Reliability Analysis of Heat Recovery Steam Generator Based on Creep

by

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Dissertation submitted in partial fulfilment of
The requirement for the
Bachelor of Engineering (Hons)
(Mechanical Engineering)

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CERTIFICATION OF APPROVAL

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Approved by,

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MUHAMMAD FADHLI BIN MUHAMMAD

Abstract

Heat Recovery Steam Generator (HRSG) is a massive heat exchanger that converts exhaust gas energy from gas turbine into steam. Since HRSG operates at high temperature, the machine is subjected to structural failure such as creep damage. According to ASM Handbook Volume 11, Failure Analysis and Prevention, creep rupture can occur within a thin-section component such as steam pipes and boiler tubes with a uniform stress and high temperature such as superheater and reheater tubes in HRSG. Reliability analysis will be used to assess the reliability due to creep at superheater and reheater tubing systems. The methodology for the research is determined based on the research by Carazas et al. (2010) to determine the reliability of a HRSG from a case study. The analysis will be a stepping stone for other HRSGs reliability analysis such as the one in Universiti Teknologi PETRONAS (UTP) which use HRSG in a cogeneration power plant. With its reliability assessed, the result can be used by the maintenance team for maintenance purpose to increase production and reduce downtime.

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NOMENCLATURE AND ABBREVIATION

HRSG	Heat Recovery Steam Generator
GDC	Gas District Cooling
UTP	Universiti Teknologi PETRONAS
GTE	Gas Turbine Engine
SAC	Steam Absorption Chiller
LPM	Larson-Miller Parameter
COV	Coefficient of Variation
POF	Probability of Failure
PDF	Probability Density Function
SA	Sensitivity Analysis
PGB	PETRONAS Gas Berhad
C	Larson-Miller equation constant depending on the material composition
h	Tube thickness [mm]
p	Tube internal pressure [MPA]
$p_{creepfailure}$	Probability of creep failure
R_{HRSG}	Reliability of HRSG
R_{mean}	Mean tube radius [mm]
t	Time period [h]
T	Absolute temperature in Kelvin
t_r	Creep time to failure (creep lifetime) [h]
σ_{mech}	Hoop stress acting on tube [MPa]