by monitoring SRB populations and applying an aggressive biocide program focused on SRB eradication at the first indication of SRB growth. The program maintains the SRB population levels low enough to prevent damage to the system during the time when the generator is in operation. When the generator is shut down, the biocide program is able to quickly eliminate the SRB from the system.

ish SRB nodules. Green material is algae

The success of this hospital engineering staff in minimizing what could otherwise be a devastating SRB attack helps point up the importance of the next step in SRB prevention and control – early detection. If detected during the early ages of infestation, SRB are relatively easy to eradicate.

The presence of SRB in a cooling tower system is usually characterized by the appearance of reddish or yellowish colored nodules on metal surfaces, frequently in the tower basin. Breaking the nodule reveals a black, slimy liquid which, when cleaned away, shows evidence of a shiny silver pit. These are certain indicators of active SRB growth, which can be verified using the Hach BART or Sani-Check SRB test.

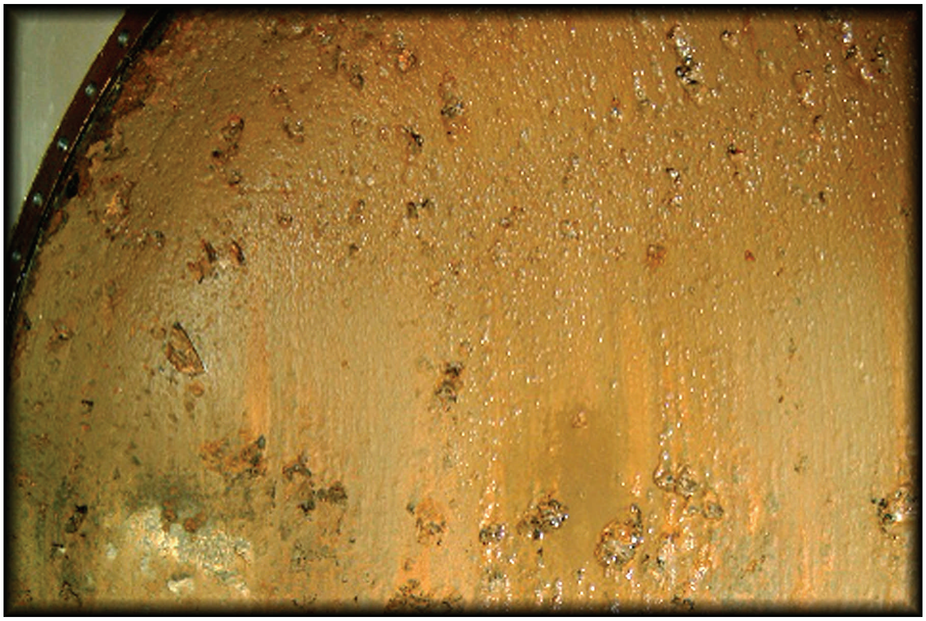


Sulfate reducing bacteria can also infest evaporative condenser and closed circuit-type towers.

Frequent inspection of tower basins and removal of dirt and other debris as it accumulates in the basin is a good way to detect SRB development in its early stages. However, SRB sometimes colonize other parts of the system such as piping or condenser end bells, with no indication of their presence in the tower basin. In this case, the only way to detect their existence in the system is through testing. It is recommended to accompany regular testing for general bacteria populations with periodic tests specific for SRB using one of the testing methods listed above. Monthly or bi-monthly SRB tests would, in most cases, catch an SRB infestation early enough to allow relatively easy elimination of the problem.

If SRB are detected in your cooling tower system, it is imperative that eradication begin immediately. The following plan should be used to eradicate and control sulfate reducing bacteria in the cooling tower system:

1. Physically remove SRB nodules from the tower basin by scraping, wire brushing or power washing.
2. Remove as much mud and dirt as possible.
3. Pre-bleed the system, then turn controller and bleed-off valve off.



SRB can attack chiller end bells, tube sheets and system piping.

4. Add biofilm cleaner specific for SRB removal. Consult your water treatment professional for product and dosage recommendations. Circulate the cleaning solution for 24 hours, then flush the solution to drain.
5. Establish a good dual biocide program for ongoing control of SRB. A good program consists of bromine fed continuously to maintain a 0.2 – 0.5 ppm bromine residual, along with an organic biocide fed a minimum of once per week. Glutaraldehyde and THPS are good options for the organic biocide, as both are effective at SRB control.
6. If airborne dust and dirt are an ongoing problem, a filtration system utilizing sweeper jets in the tower basin is recommended.
7. Test regularly for SRB using the BART or Sani-Check tests. A minimum of four days or greater development on these tests is required to assure on-going control.
8. If nodules reappear, they should be immediately removed. A second application of biofilm cleaner may be required.
9. When control is established, no new nodules will form. The pits will acquire a rusty to black appearance. The biocide program should be continued, with dosages optimized based on total count and SBR tests.

Even if subsequent SRB tests are negative, the system should not be considered "cured," rather, in remission. As a cancer patient may experience a recurrence of the disease, the affected cooling system may have a recurrent SRB outbreak. Regular inspections and testing should continue on an ongoing basis.

When an SRB infestation has been successfully eradicated and system operation returned to normal, the system owner may want to apply a protective coating to affected areas of the tower. Coatings such as ZRC, epoxy, Belzona and fiberglass can be effective in providing long-term protection against future SRB attack. If one of these coatings is to be applied, it is imperative that the surface be properly prepared and *all* active SRB sites cleaned and sterilized before application. SRB can survive and grow under these types of coatings and continue to attack the metal underneath.

In an era of tight operating budgets, most facilities can ill-afford the costs for repair or replacement of cooling system components. By following the example of the medical profession in its fight against cancer, smart facilities owners and managers use prevention, early detection and proper treatment to prevent "cooling tower cancer" from destroying their systems and busting their budgets.

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