

Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Case Studies in Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/csefa

Short communication

Failure analysis of the boiler water-wall tube



S.W. Liu, W.Z. Wang*, C.J. Liu

Key Laboratory of Pressure System and Safety, Ministry of Education, East China University of Science and Technology, Shanghai 200237, China

ARTICLE INFO

Keywords:

Boiler water-wall tube
Rupture
Failure mechanism
Oxidation

ABSTRACT

Failure analysis of the boiler water-wall tube is presented in this work. In order to examine the causes of failure, various techniques including visual inspection, chemical analysis, optical microscopy, scanning electron microscopy and energy dispersive spectroscopy were carried out. Tube wall thickness measurements were performed on the ruptured tube. The fire-facing side of the tube was observed to have experienced significant wall thinning. The composition of the matrix material of the tube meets the requirements of the relevant standards. Microscopic examinations showed that the spheroidization of pearlite is not very obvious. The failure mechanism is identified as a result of the significant localized wall thinning of the boiler water-wall tube due to oxidation.

1. Introduction

Uninterrupted power supply from a power plant mainly depends on the continued functioning of its equipment and components. In fossil fuel-based power plants, proper functioning of boiler tubes, super heater, heat exchanger, turbine, etc., is important for maintaining the power supply. Even a single component failure can lead to the shutdown of the entire power generation system. Failure of boiler tubes is one of the main reasons for the shutdown of power plants, and its occurrence has often been reported in many such power plants [1–3].

Boiler components are mainly made of steels, cast irons, stainless steels and high temperature alloys. Failure of boiler tubes is a very common phenomenon in a power plant. The investigation into the causes of a boiler tube failure is very important to prevent future tube failures. Identifying correct failure mechanism often helps to ensure the integrity of the equipment. There are many reasons for boiler tube failures such as pitting, stress corrosion cracking, stress rupture, creep, erosion, and thermal fatigue [4–8].

The failed boiler tube in this investigation is made from 20G steel. The operating pressure and the operating temperature of the tube are 10.8 MPa and 320 °C, respectively. And the working medium in this tube is deaerated water. After 8 years of service, the boiler tube was found to burst a small hole. The dimensions of the opening burst of the tube are 30 mm in length and 17 mm in width. Through detailed investigation of the failed tube, this study aims to find out the failure mechanism, and put forward the corresponding preventive measures.

2. Experimental procedure

The failure analysis was performed to the failed tube, especially the bursting section of the tube. For examining the inner wall surface morphology of the tube, samples were prepared from different regions of the failed tube. The metallography samples were prepared by using standard metallographic techniques and etched with 4% nital solution. The microstructure was analyzed by optical

* Corresponding author.

E-mail address: wangwz@ecust.edu.cn (W.Z. Wang).

<http://dx.doi.org/10.1016/j.csefa.2017.06.002>

Received 21 March 2017; Received in revised form 25 May 2017; Accepted 22 June 2017

Available online 28 June 2017

2213-2902/ © 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



Fig 1. General view of the failed tube (a) and the enlarged view of the fracture (b).

microscope and scanning electron microscope (SEM) equipped with an energy dispersive X-ray (EDX) analysis facility. In addition, the chemical composition of the failed tube was analyzed by 725ES Agilent spectrometer.

3. Result and discussion

3.1. Visual inspection

During inspection a hole has been found on the fire-facing side of the tube as shown in Fig. 1. The cocked-up metal was around the hole. Close visual inspection also revealed that the wall thickness of the fire-facing side is less than that of the back side (see Fig. 2). It may indicate that the tube has significant localized wall thinning and is eventually followed by a sudden failure. Based on this finding, wall thickness measurements on the failed tube were carried out. The thickness of the thinnest area is about 1.90 mm on the fire-facing side, far less than the wall thickness of the back side (6.08 mm). In addition, scale was observed on the internal and external surface of the failed tube, and no significant bulges were found on the ruptured part of the tube.

In order to analyze the failure reason of the tube, the sampling and analysis on the as-received tube at the rupture part and in some distance away from the rupture region were carried out. Two small pieces of specimens shown as Fig. 3a and b were cut from the fire-facing side and the back side of the tube and labeled as Sample I and Sample II, respectively. The cocked-up slice around the burst hole was also cut down (Fig. 3c), labeled as Sample III. It can be seen that the pits are very obvious on the internal surface of the fire-facing side (Sample I) and the cocked-up slice of the burst hole (Sample III), while they could hardly be found on the inner wall of the back side (Sample II). It reveals that corrosion on the fire-facing side of the failed tube is more serious than the back side.

3.2. Chemical analysis

According to the manufacturer, the failed boiler tube is made of 20G steel. And the chemical composition of the failed tube was shown in Table 1. It can be seen that the composition of the matrix material of the tube meets the requirements of the relevant standards according to GB 5310-2008.



Fig. 2. Cross section of the failed tube.

Download English Version:

<https://daneshyari.com/en/article/5011165>

Download Persian Version:

<https://daneshyari.com/article/5011165>

[Daneshyari.com](https://daneshyari.com)