



Corrosion in Boiler Tube Bundles

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MANUFACTURER	DATE
MODEL	SIZE
MAX. PRESSURE	PSI
MAX. TEMP.	°F
ELECTRICAL REQUIREMENTS	
MAIN POWER SUPPLY	
STARTING METHOD	
MAX. NO. OF DIRECT STARTS	
STARTING MOTOR	
AS SUPPLIED WITH	
IN QUANT. OF	
CONTROL CIRCUIT	
OIL PUMP MOTOR	

Introduction: Corrosion in Boiler Tube Bundles

Corrosion in the boiler system is a phenomenon that continuously costs the industry [billions of dollars per year](#), and leads to reduced performance from steam generating systems. Also known as stress corrosion cracking, boiler tube corrosion is caused by a number of different factors. An understanding of the different causes of corrosion will help you find and apply the most effective solution.



Caustic Embrittlement

One possible reason for corroded tubes is caustic embrittlement. Caustic embrittlement is characterized by “intercrystalline cracking of steel” and is created by a combination of stress, leakage and the presence of sodium hydroxide, a highly caustic metallic base and alkali salt. The most vulnerable areas of a boiler tube for caustic embrittlement are “at points where tubes are rolled into sheets, drums, or headers.” The solution for this particular cause of corrosion is to add sodium nitrate in the boiler water at the proper ratios recommended by the Bureau of Mines.



Transgranular Cracking

Unequal stresses on boiler tubes cause transgranular cracking. According to GE Water, “transgranular cracking primarily due to cyclic stress is the most common form of cracking encountered in industrial boilers.” Cyclic stress, otherwise defined as a stress that changes over time in a repetitive fashion, eventually results in loose and leaky tubes or cracks. In boilers, cyclic stress occurs when disparate pockets of hot gases accumulate across the face of the tube sheet. To avoid this issue, the boiler should never be operated outside its own design specifications for temperature and pressure.

Steam Blanketing

Steam blanketing is a phenomenon in which steam and water separate and flow through a given tube in separated layers, rather than blended together. Over time, this condition results in a “prominent water line with general thinning in the top area of the tube.” Steam blanketing typically occurs because the velocity of water and steam inside the tube is not strong enough to maintain a “thorough mixing of water and steam during passage through the tubes.” It is most likely to develop in areas of the tubes with a low heat input and inefficient circulation.

Dissolved Oxygen

Another explanation for corrosion in tube bundles is dissolved oxygen. It's a well-known fact that oxygen causes steel to rust, and the same goes for boiler steel. Oxygen leads to pitting which, over time, can cause severe damage and system failures. Oxygen scavengers such as catalyzed sodium sulfite and hydrazine, are commonly used to absorb oxygen in the water and prevent corrosion. Deaerators are also widely utilized to remove oxygen from the feedwater to steam-generating boilers. These standard practices control corrosion due to dissolved oxygen and improve feedwater quality.

Unlike oxygen corrosion, chelant corrosion is characterized by thinning, rather than pitting. Chelants are [defined](#) as "organic chemicals that react with hardness minerals to form soluble chemical complexes." According to Matco Associates, chelants are used to keep boiler water minerals in a solution form. If boiler conditions are not carefully monitored, however, corrosion can ensue. Though often confused for other types of corrosion, chelant corrosion "has some specific characteristics, and develops only under certain conditions." Those conditions are comprised of a prolonged exposure to an excess of sodium salt, especially around "rolled tube ends, threaded members, baffle edges" and other stressed areas.



Copper Deposits

If cleaning procedures are not performed properly, corrosion from copper deposits is another possibility. Copper oxides are often present in deposits, a fact which can be overlooked or underestimated during acid cleaning. After such a procedure, dissolved copper may end up on the steel surfaces of tube banks and establish "anodic corrosion areas" through electrolysis. Corrosion from the presence of copper deposits results in pitting that actually looks quite similar to oxygen corrosion.

Conclusion

Corrosion can be induced by a number of different factors. In addition to the particular types of corrosion mentioned above, boiler tube bundles can also be affected by hydrogen attacks, acid attacks and caustic attacks. In some cases, corrosion might also simply be a result of boiler design problems. The best practices for removing and preventing damage from corrosion vary, depending on the type of corrosion and specific vulnerabilities of the boiler tube itself. Generally, the best way to keep your boiler tubes free of corrosion, however, is through proper maintenance, control and monitoring.

References

Corrosion Services:

http://corrosionservices.com/tech/chelant_corrosion5.php

GE Water: Preboiler and Boiler Corrosion:

http://www.gewater.com/handbook/boiler_water_systems/ch_11_preboiler.jsp

GE Water:

Boiler System Failures: http://www.gewater.com/handbook/boiler_water_systems/ch_14_systemfailure.jsp
