Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 9-10, 2024

High Temperature Corrosion Behavior of Pure Nickel in NaCl-$MgCl_2$ Molten Salt at 600 °C

Lee Won Chan [a], Nam Seung Ju [a], Ko Uijun [a], Park jin woong [a], Hwang Seong Sik[b], Jeon Soon Hyeok[b], Yoon Jihyun[b], Kim Jeoung Han [a]*

[a]*Department of Advanced Materials Engineering, Hanbat National University, Daejeon, Republic of Korea*
Iwchan2339@naver.com, seunzu111@naver.com, gej96@naver.com, wlsdnd1121@naver.com, jh.kim@hanbat.ac.kr
[b]*Materials Safety Technology Development Division, Korea Atomic Energy Research Institute,*
111, Daedeok-daero, 989 beon-gil, Yuseong-gu, Daejeon 34158, Republic of Korea
sshwang@kaeri.re.kr, junsoon@kaeri.re.kr, jhyoon4@kaeri.re.kr

***Keywords :** Molten salt reactors (MSR), Pure Ni, Corrosion test

1. Introduction

Molten salt reactors (MSRs) use molten salt as the primary coolant in their primary cooling system, unlike conventional light water reactors, resulting in higher thermal efficiency and producing less nuclear waste. However, the high-temperature molten salt environment poses a significant barrier to commercialization due to corrosion issues. To test corrosion in a high-temperature molten salt environment, an atmosphere similar to that of an MSR was recreated inside a glove box. The concentration of moisture and oxygen was controlled to below 10 ppm, and high purity NaCl+$MgCl_2$ salt was mixed to prepare the molten salt. Tafel experiments were conducted to determine whether pure nickel is suitable in the corrosive environment [1],[2].

2. Methods and Results

High purity NaCl+$MgCl_2$ salt was dried for 3 hours at 400℃ in a glove box where moisture and oxygen were controlled to be below 10ppm. It was then melted at the process point and maintained at 600℃. A platinum wire was used for the reference electrode (RE), and a graphite rod was used for the counter electrode (CE).

OCP

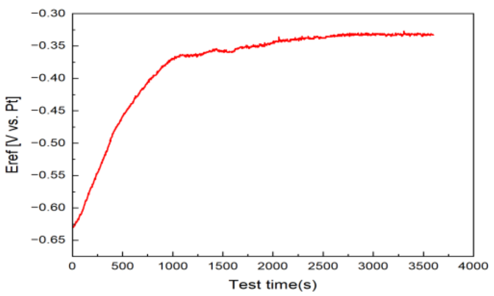

Fig. 1. An OCP (Open Circuit Potential) test was conducted using 99.9% nickel wire

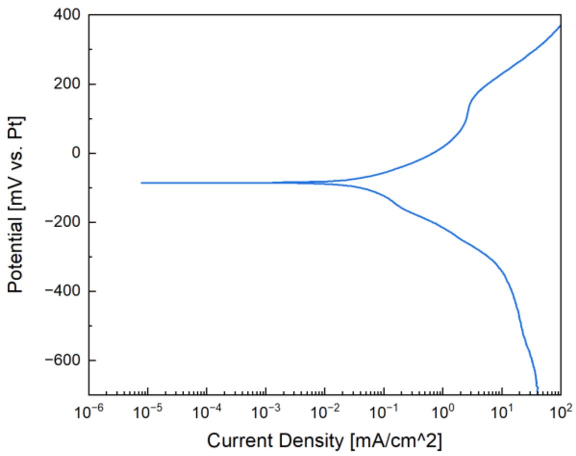

Fig. 2. Ni wire Tafel curve.

The results of the OCP (Open Circuit Potential) test showed that the Ecorr value was measured at around -320 mV. For the Tafel extrapolation, a potential of -300 mV relative to the OCP and 300 mV relative to the Re reference electrode was adopted. The calculated corrosion current density resulted in an Ecorr of -85.8mV, with a Jcorr value of 52.3 uA/cm^2.

3. Conclusions

These corrosion test results indicate that the analyzed material experiences a high rate of corrosion in a highly aggressive environment. The values of the anodic and cathodic Tafel slopes demonstrate the change in electrochemical reaction rates, while the corrosion current density and corrosion potential directly show how quickly the material corrodes. Notably, the extremely high corrosion rate can significantly impact the material's lifespan and performance. These outcomes suggest that the selected material is not suitable for highly corrosive environments, implying the need for reconsideration of material choice, application of protective coatings, or the use of alternative materials with higher corrosion resistance. Furthermore, this data provides essential information for understanding the corrosion mechanism of the material and setting design criteria.

REFERENCES

[1] Tianle Liu, Xinhai Xu, Wenrui Liu, Xiaoru Zhuang, Corrosion of alloys in high temperature molten-salt heat transfer fluids with air as the cover gas, Solar Energy, Volume 191, 2019..

[2] K. Vignarooban, P. Pugazhendhi, C. Tucker, D. Gervasio, A.M. Kannan, Corrosion resistance of Hastelloys in molten metal-chloride heat-transfer fluids for concentrating solar power applications, Solar Energy, Volume 103, 2014.