Engineering Failure Analysis 18 (2011) 1067–1075

Contents lists available at ScienceDirect

Engineering Failure Analysis

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

Health assessment of 22 years service-exposed radiant tube from an oil refinery

A.K. Ray *, Y.N. Tiwari, G. Krishna, G. Das, M. Gunjan, S.C. Bose, R.N. Ghosh

National Metallurgical Laboratory (CSIR), Jamshedpur 831 007, India

ARTICLE INFO

Article history:
Received 9 July 2010
Received in revised form 6 January 2011
Accepted 2 February 2011
Available online 26 February 2011

Keywords:
Radiant tube
Microstructure
Hot tensile
Stress rupture
Balance life

ABSTRACT

Radiant tube conforming to ASTM A-200 T5 grade of steel and service exposed for 20 years from an oil refinery was investigated for health check and safety aspect. Microstructural study of the service exposed tube revealed a ferritic–martensitic structure with significant spheroidization of second phase particles. It appears that there is total disintegration of martensitic lath boundaries in some areas. The martensitic lath grains seemed to have broadened and lath boundaries are decorated with coarse and rounded carbides. As a result, with carbides the material has softened. Analysis of hot tensile and accelerated stress rupture data revealed that the residual life at 575 °C and an operating hoop stress level of (28.11 MPa) gave a minimum balance of life of approximately four and a half years for the service-exposed radiant tube. This is provided there is no evidence of localised damage in the form of surface cracks, cavitations or dents. A further life assessment of the service-exposed radiant tube is recommended after an additional 2–3 years of service life an economical and safety reasons viewpoint. During the next shut down of the plant, NDT (non-destructive) tests viz. dimensional (thickness and diameter)measurement, hardness measurement and in situ metallography may be carried out to assess the condition of the materials for their future serviceability.

1. Introduction

Service exposed tubes in power plants have finite life because of prolonged exposure to high temperature, stress and aggressive environment. Remaining life assessment (RLA) of aged components in petrochemical industries and in power plants, in the present highly competitive industrial scene has become very popular both for economy and safety reasons. Most of these plants are over 25 years old and RLA has become an important task for evaluating their lives. In real life situations both premature retirement and life extension (in relation to design life) can be encountered. The decision for retiring a component is not purely technical but also one of economy and safety.

The consequence of service failure can be tragic and expensive. There are many cases of engineering disasters resulting in loss of life and property. For oil refinery and boiler components upmost attention is a must to ensure that such incidents do not take place. Life assessment exercise performed at regular intervals is a means to ensure absence of such tragic service failure.

Carbon and Cr–Mo steels are extensively used as high temperature components in oil refineries and power plants [1–18]. Even though most of these components have a specific design life of 20 years, many of these have been known to have survived much longer. Health assessment of these components is best estimated by conducting a systematic life assessment

* Corresponding author. Tel.: +91 6572345197; fax: +91 6572345213.
E-mail address: asokroy@nmlindia.org (A.K. Ray).

1350-6307/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.engfailanal.2011.02.005