

**DEVELOPMENT OF A METHOD TO MEASURE THE MODERATOR
TEMPERATURE DISTRIBUTION IN A CANDU REACTOR**

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A Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
The University of Michigan, The University of Oklahoma,
and Case Western Reserve University

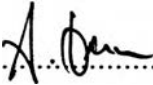
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ISBN 974-334-133-1

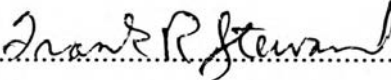
I 19316124

Thesis Title : Development of a Method to Measure the Moderator
Temperature Distribution in a CANDU Reactor
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Accepted by the Petroleum and Petrochemical College, Chulalongkorn University, in partial fulfilment of the requirements for the Degree of Master of Science.


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ABSTRACT

4171017063: PETROCHEMICAL TECHNOLOGY PROGRAM

KEYWORD: CANDU / Temperature/ Distribution/ Moderator

Maytinee Vatanakul: Development of a Method to Measure the Moderator Temperature Distribution in a CANDU Reactor. Thesis Advisors: Prof. Frank R. Steward and Prof. Somchai Osuwan 123 pp ISBN 974-334-133-1

CANDU, Canada Deuterium Uranium, represents the power reactor system using natural uranium as a fuel, and heavy water as a coolant and a moderator of the reactor. The moderator is used to slow neutrons to increase fission probability in the fuel, and act as a heat sink for reactor accident situation. Due to irradiative heating of any material present, the measurement of the temperature ability in reactor operation is difficult. The Vertical Flux Detector assembly (VFD) could be used to measure the moderator temperature. The experiments were carried out to determine the heat transfer characteristics of the VFD by using the test cell duplicated from a small section of the VFD with electrical heating to simulate the irradiative heating in the reactor core. A number of parameters were analyzed to determine their effects on the measurement technique. A numerical calculation using FLUENT was applied to determine the temperature profile in the VFD correlated with its heat transport characteristics. It was found that the temperature difference between the moderator and the positions in the detector wells of the electrical heaters was directly proportional to the internal heat generation rate. The temperature distribution along the detector wells could be used to determine the irradiative heating in the station reactor moderator.

บทคัดย่อ

เมทินี วัฒนะกุล : การพัฒนาวิธีการวัดค่าการกระจายอุณหภูมิของโมเดอเรเตอร์ในเตาปฏิกรณ์ปรมาณูแคนดู (Development of a Method to Measure the Moderator Temperature Distribution in a CANDU Reactor) อ. ที่ปรึกษา : ศาสตราจารย์ ดร. แฟรงค์ อาร์ สจิวัด (Prof. Frank R. Steward) และ ศาสตราจารย์ ดร. สมชาย โอสุวรรณ 123 หน้า ISBN 974-334-133-1

แคนดู (CANDU) หรือแคนาดา ดิวทีเรียม ยูเรเนียม (Canada Deuterium Uranium) เป็นเตาปฏิกรณ์ปรมาณูสำหรับผลิตกระแสไฟฟ้าโดยใช้ยูเรเนียมธรรมชาติเป็นเชื้อเพลิง ใช้ดิวทีเรียมเป็นสารหล่อเย็นและใช้เป็นโมเดอเรเตอร์ (Moderator) ด้วย โมเดอเรเตอร์คือส่วนประกอบสำคัญทำหน้าที่ชะลอการเคลื่อนตัวของนิวตรอนเพื่อเพิ่มอัตราการเกิดปฏิกิริยาฟิชชัน และช่วยถ่ายโอนความร้อนเมื่อระบบของเตาปฏิกรณ์ไม่สามารถทำงานได้ตามปกติ การวัดค่าอุณหภูมิขณะที่เตาปฏิกรณ์กำลังทำงานทำได้ยากเนื่องจากมีความร้อนจากกัมมันตภาพรังสีปริมาณสูง จึงได้มีการนำเครื่องเวดดิเคิลฟลักซ์ดีเทกเตอร์ (Vertical Flux Detector) หรือวีเอฟดี (VFD) มาใช้ในการวัดค่าอุณหภูมิของโมเดอเรเตอร์ การดำเนินการทดลองนี้เพื่อศึกษาลักษณะการถ่ายโอนความร้อนของวีเอฟดีโดยใช้เครื่องมือชื่อเทสเซล (Test Cell) ซึ่งเป็นแบบจำลองจากส่วนของวีเอฟดีโดยการประยุกต์ใช้ความร้อนจากกระแสไฟฟ้าแทนความร้อนจากกัมมันตภาพรังสีภายในเตาปฏิกรณ์ ควบคู่ไปกับการวิเคราะห์ผลของตัวแปรจำนวนหนึ่งที่มีต่อวิธีการวัดค่าอุณหภูมิ การคำนวณโดยโปรแกรมฟลูเอน (FLUENT) เพื่อศึกษาการกระจายอุณหภูมิภายในวีเอฟดีเปรียบเทียบกับลักษณะการถ่ายโอนความร้อนของวีเอฟดี การทดลองแสดงให้เห็นว่าการเปลี่ยนแปลงอุณหภูมิของโมเดอเรเตอร์เมื่อเปรียบเทียบกับอุณหภูมิภายในช่องตรวจวัด (Detector Wells) เพิ่มขึ้นเป็นสัดส่วนโดยตรงกับอัตราการเกิดความร้อน และการกระจายอุณหภูมิของช่องตรวจวัดสามารถใช้ในการศึกษาหาค่าความร้อนของการแผ่รังสีภายในโมเดอเรเตอร์ของเตาปฏิกรณ์ในโรงงานผลิตกระแสไฟฟ้าได้

ACKNOWLEDGEMENTS

From the deepest of my heart, I would like to acknowledge all the help and trust that I have received during my years in Thailand and Canada.

First, I would like to express my graceful thank to Prof. Frank R. Steward, my advisor, for his endless help and guidance in all phases of my work. His suggestions were very valuable and appreciated. I also would like to thank his family for their warm concern since my first day in Canada.

I would like to express my gratitude to Prof. Somchai Osuwan, my Thai advisor, who supported me many valuable suggestions and gave me the precious chance doing my thesis in Canada. Thank Dr. Thirasak Rirksomboon for his useful information and his time for discussing and correcting my work.

I would like to express my special thanks to David Rouison, Elizabet Cruz, and Savaluxs Supa-amornkul, the special friends of mine, for their valuable help, understanding care and hospitality made my visit to Canada enjoyable.

My thanks are also extended to all the CNER staff, all of my friends in Canada and all of my friends in Thailand for their assistance and friendliness.

Finally, I would like to sincerely thank my family who loves and faithfully encourages me throughout my education.

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