Boiler Chemical Cleaning Determination Protocol and References

Standard

102

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Table of Contents

1. Introduction

This guide serves to summarize industry best practices for determination of when to chemically clean boilers. During an operation, any water side insoluble impurities may adhere to the inside of tube surfaces, forming deposits. Deposits act as insulators as the heat transfer through them is significantly lower when compared to metals, such as tube walls. As such, upon an accumulation of enough deposits, heat transfer through the tube can be significantly reduced.

Significantly reduced heat transfer through boiler tubes can have the following impacts:

A. Tube failures due to short term or long term overheating, or under the deposit corrosion,
B. Increased flue gas temperatures which can affect thermal degradation or increase corrosion of downstream components (e.g. superheaters),
C. Increased fuel consumption or decreased production loads [4].

Determination of when to chemically clean a boiler is based on an overall assessment of deposits inside boiler tubes.

Many boiler operating facilities establish a policy of how to determine the deposition and when to chemically clean boilers. These policies are usually based on risk/reward tolerance of the facilities, boiler histories, availability of resources, and others.

Commonly, the industry found two means of determination of a need to chemical clean a boiler:

A. Deposit Weight Density (DWD) method,
B. Time-based method,
C. Combined method.

Hercules company [1] performed a survey in 2007 and found that about 30% of facilities choose solely the time-based method to determine chemical cleaning need, 52% choose DWD method, and 18% choose a combination of both.

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3. Deposit Weight Density (DWD) Method of Determination

DWD method is a destructive technique of removing a tube section from a boiler and sending it to a laboratory for analysis.

Deposit removal in a laboratory can be accomplished by several techniques, such as mechanical removal, chemical removal, or glass bead blast removal. Each will produce a different result of deposition and thus the results are not comparable. The last method, the glass bead blast removal, is used predominantly. Results are usually measured in g/ft^2.

The DWD method of deposition determination in a boiler tube is very accurate. However, the results correspond to the tube sample and not the entire boiler and as such they may not represent the overall deposition and thus a need for a chemical cleaning.

Despite its challenges (and costs) this method prevails in the industry for determination of chemical cleaning.

a. Location of tube samples

There appears to be an industry consensus that the highest deposition occurs in areas of the highest heat release zones. As such, majority of tube samples are removed from the lower furnace.

However, high deposition has been found in screen tubes, roof tubes, and even generating bank tubes which would be considered lower heat release zones when compared to the lower furnace.

Additionally, it has been found, and quite consistently, that deposition in the high release zones can very significantly from tube to tube. In other words, adjacent tubes at the same elevation can have significantly different deposition rates.

Due to the above, finding a representative tube sample for overall boiler tube deposition is a 'hit-or-miss' guess. As such, it is strongly recommended to vary locations, walls, elevations, and tubes when choosing a location for a tube sample.

It has been shown that identifying a location for a tube sample visually (or through a videoscope equipment) is not reliable. There have been instances of 'loose' deposits that did not produce high DWD results yet visually appeared to be high. And on the other side, there were instances of tenacious deposits that visually did not appear significant, yet DWD method revealed high deposition and a need for a chemical cleaning. Visual inspections can be used as a guide but should not be relied upon for identification of highest deposit locations inside boiler tubes.

b. Frequency of tube samples

Majority of facilities choose to evaluate a tube sample every year or every other year. This usually depends on company policy, boiler history, availability of resources (e.g. materials, welding contractor) and risk/reward tolerance of the facility.

c. When to chemically clean a boiler

The following are recommended DWD thresholds for chemical cleaning from various sources. The recommendations are based on DWD results from the highest deposition found in a boiler (not an average). That is, once any location is identified to have deposition above a threshold, chemical cleaning of the entire boiler is recommended.

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)*

Figure 1 B&W Chemical Cleaning Guide [2]

Boiler Acid Cleaning Threshold Value [grams per square foot]			
DWD Technique	All Recovery Boilers	Power Boilers Operating 600 – 1300 psi	Power Boilers < 600 psi
Glass Bead Blasting or Mechanical Scraping Followed by Glass Bead Blasting	20	40	80
Acid Removal or Mechanical Scraping Followed by Acid Removal	25	50	90

Figure 2 TAPPI Conference - DWD Result Interpretation [3]

The DWD threshold value depends on operating pressure.

Accepted thresholds are:
Below 1000 psi – 40 to 20 g/ft²
1000 to 2000 psi – 20 to 12 g/ft²

Chemical cleaning should be scheduled when any DWD measurement of the cold or hot side of a tube becomes a threshold value.

Figure 3 Valmet - When to chemically clean? [4]

4. Time Based Method of Determination

Due to the challenges, lack of reliable boiler deposition representation (and costs) of the DWD method described above, some companies choose to chemically clean boilers on a specific time intervals.

Most common intervals are:

A. Every 7 years
B. Every 10 years
C. Every 12 years

The intervals are chosen based on operating pressures of boilers (higher the pressure lower the interval), overall water quality (lower the quality lower the interval), history of water chemistry upsets, and risk/reward tolerance of facilities.

5. Non-Destructive Method of Determination

A few non-destructive methods have emerged in the last few years claiming a capability to assess internal tube deposition however no official guidelines from reliable sources have been issued yet and no information on reliability or accuracy of these methods have been found.

6. Ad-Hoc Method of Determination (Unusual Events)

The following events can be used to expediate the need for a chemical cleaning from the DWD based or time-based method. These events include:

A. Black liquor incursion [4]
B. Raw water incursion [4]
C. pH excursion [4]
D. Replacement of more than 10% of tubes in an existing boiler [3]

7. References

(1) Hercules, TAPPI Workshop, October 2007, “Waterside Cleaning of Recovery Boilers”

(2) B&W, OEM, Plant Service Bulletin PSB-44, Chemical Cleaning Guide
https://www.babcock.com/assets/PDF-Downloads/Plant-Service-Bulletins/Chemical-Cleaning-Guide-PSB-44.pdf

(3) Technical Association of Pulp and Paper, TAPPI, Conference 2002 Fall, FTC02126, “Interpretation of deposit weight density analytical results as a measure of boiler tube cleanliness”, George Totura, Tom Spry.
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(4) Valmet, OEM, “Paper Mill Boiler Chemical Cleaning – Why, When, and How”
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