CONF-840411--23

NOTICE

THIS REPORT IS ILLEGIBLE [illegible] THAT PRECLUDES [illegible] REPRODUCTION

MASS TRANSFER KINETICS IN LITHIUM-STAINLESS STEEL SYSTEMS

Austenitic stainless steels have been studied using lithium thermal-convection loops that allow periodic specimen examination without significantly disrupting the lithium flow. Weight change measurements were made as a function of exposure time to characterize the reaction kinetics of both the dissolution and deposition processes. A power curve law was found to accurately describe the weight loss and gain behavior over the entire exposure interval whereas both power curve and straight line fits adequately reflected the weight changes as a function of time at longer exposures. However, weight changes ultimately approached a steady state, in which the dissolution and deposition rates are constant (that is, the weight changes were linearly proportional to exposure time). An Arrhenius analysis of the dissolution rates from a loop experiment in which the maximum loop temperature was varied while the ΔT remained fixed yielded an apparent activation energy consistent with a phase boundary reaction as the rate determining step. Determination of steady-state deposition rates for the long-term loop experiments showed that the maximum rate of weight gain was generally not at the minimum temperature specimen position.

INTRODUCTION

1. Because of the possible applications of liquid lithium in fusion technology, there has been a renewal of interest in corrosion by this molten metal. This interest arose from the fact that corrosion and corresponding mass transfer effects can be a critical element in the use of molten lithium as a tritium breeding fluid and/or coolant in fusion reactors. The lithium corrosion studies done in response to these possible fusion applications have mainly concentrated on ferrous alloys in static and flowing environments at 400 to 700°C and were recently reviewed (refs. 1,2). Earlier studies with lithium-ferrous alloy systems (ref. 3) were generally conducted at higher temperatures with poorer control (and understanding) of impurity effects.

2. In this paper, further results on the mass transfer of type 316 stainless steel in purified, thermally convective lithium are presented in terms of weight change measurements as a function of time and temperature using data from several loop experiments. These data are then analyzed and compared to prior results to characterize the kinetic nature of the dissolution and deposition processes. If excessive, such reactions can lead not only to significant wall thinning and/or loss of mechanical integrity by dissolution, but also to severe flow restrictions and concentrated radionuclide accumulation outside the reactor core structure.

CONF-840411--23

DE84 015365

MASTER

EXPERIMENTAL PROCEDURES

3. The corrosion results presented below were obtained using lithium thermal convection loops of the type shown schematically in Fig. 1. The

Research sponsored by the Office of Fusion Energy, U.S. Department of Energy under contract W-7405-eng-26 with the Union Carbide Corporation.