Chapter

13

Dew-Point Corrosion during Idle Periods

Locations

Dew-point corrosion during idle periods can occur in the economizer, and also anywhere in the boiler where external surfaces can be covered with acid-forming, sulfurous deposits.

General Description

Dew-point corrosion may result in significant corrosion of external metal surfaces during idle periods. As the boiler cools, the temperature of its external surface may drop below the dew point, allowing moisture to form on tube surfaces. Moisture, in combination with sulfurous deposits, may form a low-pH electrolyte that is capable of generating corrosion rates of 500 mil/y (12.7 mm/y). Figure 13.1 illustrates an ash-covered tube with dew-point corrosion before deposits were removed. Figure 13.2 illustrates the corroded surface of the tube after the deposits were removed.

Critical Factors

Dew-point corrosion is caused by the presence of sulfurous ash deposits on tube surfaces and the reduction of metal temperatures within the boiler to

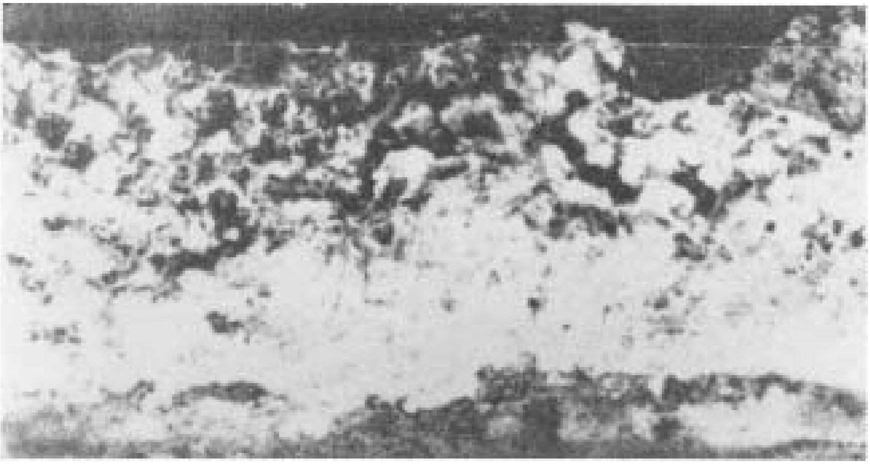

Figure 13.1 Heavy ash buildup on fire side of boiler tube. (*Reprinted with permission from Daniel P. Hamilton, "Preventing Dew-Point Corrosion during Boiler Shutdown,"* Plant Engineering, *July 22, 1982, p. 73.*)

temperatures below the dew point. Sulfurous ash deposits may form a low-pH electrolyte when moisture is present.

Identification

Once deposits are removed, simple visual inspection should disclose the occurrence of dew-point corrosion (Fig. 13.2). Typically, metal attack will

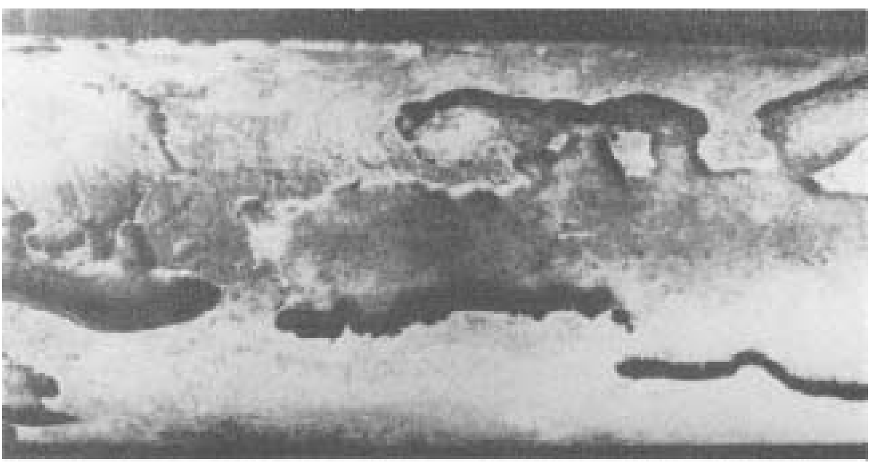

Figure 13.2 Severe, localized corrosion apparent after deposit removal. Areas adjacent to the deposits remain uncorroded. (*Reprinted with permission from Daniel P. Hamilton, "Preventing Dew-Point Corrosion during Boiler Shutdown,"* Plant Engineering, *July 22, 1982, p. 73.*)

be confined to surfaces that were covered with the sulfurous ash deposits. The attack often produces well-defined regions of metal loss and leaves islands of metal relatively intact.

