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Does Your Chiller Need Cleaning?

The first in a series of articles dealing with off-line and on-line cleaning of cooling system condensers and heat exchangers

Modern cooling water treatment programs are capable of maintaining systems immaculately clean and free of scale, corrosion and microbiological growth. Feeding and control equipment capabilities and chemical treatment technology have advanced to a degree where completely clean cooling system waterside surfaces should be the general expectation of facility engineering personnel.

While clean waterside surfaces *should* be expected in the operation of a facility's cooling water system, an improperly designed or maintained chemical program or a malfunctioning feeding and control system can result in fouling of system waterside surfaces. Fouling of cooling system heat exchangers causes what can be a substantial increase in system electrical costs and can also result in loss of water flow, under-deposit corrosion of metal surfaces and even shut-down of the system due to increased condenser head pressure. If fouling occurs, engineering personnel need to follow a series of steps to assure the fouling is completely removed.

The first step is to determine the nature and severity of the fouling. This requires a physical inspection of the fouled heat exchanger. At the first opportunity, open the fouled exchanger and visually inspect to determine the nature of the fouling. If the fouling material is a soft sludge-like substance from air-borne dust and dirt, the exchanger can probably be completely cleaned by brushing the tubes (or brushing and rinsing the plates, if the unit is a plate heat exchanger). Likewise, if the material is microbiological fouling (slime, biofilm, etc.), brushing is likely all that is required. In either case, when the brushing is completed and the unit is placed back in service, the original cause of the fouling needs to be determined and addressed to prevent recurrence of the problem.

If a hard scale is present, a different approach is required. In this case, the engineer has two options – on-line or off-line cleaning. If the scaling is relatively light (onion-skin thickness or less), or, if heat transfer is not seriously impaired, it may be possible to remove the scale on line. The engineer should consult his water treatment specialist to discuss the viability of this option, keeping in mind that the problem that caused the scale formation in the first place needs to be addressed and corrected first. If on-line removal is decided upon, it should be noted that complete removal in this manner may take several months to accomplish, and will be successful only if good control is exercised over the on-line cleaning program.

If the engineer decides that a quicker resolution to the problem is required, the scale can usually be quickly (within a day or two) removed by off-line acid cleaning. If this option is chosen, several things must be considered before proceeding with the cleaning procedure.

First (and maybe most important), what does the scale consist of? Most scales contain at least some calcium carbonate, and many are mostly comprised of this common compound. Scales consisting of primarily or entirely calcium carbonate are relatively easy to remove, but often scale samples will include calcium and magnesium hydroxides, silicates, sulfates and phosphates, along with

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elemental silica and iron oxides and hydroxides. These other constituents can make chemical removal more difficult, and will dictate which particular cleaning agent should be used.

The surest way to determine scale composition is by laboratory analysis. To accomplish this, a representative sample of the scale should be collected from the heat exchanger by carefully scraping scale material from the heat exchanger surface using a knife, screw driver or other sharp implement. Care should be taken to remove only scale and not scrape metal from the exchanger surface, as this would affect the analysis of the deposit material. If the sample is collected in this manner, approximately one teaspoon of the powdered or granulated material should be collected. If the scale has fallen off the surface in small pieces or chunks, an equivalent amount of this material can be collected; the sample should be placed in a small plastic bag or sample bottle and sent to a qualified water treatment laboratory for analysis. It should be noted that scale samples taken from a chiller end bell or tube sheet may not be representative of scale present on the chiller tubes.

Some laboratories offer the added service of trying various cleaners in the lab to determine which works best at dissolving a scale sample. If this service is available, approximately ¼ cup of scale is required.

If time does not permit sending the scale sample in for laboratory analysis, the engineer can do several things that will help him make an educated on-the-spot guess as to the scale's composition. First, drop a small amount of hydrochloric or muriatic acid (HCl) on the deposit. Effervescence (bubbling or foaming) indicates the presence of calcium carbonate; the degree of effervescence suggests the amount of calcium carbonate present in the scale.

Next, the scale should be carefully examined for color, texture and consistency. White samples likely indicate the presence of hardness salts (calcium and magnesium). If they are extremely hard and glassy, silica or silicates are almost certainly present. A black or reddish-brown appearance is likely due to the presence of iron. A tan color deposit may contain calcium phosphate, while a gray to brown scale may be calcium sulfate.

Identification of a scale deposit's composition based solely on its appearance is impossible, but when this is combined with a review of recent cooling system water test results, the accuracy of the guess can improve substantially. For example, a scale is white to light tan and foams moderately when HCl is added. A review of water test records shows that phosphate levels were high in the recirculating water and recommended total dissolved solids (TDS) levels were frequently exceeded. The scale is likely a combination of calcium carbonate and calcium phosphate. An experienced water treatment technologist can help the engineer make a relately accurate assessment as to the scale's chemical make-up.

Once this assessment has been made, or, better yet, if a laboratory analysis was completed, the water treatment technologist can recommend the appropriate procedure to follow and the correct equipment and chemical to use to clean the condenser or heat exchanger and return it to peak operating efficiency.

Next Issue: Off-line chemical cleaning of your system