Chemical Cleaning Guide

Purpose

This plant service bulletin provides guidelines to owners and operators on when to chemically clean boilers and steam generating equipment.

Background

Though current standard water treatment practices may be followed, the internal surfaces of boiler waterside components (including supply tubes, headers and drums) can accumulate deposits over a period of time. Today's modern boilers cannot operate reliably if fluid-side deposits are allowed to accumulate and impede heat transfer. Waterside deposits are generally classified as either hardness-type scales or soft, porous-type deposits. The build-up of scale or deposit is detrimental to unit operation and can lead to overheat or corrosion-related failures.

Overheat failures

Hard dense scales, such as calcium, magnesium and silicon, are impervious to water. As a result, tube scales act as an insulating barrier and can elevate the tube metal temperatures beyond the material's design use limit. Typically, these scales are encountered in low pressure (below 1000 psi, or 69 bar) boilers. However, excessive waterside scale can lead to overheat failures in any operating boiler.

Corrosion-related failures

Soft, porous waterside deposits can concentrate boiler water dissolved solids (including water treatment chemicals) to excessive levels, resulting in corrosion of internal surfaces. One form of corrosion is under deposit strong alkali attack, or caustic gouging, where sodium hydroxide is the active corrosive agent. High pressure boilers (above 1000 psi, or 69 bar) may experience hydrogen damage failures, a corrosion mechanism that occurs beneath heavy waterside deposits due to acidic conditions.

Table 1: Guideline for Chemical Cleaning

Unit Operating Pressure (PSIG)	Deposit Weight* grams/square foot (g/ft²)
Below 1000	20 to 40
1000 - 2000 including all Kraft Recovery and Refuse-Fired Boilers	12 to 20
Above 2000	10 to 12

** Deposit removed from the tube's hot or furnace side using the mechanical scraping method (ASTM D3483 Method A). (1 g/ft² = 1.07 mg/cm²)*

Chemical Cleaning Guidelines

To avoid forced outages and irreversible damage to boiler components, a chemical cleaning program should be a regular part of a preventive maintenance program.

To determine the need for chemical cleaning, it is necessary to have an understanding of both the quantity and composition of the internal surface deposits. This information can be determined through a tube sampling and deposit analysis program.

When sampling for internal deposits, the tube samples should be removed from the high heat-input zones of the boiler's furnace and areas where problems have occurred or presently exist. The amount of internal deposit, termed deposit weight, is determined by first visually selecting a section of the most heavily fouled portion of the sampled tube. After sectioning the tube (separating the hot and cold sides) the water-formed deposit is removed by scraping from a measured area on each side. The weight of the dry material is reported as grams of deposit per square foot of tube surface. A general guideline for determining when a boiler should be chemically cleaned is shown in Table 1.

Many factors were taken into consideration when establishing these chemical cleaning guidelines. The deposit weights were chosen as typical for scheduling the chemical cleaning in a timely and orderly manner. The cleaning should be scheduled during an annual outage to minimize downtime.

Because of the corrosive nature of the fuel and its combustion products in both Kraft recovery and refuse-fired boilers, furnace tubes in these boilers are particularly susceptible to gas-side corrosion. This is especially evident where the effects of elevated tube metal temperatures and localized abrasion are present. For boilers firing these fuels, through-wall failures due to external metal wastage can occur prior to achieving the internal deposit weights shown in Table 1. Therefore,

(continued on reverse side)

for Kraft recovery and refuse-fired boilers, it is important to monitor both gas-side tube wastage and internal deposition.

Note: Special precautions should be taken when using Table 1. The weight per unit area of deposit that could cause problems will depend upon the unit design, operating characteristics, and exact chemical composition and physical characteristics of the deposit.

Recommendations

Owners and operators must consider the following items when developing a chemical cleaning program for a unit:

1. **Identify the best tube sample locations**
   - A. High heat-input zones of the furnace
   - B. Areas where problems exist
2. **Tube removal**
   - A. Remove in accordance with ASTM practice standard Method D-887
3. **Deposit weights and chemical analysis**
   - A. Determine the deposit weight of the tube sample in accordance with ASTM standard Method D-3483, Method A (mechanical scraping removal method to determine grams/square foot)

   Note: Method B results in a higher deposit weight measurement than Method A.
   - B. Perform a chemical analysis of the scrapings to determine the composition of the deposit
     Note: Consult with a chemical specialist to assess the need to perform a chemical cleaning.
   - C. Conduct a chemical cleaning test to determine the appropriate solvents to use in the cleaning
4. **Planning and preparation**
   - A. Planning should begin at least several months prior to the chemical cleaning to assure adequate preparation (preparation time is a function of unit type and size, and cleaning method, and can range from ten weeks to a year)
   - B. Test or sample tubes annually to monitor the deposition rate
   - C. Extrapolate this data to project when the cleaning will be required
     Note: Do not wait until the deposit weight limits are exceeded to schedule the cleaning.
   - D. Develop a cleaning procedure for your unit
   - E. Develop a conceptual design of the overall chemical cleaning project (e.g., equipment layout, pipe routing and connections, etc.)
   - F. Evaluate the suppliers to perform the chemical cleaning
   - G. Establish an appropriate safety program
   - H. Manage the chemical cleaning project
   - I. Determine the best means of disposing of the spent chemicals in accordance with EPA requirements, and obtain proper EPA certificates and permits
   - J. Obtain a cleaning specialist to assist in the technical aspect of performing the chemical cleaning

Support

If you have any questions or require assistance, please contact your local Babcock & Wilcox Field Engineering Service office. We can provide assistance on your chemical cleaning project – from advice and consultation to a complete turnkey project.

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