THERMAL DEGRADATION RATE OF ELECTRODE MATERIAL FOR THE ALKALI METAL ENERGY CONVERTER

By

SIEW CHOO SOON

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

February 2005

Dedicated to

My wife, Soon Lan and
my beloved children,
Jia Ning, Jia Yun
and Yang Jun

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in partial fulfillment of the requirement for the degree of Master of Science

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February 2005

Chairman: Associate Professor Mohibullah, PhD

Faculty: Engineering

Alkali Metal Energy Converter, which is commonly referred to Alkali Metal Thermal To Electric Converter (AMTEC), was investigated for its use as a potential power supply unit in future space mission, for example, the Pluto Express Mission.

In this study, the degradation rate of different electrode materials used in AMTEC was examined under different hot side temperatures. The data were analyzed, using a Fortran command statements simulation program. Simulation studies carried out on Titanium Nitrate (TiN), Rhodium Tungsten (RhW) and Rh_2W electrodes for power output and conversion efficiency degradation over an operating period of 15 years, as recommended by space mission for Pluto. Simulations were also carried to test the performance of the electrodes for maximum power output and efficiency at both normal and maximum operating temperature at 1100 and 2000 Kelvin, respectively. The optimum power output

was in the range of 16W ~17W for the 3 types of electrode. The results obtained with these 3 new electrode materials agree with results of other researchers.

The solar thermal heat is proposed as the heat source of thermal energy input to the AMTEC as it is renewable and available for space applications.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KADAR PENURUNAN TERMO GRED BAHAN ELEKTROD PENUKAR TENAGA LOGAM ALKALI

Oleh

SIEW CHOO SOON

Februari 2005

Pengerusi: Profesor Madya Mohibullah, PhD

Fakulti: Kejuruteraan

Penukar Tenaga Logam Alkali yang lebih biasa dirujuk sebagai Penukar Logam Alkali Termo ke Elektrik (AMTEC) telah dikaji untuk potensi kegunaannya sebagai pembekal kuasa dalam misi angkasa lepas masa hadapan seperti misi Pluto Ekspres.

Dalam pengajian ini, kadar penurunan gred bahan-bahan elektrod AMTEC yang berlainan telah diperiksa di bawah masukan suhu yang berlainan. Data-data telah dianalisa dengan menggunakan program simulasi yang berasaskan bahasa Fortran. Simulasi telah dijalankan pada elektrod-elektrod yang bernama Titanium Nitrat (TiN), Rodium Tungsten (RhW) dan Rh_2W untuk kadar penurunan hasil kuasa dan kecekapan penukaran dalam jangka masa operasi selama 15 tahun yang mana telah dicadangkan oleh misi ke Pluto. Simulasi juga telah dijalankan untuk menguji prestasi elektrod-elektrod untuk hasil kuasa dan kecekapan yang maksimum di bawah kedua-dua suhu

operasi biasa dan maksimum iaitu 1100 dan 2000 Kelvin. Hasil kuasa maksimum adalah di antara 16W hingga 17W untuk ketiga-tiga jenis elektrod. Keputusan-keputusan yang diperolehi adalah bersetuju dengan keputusan-keputusan kerja-kerja penyelidik sebelum ini.

Pemanasan suria termo telah dicadangkan sebagai punca masukan tenaga termo kepada AMTEC disebabkan sifatnya yang boleh diperbaharui dan boleh didapati untuk applikasi angkasa lepas.

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I certify that an Examination Committee met on date of viva on_____to conduct the final examination of Siew Choo Soon on his Master of Science thesis entitled "Thermal Degradation Rate of Electrode Material for the Alkali Metal Energy Converter" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

SIEW CHOO SOON

Date:

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