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High Temperature Oxidation of T91 Alloy of Steam Reformer

(2023) *Lecture Notes in Mechanical Engineering*, pp. 37-49.

DOI: 10.1007/978-981-19-1851-3_4

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Abstract
Steam plays a significant role in the reforming process of hydrogen. It is generated in a waste heat recovery unit at temperature of 650 ℃. Along with the high operating temperature, the situation promotes acceleration of high temperature oxidation. This will cause fouling and spalling of oxide scales at the boiler tube. Eventually, fouling will reduce heat transfer between the tube and steam generated, causing a higher temperature is needed to produce steam. Until now, the only approach used by the industry is to manually replace the corroded boiler tube. Other than that, many studies have been conducted on the behavior of boiler tubes at temperatures exceeding 800 °C. However, to our knowledge, no “in-situ” study has been done to investigate the high temperature electrochemistry aspect of boiler tubes. A review conducted by B.A Pint [1] in his paper mentioned that it is notoriously difficult to imitate the harsh environments in laboratory scale. Popov [2] stated that the only available method to decrease corrosion rate at high temperature corrosion and hot corrosion is only by implementing protective coatings. This project was carried out to investigate the corrosion potential of T91 boiler tube at 650 °C for 30 min, 1 h, 2 h, 8 h, and 12 h, measure the current density (Icorr) by calculating corrosion potential (Ecorr) value using Tafel Extrapolation and determine the current conductivity of oxygen gas at 650 ℃. Apart from that, the oxide layer thickness at exposed temperature is also determined to measure the oxidation kinetics. The study concludes that there was an increase of 8.49% in current conductivity between the blank experiment and T91 alloy conductivity test. The oxide layer formed on the sample is significant to calculate the oxidation kinetics of the sample using parabolic rate constant (Kp), resulting with the value of 6.78 × 10–14 m2s−1. © 2023, The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd.

Author Keywords
Cathodic protection; High temperature corrosion; Steam reformer; T91 alloy

Index Keywords
Alloys, Boiler corrosion, Boilers, Corrosion rate, Heat transfer, High temperature corrosion, Rate constants, Scale (deposits), Steam reforming, Thermooxidation, Tubes (components), Waste heat; Boiler tubes, Corrosion potentials, Current conductivity, High operating temperature, High temperature corrosions, Oxidation kinetics, Reforming process, Steam reformer, T91 alloy, Waste heat recovery units; Steam

Funding details
Ministry of Higher Education, MalaysiaMOHE
International Islamic University MalaysiaIIUMFRGS/1/2019/TK03/UIAM/02/5

Acknowledgements This research was supported by the Ministry of Higher Education, Malaysia and International Islamic University Malaysia with Grant Number FRGS/1/2019/TK03/UIAM/02/5.

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Editors: Jalar A., Embong Z., Othman N.K., Yaakob N., Bakar M.A.
Publisher: Springer Science and Business Media Deutschland GmbH

Conference name: 7th International Corrosion Prevention Symposium for Research Scholars, CORSYM 2021
Conference date: 17 November 2021 through 17 November 2021
Conference code: 279979

ISSN: 21954356
ISBN: 9789811918506
Language of Original Document: English
Abbreviated Source Title: Lect. Notes Mech. Eng.
2-s2.0-85134163534
Document Type: Conference Paper
Publication Stage: Final
Source: Scopus