"Computer Modeling and Burnup Analysis in Light Water Nuclear Reactors"

Presented by

Basma Mahmoud Mohammed Fouad

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to
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"نمذجة بالحاسب الآلي و تحليل إحتراق الوقود في مفاعلات الماء الخفيف"

إعداد

بسمة محمود محمد فؤاد

رسالة مقدمة

إلي

كلية العلوم

كجزء من متطلبات الحصول علي درجة

الماجيستير

(الفيزياء النووية)

قسم الفيزياء

كلية العلوم

جامعة القاهرة

(**2010**)

المستخلص

أسم الطالب: بسمة محمود محمد فؤاد

عنوان الرسالة : "نمذجة بالحاسب الآلي و تحليل إحتراق الوقود في مفاعلات الماء الخفيف"

الدرجة : ماجيستير فى الفيزياء

الغرض من هذه الرسالة هى دراسة سلوك وقود الثوريوم/ يورانيوم المتباين فى مفاعلات الماء الخفيف المضغوط. تهدف هذه الرسالة الى دراسة التحليلات النيوترونية و الأحتراق لوقود الثوريوم/ يورانيوم باستخدام برنامجى الحاسب الألى MCNPX , WIMS-D5 . يعتمد تصميم المفاعل على نموذج يسمى بالوحدات المتكاملة للبذرة و الغطاء بحيث تشغل وحدات البذرة المحتوية على وقود اليورانيوم و وحدات الغطاء المحتوية على وقود الثوريوم/يورانيوم الحجم الكلى لقلب مفاعلات الماء الخفيف المضغوط و المصممة على شكل لوحة شطرنج. وقد وجدت تطابقات مرضية بين نتائج النموذج الحالى و نتائج حالات قياسية متماثله.

توقيع السادة المشرفون:

أ. د هشام محمد محمد منصور

أ. د مصطفى عزيز عبد الوهاب

أ.د. جمال عبد الناصر

رئيس مجلس قسم الفيزياء

كلية العلوم – جامعة القاهرة

ABSTRACT

Student Name: **Basma Mahmoud Mohammed Fouad**

Title of the thesis: **Computer Modeling and Burnup Analysis in Light Water Nuclear Reactors**

Degree: **Master of Science**

The purpose of this thesis is to study the feasibility of the Thorium/Uranium fuel cycle in heterogeneous Pressurized Water Reactors (PWR) core design. This thesis focuses on the neutronic and burnup analysis of the Thorium/Uranium fuel using the computer codes MCNPX and WIMS-D5. The design is based on the Whole Assembly Seed and Blanket (WASB) concept, in which the individual seed (Uranium) and blanket (Thorium-Uranium) units occupy one full-size PWR assembly in a checkerboard core configuration. The results of the present models are compared with the solution of the benchmark problems. Satisfactory agreement is obtained.

Keywords: Thorium Fuel cycle, Whole Assembly Seed and Blanket, Neutronic calculations

Supervisors: Signature:

1- **Prof. Dr. Hesham Mohammed Mansour**

2- **Prof. Dr. Moustafa Aziz Abd El Wahab**

Prof. Dr. Gamal Abd El Naser

Chairman of Physics Department
Faculty of Science- Cairo University

APROVAL SHEET FOR SUMISSION

Thesis Title: **Computer Modeling and Burnup Analysis in Light Water Nuclear Reactors**

Name of candidate: **Basma Mahmoud Mohammed Fouad**

This thesis has been approved for submission by the supervisors:

1- Prof. Dr. Hesham Mohammed Mansour

Signature:

2- Prof. Dr. Moustafa Aziz Abd El Wahab

Signature:

Prof. Dr. Gamal Abd El Naser

Chairman of Physics Department
Faculty of Science- Cairo University

Cairo University
Faculty of Science

To WHOM IT MAY CONCERN

This is to certify that: Basma Mahmoud Mohamed Foad

Has attended and passed successfully the following postgraduate Courses as a partial Fulfillment of the requirements of the degree of Master of Science:

1. **Advanced Quantum mechanics,**
2. **Group Theory,**
3. **Quantum Field Theory,**
4. **Theories of Nuclear interactions,**
5. **Molecular Spectroscopy,**
6. **Statistical and electrodynamics**

This certificate is issued at his own request.

Date of birth: 15/10/1981
Place of birth: El-Sharkya

Controller

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LIST OF ABBREVIATIONS

AGR	Advanced Gas Cooled Reactor
ANL	Argonne National Laboratory
B_d	Burnup duration
BNL	Brookhaven National Laboratory
BOL	Beginning Of Life
BWR	Boiling Water Reactor
CANDU	Canada Deuterium-Uranium Reactor
CASMO-4	A multigroup transport code for burnup calculations
DOE	Department of Energy
FBR	Fast Breeding Reactor
HTGR	High Temperature Gas Cooled Reactor
IAEA	International Atomic Energy Agency
INEEL	Idaho National Engineering and Environmental Laboratory
K_{eff}	Effective multiplication factor
KTF	Kyung-hee Thorium Fuel
LMFBR	Liquid Metal cooled Fast Breeding Reactor
LWR	Light Water Reactor
LWBR	Light Water Breeding Reactor
MA	Minor Actinides
MCNP	Monte Carlo N-Particle Transport Code System
MCODE	(MCNP + ORIGEN)
MOCUP	(MCNP4B + ORIGEN2)
MIT	Massachusetts Institute of Technology
MEU	Medium Enriched uranium

MSBR	Molten Salt Breeder Reactor
MTR	Material Testing Reactor
MWd/KgHM	Mega watt Day per kilogram of Heavy Metal
NERI	Nuclear Energy Research Initiative
ORIGEN	Oak Ridge Isotope Generation and Depletion Code
PHWR	Pressurized Heavy Water Reactor
PWR	Pressurized Water Reactor
RBMK	Light Water Graphite Reactor
RTF	Radkowsky Thorium Fuel
SBU	Seed and Blanket Unit
THOREX	Thorium-uranium Extraction process
UK	United Kingdom of Great Britain and Northern Ireland
USA	United States of America
VVER	Russian designed Pressurized Heavy Water Reactor
WASB	Whole Assembly Seed and Blanket
WIMS-D5	Winfrith Improved Multigroup Scheme Code System
W/o or Wt%	Weight percent