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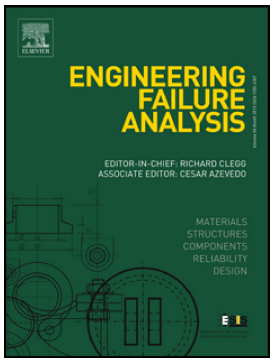

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PII: S1350-6307(17)31026-9
DOI: doi:10.1016/j.engfailanal.2018.03.005
Reference: EFA 3399

To appear in: *Engineering Failure Analysis*

Received date: 25 August 2017
Revised date: 3 January 2018
Accepted date: 3 March 2018

Please cite this article as: Arezoo Firouzeh, Khalil Ranjbar, S.M. Lari Baghal, A. Heidari Kaidan, Enayatolah Mohemi , Failure assessment of ASTM A213-T12 superheater boiler tubes in a natural gas liquid plant. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Efa(2017), doi:10.1016/j.engfailanal.2018.03.005

Failure assessment of ASTM A213-T12 superheater boiler tubes in a natural gas liquid plant

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Abstract

This paper presents the results of an investigation into the failure of steam boiler tubes in a liquefied gas treatment plant. The failure appeared in the form of a window rupture in the boiler tubes of 1.25Cr-0.5 Mo grade steel. Study revealed that a thick magnetite iron oxide layer was formed in the inner surface of these tubes, disturbing the heat flow and rising the temperature of the tubes. Consequently, the internal oxide layer led to a series of metallurgical degradation and the loss in mechanical strength of the boiler tubes. Failure analysis of the steam tubes was carried out by optical and scanning electron microscopy examinations, chemical analysis of the tube material and the results showed that the scales were formed in the inner surface of the tubes. Furthermore, the rise in operational temperature and its distribution were simulated using fluent software and the results were compared against the designed temperature of the tubes. The simulation revealed that the operating temperature of the tubes reached beyond the design temperature, confirming the microstructural degradations i.e., oxidation, decarburization and reduction in the effective tube wall thickness. The extensive scale formation on the steam side and the resultant tube wall thinning was identified as the main cause of failure in the superheater tubes.

Key words: Failure analysis, Superheater boiler tube, ASTM A213-T12 steel, Iron oxide scale, Temperature simulation.

1. Introduction

Steam boilers are among types of heat exchangers that turn water into steam by using the fuel thermal energy and transferring into cold water [1]. Since all parts of the boiler are under

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