Advanced Engineering P. Ltd.

Boiler tube failure investigation

The process environment of fossil-fired boilers and HRSGs, along with operation errors during engineering, fabrication, erection, operation, and maintenance will always result in occasional boiler tube failures . The goal is for to reduce the forced outage with zero chemistry related failures. The frequency of these failures depends on the corrective actions taken to prevent or reduce boiler tube damage. Reoccurrence of failures results in to forced outages and do poses huge cost implication for tube replacement with direct and indirect economic losses.

Metallurgical root cause investigation helps to narrow down the reason of failure and provides inputs to make proper corrective action.

Damage mechanism's causes premature failures in boiler tubes

Caustic gauging

Localized corrosion due to the concentration of caustic or alkaline salts that usually occurs under evaporative or high heat transfer conditions. It can be mitigated by water chemistry control and design.

Flow accelerated corrosion (FAC)

FAC involves the formation and removal of the protective oxide layer. It can occurs in carbon or low alloy steel piping systems under flowing, water at elevated temperature. Flow rate, pH, oxygen content, temperature and geometry can affect the mechanism.

Erosion, erosion & corrosion

Erosion is the accelerated mechanical removal due to relative movement from liquid, vapur or solid particles or mixture.
When corrosion contributes to erosion by removing protective films or scales, the combined action is erosion & corrosion.

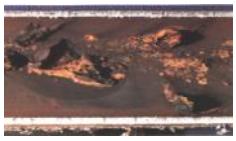
Stress assisted corrosion (SAC)

Both mechanical stress and corrosive environment are necessary to initiate SAC, dissolved oxygen, pH excursion can be the major water chemistry variable that contribute. SCC cracks are frequently found where attachments exists. Stress on the tube surface can break the magnetite film formed.

Water corrosion

Dissolved oxygen. low pH and the scale depositions are the main reason of water side corrosion. Maintaining the water chemistry with respect to operating pressure and boiler type is a key to avoid the water corrosion.

Oxygen pitting

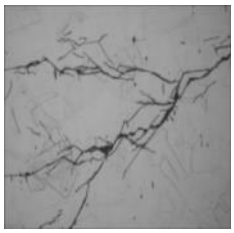


Localized corrosion occurs in form of sever pitting especially at the location where the water is not easily drain during shut down which comes contact with air.

Fire side corrosion

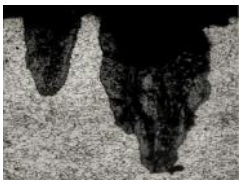
Sodium and Vanadium in fuel, Boiler operation under oxidizing atmosphere, formation of low melting (995F) Point Oxides of Sodium (Na_2O) and Vanadium (V_2O_5), Formation Pyrosulfates of Sodium and Vanadium. Release of Sulphur and Chloride compound by unburnt coal particles due to incomplete combustion, Can eat away the tube surface leading to thinning or puncture under hot condition.

Stress corrosion cracking



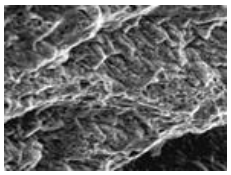
Highly stressed (Austinitic SS), Sodium salts concentration and deposition on surface hide out in dense steam and sudden release while superheated under constant pressure is susceptible to SCC. Solution annealing of SS and sodium level maintaining can prevent SCC. During shutdown precautions are necessary to avoid Polythionic Acid stress corrosion cracking(PASCC) of sensitized Austenitic SS.

Thermal fatigue



Thermal fatigue can occur due to cyclic stresses caused by temperature fluctuations. Damage is in the form of cracking that may occur due to relative movement expansion and this is constrained, under repeated thermal cycling. The cracks are observed with blunted tips and filled with scales.

Fatigue

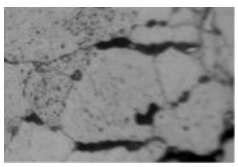


Mechanical fatigue can occur when the repetitive stresses are due to vibration, pressure fluctuation that can arise especially during start ups. The failure has typical signature of having fatigue striations on the fractured/crack surface.

Stress rupture

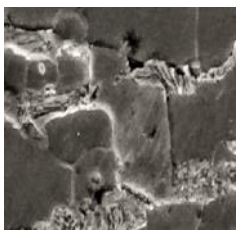
Short term over heating appears with bulging, it occurs at operating stress due to localized overheating. It can be due to design, secondary combustion in the boiler, shifting of combustion zone, starvations or obstacles to stem flow.

Long term creep failures



Creep failures occurs due to high temperature exposure of the boiler tube that slowly and continuously deformed under load below yield stress. Several factors like basic metallurgical condition, internal scale deposition and operating factors can contribute to creep failure.

High temperature hydrogen attack (HTHA)



Hydrogen damage of boiler evaporator tube, also called hydrogen attack, results in serious and irreparable damage to the tube steel and should not be confused with "hydrogen embrittlement“ which is sometimes reversible adsorption of hydrogen into steel. It occurs due to acidic condition and deposition on the heat transfer surfaces due to poor water chemistry.

Team of experts investigate the boiler tube failures with a unique approach of correlation of operational parameters along with deep down understanding of damage mechanism.

World class centre for investigation Vadodara, India

TCR Engineering Services Pvt. Ltd
Plot No. EL-182, MIDC-TTC,
Electronic Zone, Mhape,
Navi Mumbai – 400 705, India
Ph : +91-22-67380900-02
Fax : +91-22-27612044
E-mail: sales@tcreng.com
Website : www.tcreng.com

TCR Advanced Engineering Pvt. Ltd
250-252/9,
GIDC Estate, Makarpura, Vadodara-390010, India
Ph : +91-265- 2657233
Fax : +91-265-2643024
E-mail : tcradvanced@tcradvanced.com
Website : www.tcradvanced.com

TCR Engineering Consulting FZC
International HQ
PO Box 122453,
Dubai, UAE
Tel: +971-50-785-8901
E-mail: uae@tcreng.com

TCR Arabia Company Limited.
P.O.Box 3422, # 3 & 4, next to Al Kifah Construction
besides Al-Kadi Tent Factory
near King Abdulaziz Sea Port
Dammam, Kingdom of Saudi Arabia
Tel: +966-3-8475785-84
Fax: +966-3-8475768
E-Mail: sales@tcr-arabia.com
Website: www.tcr-arabia.com

TCR Kuwait
PO Box 47928, Al-Anud complex, 4th floor
Fahaheel-64023, Kuwait
Tel: +965-23910315
Fax: +965-23910335
E-Mail:kuwait@tcreng.com
Website: www.tcr-kuwait.com

TCR Engineering Malaysia
C/o Approved Group International
No 6 Jalan DBP 3, Dolomite Business Park
68100 Batu Caves, Selangor, Malaysia
Tel: +603-6188 6311
E-Mail: malaysia@tcreng.com

Printed in India