Energy Production Processes in Deuterated Metals: Volume 1

Product ID: TR-107843-V1
Date Published: 6/30/1998
File size: 7.19 MB
Sector Name: Nuclear
Document Type: Technical Report
File Type: Adobe PDF (.pdf)

Full list price: No Charge

This Product is publicly available.

Download

Abstract

EPRI sponsored an experimental program to investigate the idea that heat, and possibly nuclear products, could be created electrolytically in palladium lattices. Observations using high precision mass flow calorimetry revealed that excess heat could be produced in electrochemical cells with palladium cathodes and a heavy water electrolyte in a more or less reproducible manner, when a number of criteria were satisfied. This excess heat generated is far too large to be a chemical or metallurgical transformation. By inference, a nuclear reaction of some as yet undetermined nature is the hypothesized heat source. This report details the observation of excess powers documented in calorimetry experiments.

Background

Palladium (Pd) cathodes electrochemically charged with deuterium (D) to unusually high D/Pd ratios have exhibited episodes of heat in excess of measured electrical inputs. While investigators have not yet definitively observed nuclear reaction products commensurate with the excess heat, they have detected suggestive evidence of nuclear reactions in the form of helium-4 ((4)He), in the cell vapor space in a few cases.

Objective

To measure, optimize, and control the excess heat produced in highly deuterated Pd cathodes; to measure any signatures of possible nuclear reactions associated with the production of the excess heat.

Approach

The project team designed electrochemical cells within totally closed, precision flow calorimeters equipped with catalytic recombiners of the electrochemically produced D and oxygen gases. These systems were sensitive to excess heat episodes in the range above 50 mW, during inputs ranging from 1-45 W. Approximately 38 separate cells/calorimeters operated for periods of several days to several weeks each, with one cell operating nearly 3 mo. Separately, the team operated 107 open cells to test various procedures for attaining the high cathode D/Pd atomic ratios, believed to be a key condition for obtaining excess heat. They measured loading every few minutes by monitoring the electrical resistance of the cathode relative to its value in the pure metal, which has a known functional dependence with respect to D/Pd ratios. They accomplished loading with a combination of initial low cathode current densities of about 20-50 mA/cm(2), followed by current ramps up to about 1.0 A/cm(2). Current reversals to deload or "strip" the cathodes of D and clean the surface by temporarily making it an anode resulted in high loadings. Lithium deuteroxide was almost always the electrolyte at a concentration of 1.0 mol/l, with occasional additions of 100-200 ppm of aluminum, boron, silicon, or copper.

Results

Four conditions were characteristic of all cells yielding episodes of excess heat: a D/Pd ratio greater than 0.9, initial heat appearance times of 8-23 days, cathodic current densities above 0.1 A/cm(2), and high D fluxes across the cathode surface. Excess powers in the range of 5-30% were observed and measured to an accuracy of about 0.4%. These excess powers integrated to a total of about 0.1 to 1.1 MJ for about 1.0-2.5 g (1/100 to 1/40 mol) Pd cathode. Thus, the excess heats ranged from 4-67 MJ per mol Pd, well above the largest known heats of chemical or metallurgical transformations. (4)He, measured in helium-tight cells designed to exclude atmospheric helium, indicated that this may be the ash of a nuclear reaction heat source. The absence of tritium, neutrons, and (3)He shows this hypothetical nuclear reaction to be something other than the D+D reaction observed in "hot fusion" research (unless the rare reaction pathway producing (4)He has somehow become completely dominant over the two pathways producing tritium and neutrons).

EPRI Perspective

Though the heat-producing phenomena were obtained in only about one-fifth of the cells, this work confirms the claims of Fleischmann, Pons, and Hawkins concerning the production of excess heat in D-loaded Pd cathodes at levels too large to be chemical transformations. Further work on this subject remains to demonstrate which nuclear reactions, if any, are generating the and excess heat. The only way to achieve this is to observe in generally quantitative fashion the nuclear reaction products, or "ashes." At this time, investigators believe that the most likely ashes to be found will be (4)He observable in the vapor phase of closed cells. This study provides information that will be valuable for long-term utility planning concerning potential heat sources that might become available several decades into the future. However, the specific reaction(s) producing the heat and (4)He must be determined to maximize this phenomena for practical uses in the power industry. Related EPRI reports address the "Development of Advanced Concepts for Nuclear Processes in Deuterated Metals" (TR-104195) and Cavitation-Induced Excess Heat in Deuterated Metals (TR-108474). Also available are "Proceedings: Fourth International Conference on Cold Fusion" (TR-104188, Vols. 1-4).

Program

2005 Program 041.0 Nuclear Power

History

2004 Program 041.0 Nuclear Power
2003 Program 041.0 Nuclear Power
2002 Program 041.0 Nuclear Power
2001 Program 041.0 Nuclear Power
2000 Program 031.0 Nuclear Power
1999 Program 088.0 Nuclear Power
1998 Program 047 NUCLEAR POWER FULL GROUP PURCHASE
1997 Program T3000 Nuclear Power Full Group Purchase
1997 Program T3004 Advanced Nuclear Technology

Keywords

Palladium
Electrochemical Cells
Deuterium
Nuclear Reactions
Calorimetry
Helium

Other Keywords

Palladium Lattices
Deuterated Palladium Cathodes

Report

TR-107843-V1

Note

For further information about EPRI, call the EPRI Customer Assistance Center at (800) 313-3774 or email askepri@epri.com

Direct URL

http://my.epri.com/portal/server.pt?Abstract_id=TR-107843-V1