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GENERAL COMMENT OXYGEN ATTACK

By

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GENERAL COMMENT OF OXYGEN ATTACK

One of the most frequently encountered corrosion problems is caused by the exposure of boiler metal to dissolved oxygen. Although relatively infrequent in an operating boiler, oxygen attack is a problem often found in idle boilers. The entire boiler system is susceptible.

The most common occurrence is in superheater tubes where condensed moisture and atmospheric oxygen combine to produce deep, distinct, almost hemispherical pits.
Often tubercles or remnants of tubercles will cap these pits. Pitting will frequently occur at the bottom of U-shaped pendants where moisture can accumulate.

In an operating boiler, corrosion of this type is generally linked to a poorly operating deaerator or improper oxygen scavenging. The first areas to be affected are the economiser and feedwater heater.

The corrosion will manifest itself as distinct pits capped by mounds of nonprotective iron oxide corrosion products which will frequently be reddish in colour. In cases of severe oxygen contamination, metal surfaces in other areas of the boiler such as along the water line in the steam drum and in the steam separation equipment, may be affected.

The three critical factors governing the onset and progress of oxygen corrosion include the presence of moisture or water, the presence of dissolved oxygen, and an unprotected metal surface.

The corrosiveness of water increases as temperature and dissolved solids increase, and as pH decreases. Aggressiveness generally increases with an increase in oxygen.

An unprotected metal surface can be caused by three conditions :-

(1) The metal surface is bare - for example, following an acid cleaning.

(2) The metal surface is covered with a marginally protective, or nonprotective, iron oxide, such as hematite, Fe_20_3 (red).

(3) The metal surface is covered with a protective iron oxide, such as magnetite, Fe_30_4 (black), but holidays or cracks exist in the coating.

Breakdown, or cracking of the magnetite, is due largely to mechanical and thermal stresses induced during normal boiler operation. These stresses are increased and therefore are more damaging during boiler start-up, during boiler shutdown and during rapid load swings.

During normal boiler operation the environment favours rapid repair of breaches in the magnetite. However if excessive levels of oxygen are present, either during operation or outages the cracks in the magnetite cannot be adequately repaired and corrosion commences.

Elimination

The three critical factors that govern oxygen corrosion in a boiler are moisture or water oxygen and an inadequately protected metal surface.

Operating Boiler

Water is always present in an operating boiler. Also the protective magnetite coating exists in a state of continuous breakdown and repair. At any given time, holidays and cracks in the magnetite will be present, although the percentage of the entire internal surface they represent will be very small.

Therefore since both water and corrosion sites are present, mitigation levels of oxygen corrosion is achieved by sufficiently diminishing dissolved oxygen levels.

Possible causes of excessive levels of dissolved oxygen are, for example a malfunctioning deaerator, improper feed of oxygen-scavenging chemicals or air in - leakage.
Monitoring of oxygen levels at the economiser inlet, especially during start-up and low-load operation is recommended.

Idle boiler - wet lay-up

An idle boiler during wet lay-up is subjected to conditions similar to those in an operating boiler as far as oxygen corrosion is concerned. Therefore the preventative method, reduction of oxygen content to very low levels and continuous control that prevents these levels from rising is the same.

In general this procedure requires complete filling of the boiler, use of sufficiently high levels of oxygen-scavenging chemicals and maintenance of properly adjusted pH levels, as well as periodic water circulation.

Idle boiler - dry lay-up

Successful protection of an idle boiler during dry lay-up depends upon consistent elimination of moisture and/or oxygen. A procedure for boiler protection by dry lay-up can involve the use of desiccants and nitrogen blankets, or the continuous circulation of dry, dehumidified air (<30% relative humidity).

Boiler after chemical cleaning

Protection of a boiler following acid cleaning is achieved by developing a protective iron oxide coating in the metal surface. This is usually accomplished by a thorough rinsing followed with a "post boilout".

A sodium carbonate solution or other alkaline substance can be used in the post boilout - passivation step.