

***“Computer Modeling and Burnup Analysis in
Light Water Nuclear Reactors”***

Presented by

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"نمذجة بالحاسب الآلي و تحليل متراق الوقت في مفاعلات الماء الخفيفة"

إعداد

بسمه محمود محمد فؤاد

رسالة مقدمة

إلى

كلية العلوم

كجزء من متطلبات الحصول على درجة

الماجستير

(الفيزياء النووية)

قسم الفيزياء

كلية العلوم

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المستخلص

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عنوان الرسالة : "نمذجة بلعاصب الألي و تحليل إحتراق الوقود في مفاعلات الماء الخفيف"
الدرجة : ماجستير في الفيزياء

الغرض من هذه الرسالة هي دراسة سلوك وقود الثوريوم/يورانيوم المتباين في مفاعلات الماء الخفيف المضغوط. تهدف هذه الرسالة الى دراسة التحليلات النيوترونية و الأحتراق لوقود الثوريوم/يورانيوم باستخدام برنامجي الحاسب الألي WIMS-D5 , MCNPX . 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 الكلي لقلب مفاعلات الماء الخفيف المضغوط و المصممة على شكل لوحة شطرنج. وقد وجدت تطابقات مرضية بين نتائج النموذج الحالي و نتائج حالات قياسية متماثلة.

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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

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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