HYDRIDE PRODUCTION IN ZIRCALOY-4 AS A FUNCTION OF TIME AND TEMPERATURE

A Thesis

by

ADAM JOSEPH PARKISON

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2008

Major Subject: Nuclear Engineering

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Approved by:

Chair of Committee,	Sean McDeavitt
Committee Members,	Lin Shao
	Haiyan Wang
Head of Department,	Raymond Juzaitis

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ABSTRACT

Hydride Production in Zircaloy-4 as a Function of Time and Temperature. (May 2008)

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Chair of Advisory Committee: Dr. Sean M. McDeavitt

The experiments performed for this thesis were designed to define the primary process variables of time, temperature, and atmosphere for an engineering system that will produce metal powder from recycled nuclear fuel cladding. The proposed system will hydride and mill Zircaloy cladding tubes to produce fine hydride powder and then dehydride the powder to produce metal; this thesis is focused on the hydride formation reaction. These experiments were performed by hydriding nuclear grade Zircaloy-4 tubes under flowing argon-5% hydrogen for various times and temperatures. The result of these experiments is a correlation which relates the rate of zirconium hydride formation to the process temperature. This correlation may now be used to design a method to efficiently produce zirconium hydride powder.

It was observed that it is much more effective to hydride the Zircaloy-4 tubes at temperatures below the α-β-δ eutectoid temperature of 540°C. These samples tended to readily disassemble during the hydride formation reaction and were easily ground to powder. Hydrogen pickup was faster above this temperature but the samples were generally tougher and it was difficult to pulverize them into powder.

DEDICATION

This thesis is dedicated to my parents, Scott and Melanie Parkison, as well as my brothers, Brian and Alex Parkison.

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NOMENCLATURE

BCC	Body Centered Cubic
FCCI	Fuel-Cladding Chemical Interaction
HCP	Hexagonal Close-Packed
RTV	Room Temperature Vulcanizing
SCFH	Standard Cubic Feet per Hour
TRU	TRansUranic
UHP	Ultra High Purity
VAC	Volts Alternating Current
XRD	X-Ray Diffraction

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