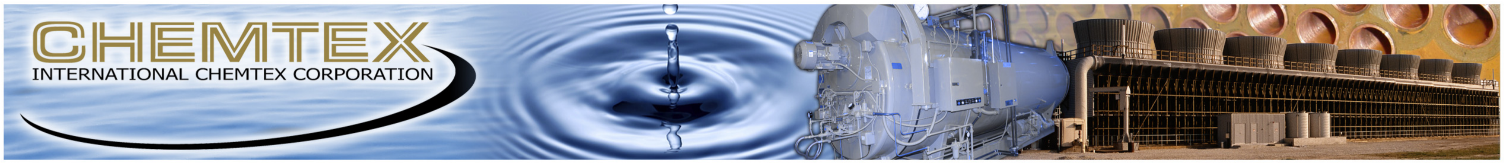

WATER TREATMENT NEWS

Is Your Closed Loop Dirty? Clean it Up!

Volume 42
Winter 2011

The Merriam-Webster dictionary lists twelve definitions for the word *closed*. The word has applications from horse racing to linguistics to mathematics. One of the definitions, though, is significant for water treaters. Webster's definition 2c reads "characterized by continuous return and reuse of the working substance <a closed cooling system>."

The working substance Webster refers to is, of course water, which is recirculated and reused for cooling *or* heating over and over again in a closed loop system. This is a good thing in that closed loops typically require very little make-up water, making utility costs for closed systems low.

But what is a good thing regarding water costs is often a bad thing where system operation and maintenance is concerned. The water in closed loop systems typically contains suspended solids or particulate matter. This material - mill scale, dirt and other debris not removed from piping and associated equipment during start-up and initial operation of a closed loop is picked up by the loop water and held in suspension as the water circulates. Since the closed loop has no outlet, the particulate matter is trapped in the system. It is carried through the loop by the circulating water and eventually deposits in heat exchangers, coils and crevices or rough patches on pipe surfaces.

Deposition in a closed loop also results from corrosion of system metals. Oxygen and other gases, along with chlorides, sulfates and other dissolved solids combine to make closed loop water aggressive to system metals. Corrosion to the metal components in the closed loop results in the release of iron and copper oxides into the loop water. These corrosion products readily form deposits or add to existing deposits of construction debris.

Low levels of bacteria survive city water chlorination and are introduced into the closed loop in the make-up water. Closed loops often present bacteria with an environment in which they form colonies, become fixed in place and begin to multiply. Suspended matter and other loop debris provide habitat and nutrients for the bacteria, which produce a gooey, highly insulating substance called biofilm, a common cause of, or contributor to, closed loop fouling and deposition.

Closed loop deposition causes a myriad of problems for facility owners and building engineers. Deposits restrict flow through piping and HVAC equipment, increasing pumping costs. Deposition in coils and heat exchangers impedes heat transfer, resulting in increased heating and cooling costs. Under-deposit corrosion destroys system components and results in substantial expense for repair and/or replacement of piping, coils, evaporator tubes and other HVAC equipment.

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CHEMTEX
INTERNATIONAL CHEMTEX CORPORATION

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

The best way to eliminate closed loop deposition problems is to prevent them from occurring in the first place. The Summer, 2004 edition of *The Water Treatment News* entitled "Don't Neglect Your Closed Loop System," details the procedures necessary to prevent deposition and other water-related problems in closed loop systems. The procedures outlined in that article will, if implemented correctly, prevent all types of closed loop deposition, in addition to protecting the system from ongoing corrosion and microbial growth.

If your closed loop is already fouled, prevention is a moot point - it's time for clean-up. Clean-up of a fouled closed loop may involve both physical or mechanical and chemical procedures. The specific procedure or procedures to follow to provide a complete clean-up of the system depends on several factors:

- Where is the deposit located in the system?
- What are the physical characteristics of the deposit material?
- What are the chemical characteristics of the deposit material?
- Is it necessary to clean up the deposits quickly, or can it be done over time?

Location of the deposition in a closed loop system can usually be determined only by shutting the system down and opening a heat exchanger or the chiller evaporator section, or by opening a section of piping and visually examining the equipment. At that time, the physical characteristics of the deposit material can be determined and a sample collected for laboratory analysis to determine the chemical characteristics. With all this information, the type of cleaning procedure to be used can be determined. The first decision to be made is whether to clean the system mechanically or chemically.

If the heat exchanger is dirty, it should be cleaned as quickly as possible, because *any* deposition there impedes heat transfer and increases energy costs or decreases plant production. Cleaning heat exchanger deposits quickly provides immediate payback. It is generally recommended that mechanical or physical cleaning procedures be utilized first, if possible, before chemical means are used. In an evaporator or process shell and tube heat exchanger, this involves brushing the tubes. In a plate heat exchanger, the plates can be brushed or scraped to remove deposition. Oftentimes, this will completely remove the deposit material and restore full heat transfer capability to the equipment.

