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How to inspect the waterside of a fired boiler

Most refineries and chemical plants inspect the waterside of each fired boiler during the annual or bi-annual outage. The purpose of this inspection is to ensure that the corrosion and deposit control program is consistent with industry standards to preserve boiler reliability. The appearance of the waterside heat-transfer surfaces can provide direct evidence of the success for the chemical-treatment program and proper boiler operation. Therefore, it is imperative that the chemical supplier and refinery personnel participate in the waterside inspection.

Preparation for inspection. Conventional fired boilers typically have at least one steam drum and a mud drum or blowdown header. Older boilers often have a "dry drum" that acts as a steam separator. Refinery personnel should inspect all drums large enough to permit access through the manway, document the appearance of the waterside surfaces using a digital camera and collect samples of any deposits.

Steam separators may obstruct access within the drum and may require removal before the inspection. Ideally, refinery personnel should inspect the heat-transfer surfaces using a video camera with a fiber optic probe (borescope). A borescope inspection requires removing the belly plates that cover the outlets of the riser tubes—a time-consuming activity. If plant personnel have conducted a borescope inspection during previous outages, the inspector should view that recording prior to the inspection.

TABLE 1. Key visual inspection observations

Component	Visual observation	Significance
Water level line in steam drum	Height of waterline Deposits	Risk of carryover or downcomer starvation Potential foaming and risk of carryover
Steam separators	Mechanical integrity White deposits	Poor performance Carryover
Steam drum surface above waterline	Deposits Iron oxides	Foaming and risk of carryover Possible poor shutdown and/or idle procedure
Steam drum surface below waterline	Deposits	Improper water chemistry
Feedwater line	Mechanical integrity Deposits below outlet holes	Possible corrosion or erosion issues Potential feedwater corrosion issues or chemical incompatibility
Chemical feed line	Mechanical integrity	Possible corrosion or erosion issues
Belly plates	Mechanical integrity	Excessive turbulence in steam drum risking carryover
Mud drum	Deposits	Potential of inadequate manual or automatic blowdown

TABLE 2. Key borescope inspection observations

Component	Borescope observation	Significance
Risers—vertical surfaces	Deposits Color or reflectivity of tube surface	Poor water chemistry or excessively high firing rates Allows the identification of hot and cold side deposition severity
Risers—roof and floor tubes	Deposits	Excessively low circulation or firing rates High rates of heat transfer due to loss of fireside or case insulation or over-firing
Downcomers	Deposits	Poor water chemistry or idle procedures

Key observations. As shown in Table 1, a visual inspection can confirm some aspects of boiler operation but cannot confirm the condition of the heat transfer surfaces. It is critical to confirm the mechanical integrity of all components in the steam drum.

Using a borescope allows an inspection of the most critical waterside component of a boiler—the heat-transfer surface. In addition, a borescope inspection can provide a permanent record of the condition for the heat-transfer surfaces by recording the images on a videotape or CDROM.

A proper borescope inspection begins with creating a "tube map" that identifies each tube with a number and/or letter. Inspection personnel should identify the critical tubes for inspection, e.g., waterwall tubes with the highest rates of heat transfer and risers farthest from the burners that may be prone to poor circulation. A proper inspection should include a subset of tubes located within each area. Personnel should make written notes that list the sequence of inspected tubes, observations of the general condition and any irregularities for inclusion in a written report.

Proper interpretation. Borescope cameras magnify particles and surface textures and show false colors, making interpretations by the viewer more difficult. Inspectors must use various cues to identify the orientation of the video image such as tube bends and fireside.

Inspectors can qualitatively evaluate the scale density based on evidence of abrasion or "tracks" left by the borescope probe, especially at the lower tube bends. However, it is nearly impossible to judge deposit thickness even if the scale exfoliates from the surface.

Proper interpretation of borescope observations is a highly empirical skill, requiring an experienced professional. Comparisons of identical tubes during successive inspections provide the most reliable interpretations. HP

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