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Effect of Silicon Content on the Corrosion Resistance and Radiation-Induced Embrittlement of Materials for Advanced Heavy Liquid Metal Nuclear Systems: Quarterly Progress Report (August 2004 – October 2004)

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Quarterly Progress Report

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Introduction

The purpose of this collaborative research project involving the University of Nevada Las Vegas (UNLV), Los Alamos National Laboratory (LANL) and Idaho State University (ISU) is to evaluate the effect of silicon (Si) content on the corrosion behavior and radiation-induced embrittlement of martensitic stainless steels having chemical compositions similar to that of the modified 9Cr-1Mo steel. Recent studies at LANL involving Alloy EP-823 of different Si content have demonstrated that increased Si content in this alloy may enhance the corrosion resistance in molten lead-bismuth-eutectic (LBE). Since very little data exists in the open literature on the beneficial effect of Si content on the corrosion properties, it seems appropriate to initiate a research project to address this technical issue. This proposal is intended to study the effect of Si content not only on the corrosion resistance but also on the radiation-induced embrittlement of martensitic stainless steels. The susceptibility of these alloys with different Si content to stress corrosion cracking, general corrosion and localized corrosion will be evaluated in the molten LBE and aqueous environments of different pH values using state-of-the-art testing techniques. Testing in the aqueous media is intended to develop baseline data for comparison purpose. Radiation-induced embrittlement of these alloys will initially be studied by irradiating the test specimens with bremmstrahlung gamma radiation from 20-40 MeV electron beams at ISU. These gammas induce (γ, n) reactions in the giant dipole energy region. The principal radiation damage from these irradiations, in turn, stems from the recoiling residual nucleus (with average kinetic energy of approximately 20,000 eV) after the neutrons are emitted. The high penetrability of gammas, whose range is of order one meter in steel, ensures that the resulting damage will be uniform over the volume of the sample. The induced activity of these specimens will have very short half-lives (typically minutes) due the systematics of (slightly) proton-rich nuclei. The resulting radiation-induced hardening can subsequently be evaluated by proper experimental techniques. Later, similar studies can be performed using specimens radiated by neutrons at LANL.

Personnel

The current project participants are listed below.

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Accomplishments

- Four experimental heats of martensitic alloys (similar to Mod9Cr-1Mo) with different Si content (0.5, 1.0, 1.5 and 2.0 weight percent) have been melted by vacuum-induction melting (VIM) practice at the Timken Research Laboratory. These heats are currently being processed by forging and rolling, which will subsequently be thermally treated.

- Literature review on relevant topics is in progress.

Problem

No problems are anticipated.

Status of Funds

Expenditures incurred during this quarter are within the target amount allocated.

Plans for the Next Quarter

- Machine different types of specimens for metallurgical and corrosion studies

- Initiate testing

- Continue literature search