Stress-Assisted Corrosion (SAC) in Boiler Tubes

Benefits

The research project is expected to

- Lead to improved awareness and control of SAC factors, which increases safety and efficiency by decreasing the frequency and duration of maintenance outages.
- Improve inspection schedules using risk-based assessments.
- Energy savings are estimated in excess of 20 trillion Btu's and a decrease of over 300,000 tons of greenhouse gases is anticipated per year 2020.

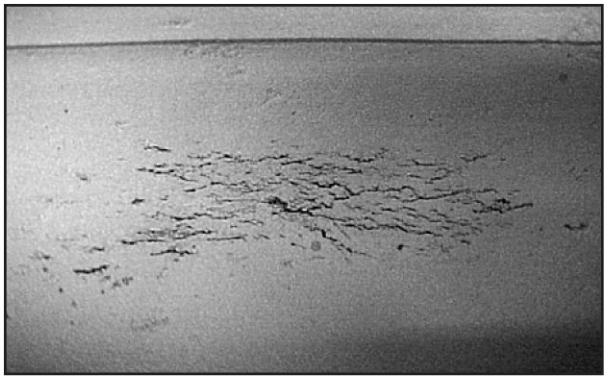
Applications

Identification of boilers with certain "risk factors" for SAC could lead to risk-based inspections that encompass frequency and scope for individual boilers. This project is applicable to boilers in the IOF and supporting industries including

- **Agriculture**,
- **Aluminum**,
- **Chemical**,
- **Forest Products**,
- **Glass**,
- **Heat Treating**,
- **Metalcasting**,
- **Mining**,
- **Petroleum**,
- **Process Heating**, and
- **Steel**.

Understanding mechanisms of stress-assisted corrosion (SAC) in boiler tubes will potentially allow for mitigation and control

The R&D partners and industry contributors will use information gathered across multiple industries, make in situ measurements of strain and water chemistry in operating boilers, and perform laboratory simulations of SAC. Through these activities, significant environmental, operational, and material characteristics will be identified to select parameters for each that reduce the frequency and severity of SAC. In addition, risk factors for SAC will be identified to determine inspection intervals and priorities for control. It is anticipated that the results will yield increased operating efficiencies represented by decreased downtime (greater intervals between inspection and maintenance cycles) with associated energy and cost savings.



Inside surface of a boiler tube at a location exhibiting cracking.

Metallographic cross section of a cracked area; the cracks shown penetrate about 20% of the tube wall thickness.

Project Description

Goal: The goal of this project is to clarify the mechanisms of SAC of boiler tubes for the purpose of determining key parameters in its mitigation and control.

Issues: SAC is indicated by crack-like fissures that initiate and propagate on the waterside of boiler tubes, typically near external attachment welds. Such cracks potentially violate most state boiler-operation laws and codes and are very difficult to detect and quantify. However, propagation of SAC (with or without concomitant external corrosion) can lead to de-rating of boilers and tube failures, possibly resulting in smelt-water explosions and extended downtime for maintenance or repairs. Issues with research include analyses in the field and developing true simulations.

Approach: The centerpiece of this R&D is the development of a laboratory test that (1) simulates SAC in industrial boilers and (2) permits the control of key conditions to establish the parameters that have the greatest effects on SAC initiation and propagation. The work will be divided into five tasks.

Task 1. Simulate SAC in the laboratory for the purpose of testing current and new remediation strategies under a range of conditions applicable to all types of boilers and the variety of operating conditions encountered industrially.

Task 2. Characterize material parameters associated with SAC.

Task 3. Identify key factors related to the influence of residual and operating stresses.

Task 4. Evaluate environmental effects on the initiation and propagation of SAC with field measurements, in laboratory tests, and through a critical analysis of a large amount of field inspection data that will be supplied by industrial partners in the project.

Task 5. Communicate the results of the research to U.S. industry.

Potential Payoff: This research project is expected to lead to improved awareness and control of SAC factors, which increases safety and efficiency by decreasing the frequency and duration of maintenance outages. Energy in excess of 20 trillion Btu's and over 300,000 tons of greenhouse gases will be saved per year if this work is fully implemented.

Progress and Milestones

- Evaluate state-of-knowledge based on focus group exchange and publication/report analyses.
- Develop a laboratory test that simulates SAC in industrial boilers.
- Complete initial evaluation of SAC in tubes provided by industrial partners.
- Complete comparison of field specimens to assess SAC rate.
- Correlate key variables and mitigation factors across a range of boiler operating conditions.

Primary

Institute of Paper Science and Technology
Atlanta, GA

Project Partners

Babcock and Wilcox
Barberton, OH

International Paper
Loveland, OH

Mead Central Research
Chillicothe, OH

Oak Ridge National Laboratory
Oak Ridge, TN

Westvaco
Laurel, MD

For Additional Information, Please Contact

EERE Information Center
Phone: (877) 337-3463
Fax: (360) 236-2023
eereic@ee.doe.gov

Visit our home page at
http://www.oit.doe.gov/imf/

Office of Industrial Technologies
Energy Efficiency
And Renewable Energy
U.S. Department of Energy
Washington, DC 20585
http://www.oit.doe.gov

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