Papers submitted to the Conference "Applications of Physics in Mechanical and Material Engineering"

Microstructure and High Temperature Oxidation of Modified Ductile Ni-Resist Alloy with Higher Manganese Content

M.M. Rashidi[a,*], M.H. Idris[b], Z. Shayfull[c], A.H. Ahmad[a], M.M.A. Abdullah[d], P. Pietrusiewicz[e], M. Nabiałek[e] and J. Garus[f]

[a] *Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia*
[b] *Department of Materials Engineering, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia*
[c] *Faculty of Mechanical Engineering Technology, Universiti Malaysia Perlis, Kampus Tetap Pauh Putra, 02600 Arau, Perlis, Malaysia*
[d] *Faculty of Chemical Engineering Technology, Universiti Malaysia Perlis, Kampus Tetap Pauh Putra, 02600 Arau, Perlis, Malaysia*
[e] *Department of Physics, Faculty of Production Engineering and Materials Technology, Czestochowa University of Technology, al. Armii Krajowej 19, 42-200 Częstochowa, Poland*
[f] *Department of Mechanics and Fundamentals of Machinery Design,Faculty of Mechanical Engineering and Computer Science, Częstochowa University of Technology, Dąbrowskiego 73, 42-201 Częstochowa, Poland*

Doi: 10.12693/APhysPolA.142.56 *e-mail: mrashidi@ump.edu.my

In this study, ductile Ni-resist with a minimum of 18 wt% nickel composition was modified. Up to 12 wt% manganese was added together with 10 wt% nickel to investigate the effects of the alloying elements on its microstructure, mechanical properties and isothermal oxidation behaviour. The results show a higher manganese composition on modified ductile Ni-resist with increased carbide formation, and a slightly decreased elevated temperature tensile strength. The addition of higher Mn [wt%] slightly increased the oxidation resistance. Three different oxide layers were observed on the modified ductile Ni-resist after 25 h hot corrosion at 765°C.

topics: Ni-resist alloy, manganese, high temperature oxidation, modified ductile

1. Introduction

Ductile nickel-resist (DNR) with an austenite structure is a material developed for high temperature applications due to a combination with austenitic matrix, which occurs at all temperatures. For comparison, in applications at high temperature of up to 675°C, cast iron and steel pass through a critical range that frequently results in the cracking and distortion of castings [1]. This phenomenon happens due to volume changes, which occur because of matrix phase changes between ferrite and austenite. DNR alloys, as an austenitic matrix at all temperatures, do not undergo this transformation and contribute to a high temperature application [2]. A recent study has reported that nickel (Ni) was accepted as the prime alloying element for processing DNR. The as-cast austenite microstructure of DNR occurs due to the influence of Ni contained in the metal composition, which acts as an austenite matrix stabilizer. Ni suppresses austenite (γ) $\rightarrow$ ferrite (α) changes into conventional ductile iron at a minimum of 18 wt% [3]. They also reported the potential of manganese (Mn) and copper as an alternative to the DNR alloying element. However, those results have shown a dissimilar effect. This study attempted to combine both Ni and Mn at a certain composition in order to produce a DNR alloy. Ni [wt%] was reduced to as low as 10 wt%, and Mn [wt%] was increased to as high as 12 wt%. This modified alloy should form an austenite structure with a graphite nodule in its microstructure. The research will simulate environmental conditions that are suitable for elevated applications at up to 765°C, such as furnace parts, exhaust lines, and valve guides.