WATER TREATMENT NEWS

Volume 31
Spring 2008

Mechanical Water Treatment Devices— Do They Really Work?

de • vice (di-vīs´), n. 3. A mechanical contrivance.

gadg • et (gaj´it), n. [? ult. < gauge], 1. Any small mechanical contrivance.

Gadgets, black boxes, magnets. Chemical water treatment professionals use these and other, more colorful terms to describe a whole range of mechanical devices that are touted as having the ability to completely prevent scale, corrosion and microbiological growth in cooling tower and steam boiler systems. These types of devices have been marketed for over 50 years, and from the very beginning, chemical water treaters dismissed the claims of scale, corrosion and microbiological growth control as being fraudulent, and the makers of the devices as fly-by-nights or goof balls.

It's not surprising that traditional water treatment professionals refute these claims - if the devices performed as advertised, the water treatment chemical industry would likely cease to exist.

Chemicals have been used to prevent scale and corrosion in boiler and cooling water systems for over 100 years, and modern chemical programs are able to keep boilers, chillers and auxiliary piping and equipment in like-new condition over the equipment's expected life span. The vast majority of boiler and cooling water systems worldwide are protected by water treatment chemical programs. Chemical water treatment is the gold standard in industry for water-using system protection.

As effective and efficient as chemical treatment programs are at protecting cooling and boiler systems, the use of treatment chemicals carries with it some downside risks. Some treatment chemicals in their neat form are corrosive to metals and cause harm on contact with skin or eyes. Some are potential pollutants when they are discharged to the environment in normal system blowdown or bleedoff. And, since treatment chemicals are used up in these regular system water losses, they represent a permanent, ongoing expense to boiler and cooling system owners.

Most facilities owners and managers believe that the advantages to using water treatment chemicals outweigh these risks. But if claims made by the sellers of mechanical water treatment devices are true, they might begin to rethink that belief.

So the $64,000 question facing facilities personnel is, "Do water treatment devices really work?"

The easy answer is – "They must not work, or they would have caught on by now – they would have replaced chemicals as the preferred treatment for cooling and boiler systems." Yet devices - particularly two types- continue to be marketed and have gained the interest of many facilities owners and managers. A look at the claims and performance records of the two most aggressively marketed devices will give a clearer indication of their effectiveness, or lack thereof, at protecting industrial water-using systems.

One device, a "pulsed power" unit, purportedly works by imparting "pulsed, high frequency electromagnetic energy into flowing water by inducing varying electromagnetic fields 60 times per second. During each cycle, the field strength varies from 0 to a maximum value then back to 0. Halfway through each cycle the field is pulsed, causing a ringing effect. This ringing has a natural

This Newsletter courtesy of:

CHEMTEX
INTERNATIONAL CHEMTEX CORPORATION

8287—214th Street West ·Lakeville, MN 55044
952.469.4965

frequency based on the geometry of the coil and the capacitance of the circuitry. Over a time period of about 3 milliseconds, this field dampens to a few percent of its original intensity. The transient dampening causes harmonics of the natural frequency, resulting in measurable frequencies up to the megahertz range. This time-varying magnetic field induces a rapidly changing electric field in the water of the same frequency as the magnetic field but in a direction around the circumference of the pipe."

Indeed! All of that is supposed to cause calcium carbonate to precipitate in the bulk water rather than directly on a heat exchange surface. The precipitated calcium carbonate is removed from the system via blowdown or sidestream filtration. The literature states that corrosion is controlled by calcium carbonate, "which is a cathodic corrosion inhibitor." For this claim to be true, the calcium carbonate would have to deposit at cathodic sites on system metal surfaces. This contradicts the reported scale control mechanism!

The pulsed power unit controls bacteria populations by "encasing bacteria in the forming precipitate." The bacteria are not killed, rather they are held in captivity until they die. Those bacteria that escape entrapment by the precipitate are "'zapped' by the secondary pulse, forcing them to spend their life span repairing cell wall damage rather than reproduce." The literature admits that the pulsed power unit does not always control algae growth, and suggests feeding an algaecide or simply removing the algae when normal tower cleaning is conducted.

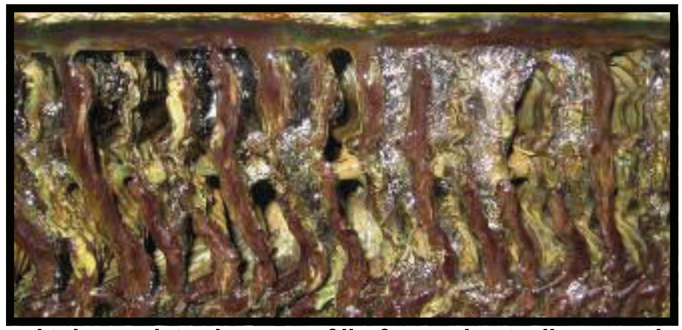
The description of how the other device works is only *slightly* less obtuse. In this one, cooling water is sent through the unit, where "velocity, trajectory, and rotation are imparted to create opposing water streams as they leave the precision nozzles. The water collides with tremendous kinetic energy and shear. At the core of these streams, a region of near total vacuum is created which degasses the flow. Under these conditions, hydrodynamic cavitation occurs with intense, microscopically localized extremes of temperature (up to 9,000°F), pressure (up to 1,000 atmospheres), and high-energy micro-jets." Purportedly, the "microscopically localized extreme temperature" causes calcium carbonate to precipitate in the form of "non-sticking $CaCO_3$ colloids."

