Scopus

Documents

Rosdin, M.R.H.[a] , Ismail, A.A.M.[a] , Hamid, A.M.A.[a] , Purwanto, H.[a] , Illias, S.[b] , Bakar, S.N.S.A.[a] , Ani, M.H.[a]

Effect of Oxygen Gas Exposure on T91 Alloy at High Temperature Oxidation of Steam Reformer
(2023) *Lecture Notes in Mechanical Engineering*, pp. 491-499.

DOI: 10.1007/978-981-19-9509-5_65

[a] Department of Manufacturing and Materials Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Gombak Selangor, 53100, Malaysia
[b] Faculty of Mechanical Engineering Technology, Universiti Malaysia Perlis, Arau Perlis, 02600, Malaysia

Abstract
Steam-Methane Reforming (SMR) is one of the most economical ways to produce hydrogen from natural gas. Steam reforming industry is hugely relied on using supercritical power plant where the working temperature of the plant must exceed 600 °C. Along with the high operating temperature, the situation promotes the 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 study has been done to investigate the air electrolyte substrate interfacial electrochemical reaction at high temperature. This project was carried out to investigate the corrosion potential of T91 boiler tube at 650 °C for 2 h, 8 h, and 12 h, measure the current density (Icorr) by calculating corrosion potential (Ecorr) value using Tafel Extrapolation and determine the oxidation potential of oxygen gas at 650 °. The oxide layer thickness at exposed temperature was 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 oxidation potential test. The oxidation process was following the parabolic rate law which manifest that the corrosion is controlled by ionic diffusivity in the oxide layer. The oxide layer formed on the sample has an average thickness of 54.10 μm and this value can be used to calculate the oxidation kinetics of the sample using parabolic rate constant, Kp, resulting with the value of 6.78 × 10−14 m2/s. © 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
Boiler corrosion, Boilers, Cathodic protection, Corrosion rate, Heat transfer, Rate constants, Scale (deposits), Steam, Steam reforming, Thermooxidation, Tubes (components); Boiler tubes, Corrosion potentials, High temperature corrosions, Highest temperature, Oxidation kinetics, Oxidation potentials, Oxide layer, Oxygen gas, Steam reformer, T91 alloy; High temperature corrosion

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

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

References

- **Push-ing the Limits of the Maximum Punch-Through Design with an Advanced Buffer for Thin Wafer IGBTs**
  (2020) *Proc. Int. Symp. Power Semicond. Devices Ics*, pp. 509-512.
- Khan, Z., Yusup, S., Ahmad, M., Vui Soon, C., Uemura, Y., Sabil, K.
  Review on hydrogen production technologies in Malaysia
  (2010) *Int J Eng Technol*, 10 (2), p. 111.
- Kumar, R., Kumar, A., Pal, A.
  An overview of conventional and non-conventional hydrogen production methods
  (2020) *Mater Today Proc*, 46, pp. 5353-5359.

- Subraveti, S.G., Roussanaly, S., Anantharaman, R., Riboldi, L., Rajendran, A.
Techno-economic assessment of optimised vacuum swing adsorption for post-combustion CO2 capture from steam-methane reformer flue gas
(2021) *Sep Purif Technol*, p. 256.

- Al-Megeren, H., Xiao, T.
(2012) *Natural Gas Dual Reforming Catalyst and Process*,
Adv Nat Gas Technol

- (2021) *Hydrogen Production: Natural Gas Reforming*,

- Poquillon, D., Monceau, D.
Application of a simple statistical spalling model for the analysis of high-temperature, cyclic-oxidation kinetics data
(2003) *Oxid Met*, 59 (3-4), pp. 409-431.

- Ahmad, J., Purbolaksono, J., Beng, L.C., Ahmad, A.
Failure evaluation on a high-strength alloy SA213-T91 super heater tube of a power generation
(2010) *Proc Inst Mech Eng Part E J Process Mech Eng*, 224 (4), pp. 269-273.

- Vazirinasab, E., Jafari, R., Momen, G.
Application of superhydrophobic coatings as a corrosion barrier: A review
(2018) *Surf Coat Technol*, 341 (November 2017), pp. 40-56.

- Ueda, M., Kawamura, K., Maruyama, T.
(2006) *Void Formation in Magnetite Scale Formed on Iron at 823 K-Elucidation by Chemical Potential Distribution*, 523, pp. 37-44.

- Taniguchi, S.
(1985) *Stresses Developed during the Oxidation Alloys*,

- Wagner, C.
(1959) *Reaktionstypen Bei Der Oxydation Von Legierungen*, pp. 772-782.

- **Push-ing the Limits of the Maximum Punch-Through Design with an Advanced Buffer for Thin Wafer IGBTs**
(2020) *Proc. Int. Symp. Power Semicond. Devices Ics*, pp. 509-512.

- **Push-ing the Limits of the Maximum Punch-Through Design with an Advanced Buffer for Thin Wafer IGBTs**
(2020) *Proc. Int. Symp. Power Semicond. Devices Ics*, pp. 509-512.

- **Push-ing the Limits of the Maximum Punch-Through Design with an Advanced Buffer for Thin Wafer IGBTs**
(2020) *Proc. Int. Symp. Power Semicond. Devices Ics*, pp. 509-512.

- Khanna, S.
High-temperature oxidation
(2018) *Handbook of Environmental Degradation of Materials*, pp. 117-132.
3rd edn. Elsevier Inc

Correspondence Address
Ani M.H.; Department of Manufacturing and Materials Engineering, Malaysia; email: mhanafi@iium.edu.my

Editors: Maleque M.A., Ahmad Azhar A.Z., Sarifuddin N., Syed Shaharuddin S.I., Mohd Ali A., Abdul Halim N.F.
Publisher: Springer Science and Business Media Deutschland GmbH

Conference name: 5th International Conference on Advances in Manufacturing and Materials Engineering, ICAMME 2022
Conference date: 9 August 2022 through 10 August 2022
Conference code: 294689

ISSN: 21954356
ISBN: 9789811995088

Language of Original Document: English
Abbreviated Source Title: Lect. Notes Mech. Eng.
2-s2.0-85161128854
Document Type: Conference Paper
Publication Stage: Final
Source: Scopus

ELSEVIER

Copyright © 2023 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.

RELX Group™