If deposited material remains on heat exchange surfaces, or if heat exchanger inlet or outlet piping shows evidence of deposition, chemical cleaning should be used to finish the job. If sufficient deposit material can be collected, laboratory analysis of the material should be conducted to determine the deposit's chemical make-up and identify the specific chemical that will provide the most complete removal of the deposit material.

A laboratory deposit analysis report typically includes the percentage of mineral components, including calcium, magnesium, silica and iron, as well as a value reported as "Loss on Ignition," or LOI. After the chemical analysis of the deposit is completed, a portion of the remaining deposit is dried at 110°C, weighed on an analytical balance, and placed in a high temperature furnace where it is heated to 850°C for thirty minutes. This procedure burns off all the organic matter in the deposit. The sample is then reweighed on the analytical balance; the deposit's weight loss after firing in the high temperature furnace is the LOI. In a closed loop deposit, this represents microbial growth, or biofilm.

The laboratory analysis report of the composition of the deposit material provides the information necessary to determine which chemical or combination of chemicals will most effectively clean the system. When microbial growth is the primary foulant, a biofilm cleaner can be used very effectively to clean the system. Before the biofilm cleaner is added, the total loop water volume should be determined. If the volume is not known, a knowledgeable water treatment professional can conduct a loop volume study. This is critical to assure that the correct amount of biofilm cleaner is used to effect a complete clean-up of the system.

In most cases, iron is the primary constituent in closed loop deposits. When this is the case, the decision must be made whether to clean the loop gradually on-line (during normal loop operation), or if a quick clean-up is desired. Generally, a slightly to moderately fouled loop can be successfully cleaned on-line. If this approach is selected, it is best to use a neutral cleaner, which is safe to leave in the system for weeks or even months.

When a more aggressive cleaning of iron-based deposits is desired, an acidic loop cleaner provides quicker clean-up. Acidic cleaners are available that feature various combinations of organic acids that have powerful iron dissolution capabilities. A high quality acidic iron cleaner will also contain a surfactant to aid in removal of deposit material from the metal surface.

The following procedure provides effective removal of iron-based deposits from a closed loop system:

1. If possible, pre-flush the system to remove any loose particulate matter.
2. Add the acidic cleaner at the dosage prescribed for the product. The pH of the loop water will be reduced to 3.0-5.0. The actual pH will be dependent on the pH and M alkalinity of the loop water prior to addition of the product.
3. As iron is removed from the metal surfaces, the iron level in the loop water will increase, and the pH of the loop water will also gradually increase. Add cleaner as necessary to maintain the pH achieved immediately after the first addition of the cleaner.
4. Iron levels will continue to increase as deposit material is removed. When the iron level plateaus or reaches 200 parts per million (ppm), the loop water should be drained and the loop flushed to remove the suspended solids.
5. Refill the loop and add the prescribed amount of cleaner to again reduce the loop pH to the 3.0-5.0 range.
6. Monitor the loop water iron level as it again begins to increase. If the iron level again reaches 200 ppm, the procedure should be repeated a third time. If the iron level plateaus at less than 200 ppm and the pH remains constant at or below 4.0 for eight hours, the cleaning is complete. The time it takes for complete cleaning and the number of times the procedure must be repeated depends on how much iron oxide was in the system to begin with.
7. When cleaning is complete, purge the system until the effluent is clear and the loop water pH is within 1.0 point of that of the make-up water.
8. After purging, add an alkaline neutralizer to raise the pH to 9.0-9.5 to make certain that all remaining acid is neutralized. While straight caustic soda ($NaOH$) can be used for neutralizing, it is recommended that a high quality neutralizer product that contains a polymer dispersant be used. The polymer helps provide more thorough removal of suspended matter from the system.

Circulate the loop water at pH 9.0-9.5 for a minimum of two hours, then drain and flush the system to lower the loop water pH to within 0.5 points of that of the make-up water. Immediately add the correct level of corrosion inhibitor to the loop and return to normal operation.

If the loop did not have filtration, it is highly recommended that a good quality bag- or cartridge-type filter be installed. The ideal location for a filter is on a by-pass around the circulating pump. Not all the suspended matter may have been removed following the cleaning procedure. Any remaining material will be removed by the filter. Over time, more particulate matter can slough off pipe walls, and additional particulates will enter the system in the make-up water. A correctly sized side-stream filter removes this material from the loop water, helping prevent a recurrence of the deposition problem.

A properly performed loop cleaning procedure using a quality biofilm cleaner or the correct iron cleaner will return your closed loop to its design performance capabilities, maximizing system efficiency and reducing operating costs. Following the cleaning with the implementation of a well-designed treatment program, coupled with the installation and operation of a good side-stream filter will help assure that your loop system remains clean, corrosion free and operating efficiently.

Is your closed loop dirty?
Ask your Chemtex Representative for help in cleaning it up!