This unit does not claim to actively prevent corrosion, rather, it operates in an environment in which corrosion is less severe. Microbial growth is reportedly controlled as "tremendous localized temperatures and extreme fluctuations in fluid pressure within the chamber causes cell walls of microorganisms to rupture."

All of this sounds good, I *think,* but the proof of the pudding is in the eating, as they say, so what kind of results have these units produced in actual field applications? A definitive study was conducted from August 2004 to September 2005 by KEMA, Inc., a technical consulting firm out of Oakland, CA in conjunction with Nevada Power Company of Las Vegas, NV. The study was conducted for Clark County School District (CCSD) in Las Vegas. The study evaluated the performance of three mechanical water treatment devices – a pulsed power unit, a hydrodynamic cavitation system and a unit that employed electrostatic precipitation.

Each device was installed and operated in the cooling water system of a different high school in the CCSD. The schools were selected for the study based on the similarity of their cooling system size, load, operating schedule, materials of construction and make-up water chemistry. The cooling system of a fourth similar school was treated during the time of the study with a conventional chemical program as a control site. The objective of the study was "to aid the CCSD in determining the effectiveness and costs of alternative cooling tower treatment systems for its facilities. The CCSD is interested in non-chemical treatment of its cooling tower water because it believes that non-chemical treatment may be more effective, less expensive, and use less water and power than the conventional chemical treatment program it has been using."

The systems in all four schools were operated for the same 12-month period, each using its respective treatment regime. Keeping in mind that the study was conducted to prove that one or more of the mechanical devices would perform better than the chemical program, the results of the study are revealing.



Microbial growth in the tower fill of a mechanically treated system.

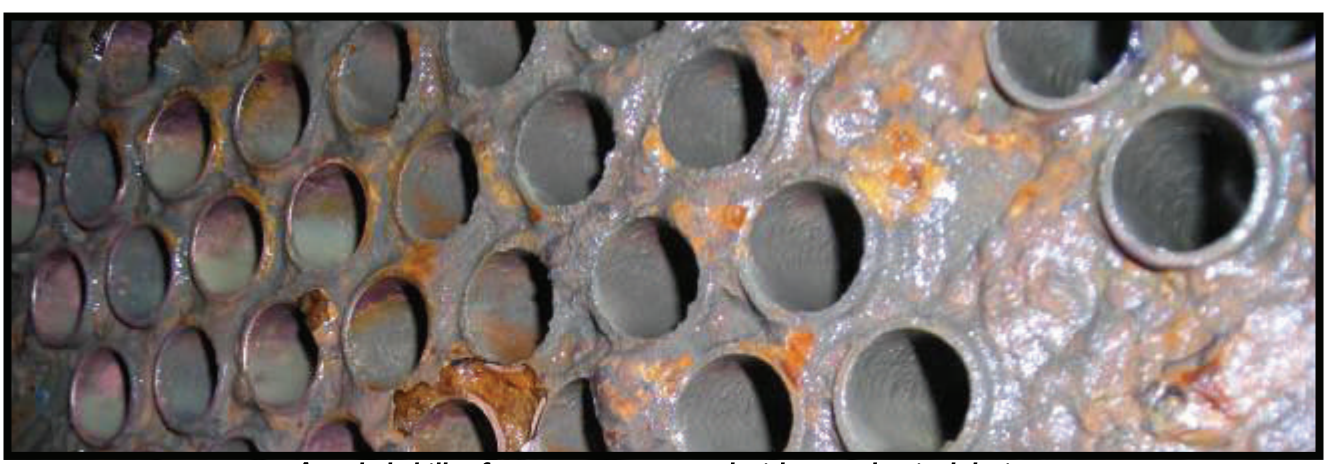
"boroscope inspection revealed white scale on the ID of the tubes in the systems with non-chemical treatment . . ."

At the end of the 12 month study period, the chillers at all four schools were opened for inspection. The study report states that the "boroscope inspection revealed white scale on the ID of the tubes in the systems with non-chemical treatment. In general, deposits like these interfere with efficient heat transfer and can lead to corrosion problems if not removed." No scale was found in the tubes of the chiller in the chemically treated system. The report went on to say, "From observations, algae was growing in the tower basins of all three remaining test sites (the non-chemically treated systems)."

Copper and steel corrosion coupons were installed in all four systems during the study period. Based on the coupon analyses, the report stated, "The chemical treatment system at Desert Pines High School (control site) achieved the lowest corrosion rates as compared to the other testing sites and improved over the course of the study. Overall, the corrosion rates achieved at Desert Pines with the chemical treatment system are very, very low and demonstrate an extremely high level of protection."

The report can be summed up in a statement from the report's summary: "It is interesting to note that the Desert Pines chemical treatment system during the study period far exceeded what was achieved by the average baseline system…. These results and the corrosion results show just how effective a chemical treatment system can be when operated diligently by District personnel."

"From observations, algae was growing in the tower basins of all three remaining test sites (the non-chemically treated systems)."



A scaled chiller from a system treated with a mechanical device.

Literally hundreds of mechanical water treatment devices have been introduced into the market over the past 50+ years, each one touted to be *the* answer to scale, corrosion and microbial problems. It is possible that such a device will be developed that will bear out all the claims, but the evidence all indicates that hasn't happened yet. As the saying goes – "If it seems too good to be true, it probably is." The KEMA study suggests that this saying is particularly apt when applied to water treatment gadgets

"…These results and the corrosion results show just how effective a chemical treatment system can be when operated diligently by District personnel."

A mechanical device going to its final resting place.