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Fast identification of O_2 corrosion in economiser tubes

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ABSTRACT

Failure investigation was conducted on three tube samples via visual/metallographic examination and analysis of operational history. The investigation employed a fast-identification approach, which allowed a shorter down time and faster production recovery after tube failure. Visual and metallographic evidence showed that the tube samples had suffered from abnormally high wastage at the external and internal surfaces; the latter surface, in addition had suffered from deep pitting. Analysis of operational history confirmed the presence of dissolved O_2 in the feedwater. It was concluded that leakage was primarily caused by tube thinning from internal wastage/pitting, aggravated by external wastage.

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1. Introduction

Boilers are used to heat water to generate steam for a variety of purposes. Boiler components such as economisers, water-wall tubes and superheaters are today mainly made of steels and high temperature alloys. An economiser is a heat exchanger located in the lower gas temperature region (450–600 °C), designed to recover some of the heat from the discharged flue gas. It consists of a series of tubes through which feed water flows to the drum or to the inlet headers of furnace walls. Flue gases flow over the outside of the tubes. Economisers can be constructed with cast iron or steel tubes; the former is usually used in low-pressure industrial boilers (pressure $\leqslant$ 2.5 MPa) and the latter, in high pressure boilers [1].

Failure of boiler tubes is a very common phenomenon, therefore it is important to investigate their root causes to prevent future occurrences [2,3]. López-López et al. [4] investigated the association between the carburisation of austenitic stainless steels and high fireside corrosion rates. The methodology encompassed microhardness profiling, electron probe microanalysis and metallographic studies of the external surfaces of superheater and reheater tubes. Chaudhuri [5] described case studies related to failures of a 1.25Cr–0.5Mo reheater tube, a carbon steel tube and some 2.25Cr–1Mo final superheater tubes. Lee et al. [6] presented failure analysis cases on final superheater tubes in an ultra-supercritical coal power plant. Ahmad et al. [7] investigated the failure of a SA210-A1, rear water-wall tube by visual site inspection, tube wall thickness measurements and metallographic examination. Saha et al. [8] examined the probable causes of failure of a welded joint in a 210 MW thermal power plant. Dhua [9] investigated failed water-wall tubes from a thermal power station via visual examination, metallographic examination, and electron probe microanalysis.

The reasons for boiler tube failures are varied, and common mechanisms include pitting, erosion, thermal fatigue, creep and stress corrosion cracking [2,3,10,11]; other more complex ones include stress assisted corrosion, caustic gouging and acid phosphate corrosion. Some of the failures, for example pitting, are caused by dissolved oxygen in the feed water. In boilers, water coming out of deaerators usually has some residual oxygen, which is removed chemically. Sodium sulphite and hydrazine, or some other chemicals, are used for removal of residual oxygen; sodium sulphite is used for low pressure boilers.

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