Analysis of ash deposits covering the tube may also be useful in identifying dew-point corrosion. Generally, dew-point corrosion is caused by exposure to sulfurous deposits which form low-pH water solutions.

Elimination

Elimination is achieved through controlling the critical factors that cause the corrosion. Two critical factors govern dew-point corrosion; the presence of sulfurous ash deposits which form low-pH electrolytes when combined with water, and reduction of fire-side metal temperatures below the dew point.

In order to eliminate the presence of sulfurous ash deposits, the following steps may be taken:

- Specify fuels with lower sulfur content. This reduces or eliminates the formation of corrosive ash.
- Remove fire-side deposition from metal surfaces immediately after boiler shutdown by using high-pressure water sprays. This should be followed by a lime wash to neutralize remaining acidic substances. Allow the metal surfaces to air-dry.
- Fire-side metal can be protected from rust by coating metal surfaces with a light oil.
- Containers of unslaked lime placed in the firebox during shutdown will help keep the air dry. This lime should be renewed periodically.

It is generally not possible to maintain metal temperatures above the dew point unless the boiler-water temperature is maintained above the dew point.

Cautions

Corrosion may not be visually apparent until deposits are removed. The irregular pattern of metal loss typical of dew-point corrosion may be helpful in distinguishing it from cold-end corrosion.

Related Problems

See Chap. 12, "Cold-End Corrosion during Service."

CASE HISTORY 13.1

Industry:	Pulp and paper
Specimen Location:	Screen tube, recovery boiler
Specimen Orientation:	Vertical
Years in Service:	10
Drum Pressure:	600 psi (4.1 MPa)
Tube Specifications:	2 in. (5.1 cm) outer diameter
Fuel:	Black liquor

Figure 13.3 illustrates the appearance of the external surface of a screen tube. General metal loss has produced an irregular surface contour. Microstructural examinations revealed that the external surface was covered with a dense layer of iron oxide beneath a layer of iron sulfide. This corrosion occurred during idle periods when moisture, possibly from inadequate water washing, combined with external, sulfur-containing deposits, forming an acidic solution.

Figure 13.3 Appearance of the external surface of a screen tube after exposure to moisture and corrosive deposits during idle periods.

CASE HISTORY 13.2

Industry:	Pulp and paper
Specimen Location:	Front row of economizer, recovery boiler
Specimen Orientation:	Bend, slanted
Years in Service:	11
Drum Pressure:	600 psi (4.1 MPa)
Tube Specifications:	2 in. (5.1 cm) outer diameter
Fuel:	Black liquor

The economizer tube shown in Fig. 13.4 has an irregular, pebblelike surface contour covered with nonprotective corrosion products and deposits. The appearance of this surface is characteristic of corrosion occurring during idle periods when acid-producing salts combine with atmospheric moisture to produce a corrosive environment.

Figure 13.4 External surface of economizer tube following dew-point corrosion.

CASE HISTORY 13.3

Industry:	Pulp and paper
Specimen Location:	Wall tube, 2 ft below roof
Specimen Orientation:	Vertical
Years in Service:	12
Drum Pressure:	600 psi (4.1 MPa)
Tube Specifications:	3 in. (7.6 cm) outer diameter
Fuel:	Black liquor

The corrosion illustrated in Fig. 13.5 was typical of that found in the boiler in the upper furnace area around openings. All corrosion had occurred under refractory. The boiler was water-washed twice annually and was not dried after washing. Measurement revealed a 16% reduction in tube-wall thickness.

The corrosion occurred as a result of the presence of sulfur-containing deposits on the metal surface that were not removed during water washes. Corrosion of this type is not uncommon in stagnant areas, such as beneath refractory. Corrosion rates of up to 50 mil/y (1.27 mm/y) have been reported in similar circumstances.

