Failure analysis of an attemperator in a steam line of a boiler
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A R T I C L E   I N F O
Article history:
Received 4 December 2010
Received in revised form 26 March 2011
Accepted 30 March 2011
Available online 5 April 2011

Keywords:
Attemperator
Thermal fatigue
Creep
Inconel
Boiler

A B S T R A C T
Spray flow attemperator is used for controlling superheater outlet steam temperature in power house. The attemperator undergoes cyclic thermal load and pressure and is prone to failures associated with thermal fatigue cracking of its components and welds. This paper presents the investigation of such a failure in a power house. The investigation consists of visual inspection, chemical analysis, characterization of microstructures, energy dispersive spectroscopy, measurement of hardness and fractography. Multiple cracks are observed on the surface as well as on the weld joint of the spray nozzle dislodged from the attemperator. Fracture surface shows dull woody appearance which reveals striations during examination under scanning electron microscope. The material is found to be nickel based Inconel as obtained by chemical analysis. Microstructural examination exhibits transgranular/intergranular cracks. Presence of chromium carbide precipitations are observed inside the grains and along the grain boundaries. The investigation reveals that the component suffered from thermal fatigue and crack growth occurred under the combination of creep–fatigue.

1. Introduction

The failure of an attemperator at a boiler steam line in an integrated steel plant has been investigated. There were four multi-fuel boilers, each having a production capacity of 136 T/h, in a power house of the steel plant. The boilers were having steam pressure of 63.5 kg/cm² (gas) and the superheater outlet temperature of 485 °C. The steam generated from these boilers were used in (i) running high pressure steam driven blowers for blast furnaces, (ii) supplying steam to process, and (iii) generating power through condensing turbo generator (TG) sets. There were three TG sets of 25, 20 and 12.5 MW back pressure at the power house, respectively. The power house has a production capacity of around 45–47 MW.

Boiler # 2 of the power house was generating steam at 112 T/h with 96,000 N m³/h blast furnace gas and 4000 N m³/h coke oven gas for flame support just before the failure. Suddenly the steam flow came down to 56 T/h and the drum pressure shoot up to 75.6 kg/cm² (gas). Boiler # 2 was shutdown. Non return valves and main steam stop valves (MSSV) were checked, but no abnormalities were found. Boiler # 2 steam drum was opened and inspected. Secondary scrubbers were also opened to check for blockage due to deposits. No deposit was found and scrubbers were observed clean.

The drawing of the attemperator was studied and it came out that the following might be the probable causes of the steam flow restriction through the attemperator: (i) detachment of thermal sleeve (liner plate) which blocked the steam passage, and (ii) dislodging of spray nozzle which restricted the steam outlet path. One of the methods used to control the final steam temperature in a packaged boiler is inter stage attemperation. In this method, feed water of demineralized quality is