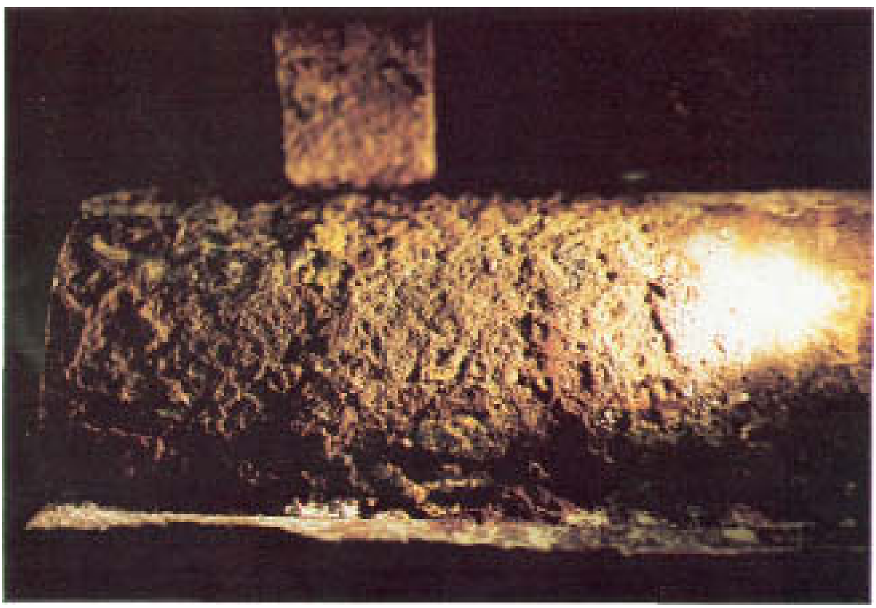

Figure 13.5 Idle-time corrosion occurring beneath refractory.

CASE HISTORY 13.4

Industry:	Pulp and paper
Specimen Location:	Generating tube 2 ft above mud drum
Specimen Orientation:	Vertical
Years in Service:	21
Drum Pressure:	750 psi (5.2 MPa)
Tube Specifications:	2½ in. (6.3 cm) outer diameter
Fuel:	Black liquor

The metal loss apparent in Fig. 13.6 had affected tubes throughout the generating bank, requiring a major boiler rebuild. The problem was discovered after a major leak resulted in emergency shutdown of the boiler. The corrosion had not been observed previously. The external surfaces of the boiler were water-washed every 4 months.

Measurement revealed a reduction in tube-wall thickness of approximately 20%. The corroded surface is rough, but smooth islands of the original surface remain.

Microstructural examinations revealed no evidence of attack of the external surface by high-temperature slag. The corrosion occurred during idle periods. An inadequate water wash of the boiler can leave corrosive, sulfur-containing, acid-producing salts. The remaining salts, coupled with moisture, are capable of producing the type of corrosion apparent on this tube.

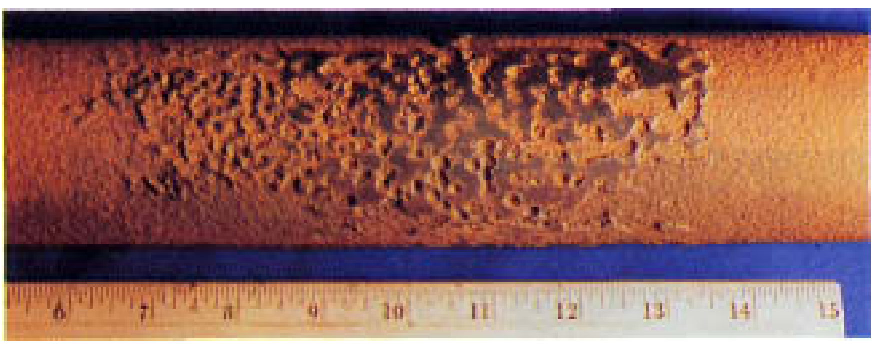

Figure 13.6 Corrosion resulting from inadequate water washing of external surfaces.

CASE HISTORY 13.5

Industry:	Steel
Specimen Location:	Downcomer 12 in. from steam drum
Specimen Orientation:	Slanted 45°
Tube Specifications:	2½ in. (6.3 cm) outer diameter
Fuel:	High-sulfur fuel oil

The tube illustrated in Fig. 13.7 was one of several similar tubes discovered during a fire-side inspection. The tube was positioned at a 45° angle in the boiler. The massive, perforating groove was oriented vertically. It was observed that the groove was directly aligned with water dripping from the economizer section above.

An inspection of the economizer section revealed another series of grooved tubes. The grooves in these tubes were aligned with water dripping from the air preheater section above the economizer.

An inspection of the bottom of the air preheater section, which had recently been water-washed, revealed an accumulation of wet, dripping deposits. Water dripping from these deposits had a pH of 2. Analysis of the deposits by *x*-ray fluorescence disclosed a high level of sulfur.

Incomplete washing of highly corrosive deposits in the air preheater furnished a source of highly corrosive water, which corroded every tube in its drip paths. Tubes in both the economizer and the boiler proper were affected.

From a corrosion-engineering perspective, this case underscores the importance of recognizing boiler systems as a continuum. Environmental conditions existing in one part of the system can have a direct adverse impact on another part of the system that is physically separate and apparently unconnected.

Figure 13.7 Grooving and perforation of a slanted tube resulting from corrosive water dripping from above.