報　告

Educational Activities in the Academic Year 2018

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1．Introduction

The first operation of UTR-KINKI for education and training in the academic year 2018（April 1, 2018 – March 31, 2019）was conducted on April 19, and many others were supposed to follow. In early June, however, we found the malfunction of a motor to drive the regulating rod of UTR-KINKI. The investigation on the motor showed that it needed to be replaced with a new one, and the replacement took several months including regulatory procedures.

We immediately started a preparation for alternative educational programs for students such as reactor physics experiments by using fuels and a start-up neutron source without operating UTR-KINKI, but in late August the Nuclear Regulation Authority（NRA）presented a negative view of using the reactor facility with the malfunctioned regulating rod with or without reactor operation. As a result, we had to give up to conduct all the educational programs with the reactor facility in the academic year 2018.

We applied to NRA to obtain "approval of the design and construction method" for the replacement of the motor in October, which was approved in January 2019. Then the motor was replaced with a new one, and a pre-service inspection was conducted by NRA in February 2019. The certificate of the pre-service inspection was issued in the same month.

2．Higher Education

2．1　Kindai University's Curriculum

UTR-KINKI is used for one of the compulsory subjects "Energy and Environment Experiment" in the curriculum of Energy and Environment Course, Department of Electric and Electronic Engineering, Faculty of Science and Engineering. The subject is offered in the second half of an academic year and includes a lecture on nuclear reactors, facility tour of UTR-KINKI, reactor operation and neutron radiography. Since the reactor was not available in the academic year 2018, neutron measurement with a He-3 counter, X-ray radiography and gamma-ray shielding experiment were offered as substitutes for the original contents.

2．2　Programs for Other Universities

Seven universities were supposed to use UTR-KINKI for nuclear engineering students in the academic year 2018, but all the programs were canceled. Tokyo Metropolitan University only held a workshop without a reactor operation for medical physics students, in which nine students experienced neutron measurement with a BF_3 counter and thermal neutron flux measurement by gold foil activation with a start-up Pu-Be neutron source.

2．3 MEXT International Nuclear Human Resource Development Initiative Program

Kindai University received a funding for a three-year educational program (AY2016-2018) from International Nuclear Human Resource Development Program by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The title of the program is "International Workshop Utilizing Educational Nuclear Reactors in Japan and Korea" . The academic year 2018 was the final year of the program, and the following programs were offered for eight member universities (Kindai University, Kyoto University, Kyushu University, Nagoya University, University of Fukui, Tokyo City University, Tokai University and Kyung Hee University).

(1) Nuclear Energy Workshop (Basic):

The nuclear energy workshop (basic) consists of basic level experiments on reactor physics and radiation measurement using UTR-KINKI. Six workshops were planned under this program, but all the workshops were cancelled because the reactor was not available.

(2) Nuclear Energy Workshop (Advanced):

The nuclear energy workshop (advanced) is a four-day program which consists of rather professional reactor physics experiments using UTR-KINKI and a seminar to develop academic presentation skills in English. The workshop was planned in November, but it was also canceled because the reactor was not available.

(3) Reactor Experiment Program at Kyung-Hee University

This workshop is a four-day program in which students experience basic reactor physics experiment using the education-oriented research reactor AGN-201K (rated thermal power: 10 W) of the Reactor Research and Education Center (RREC), Kyung Hee University in Korea. The schedule of the workshop is shown in Table 1. This workshop was originally planned to be held once in summer, but additional one was held in winter since other workshops using UTR-KINKI were cancelled. The first workshop was held from July 3 to 6, and the second was held from November 27 to 30. The number of participating students for the first and second workshop was twelve and fourteen, respectively. All the lectures and experiments were given in English in order to develop the international communication skills of the students through working with Korean professors and students.

Table 1. The schedule of reactor experiment program at Kyung Hee University

day	time		contents
1	AM		Flight from Japan to Incheon International Airport
	13:00		Bus from Incheon International Airport to Kyung Hee University
	15:30	LEC	Opening Ceremony & Introduction to RREC
	16:00	LEC	Safety Instruction & Introduction to AGN-201K　Gold wire loading and irradiation for EXP2
	18:00		Welcome Reception
2	9:00	EXP1	Reactor Operation Practice（search for critical rod position）
	12:00		Lunch
	13:00	EXP2	Thermal Flux Measurement（Neutron Activation Analysis）
	16:00		Preparation of Presentation
3	9:00		Presentation and Discussion for EXP1&2
	10:30	EXP3	Critical Mass Approach（1/M Experiment）
	13:00		Lunch
	14:00	EXP4	Temperature Feedback and Reflector Effect Measurement
	17:00		Preparation of Presentation
4	9:00		Presentation and Discussion for EXP3&4
	10:00		Wrap-up Session
	11:00		Campus Tour and Lunch
	15:00		Bus from Kyung Hee University to Incheon International Airport
	17:00		Flight from Incheon International Airport to Japan

3．Secondary Education

3．1　Training Workshop for Teachers

Science teachers learned radioactivity measurement for food inspections.

Training workshop for teachers began in 1987 and has been continued for more than thirty years. The aim of the workshop is to provide teachers with scientifically correct knowledge on nuclear science and technology through experiencing experiments on a real nuclear reactor and radiation measurements. Though the reactor was not available in the academic year 2018, five workshops were held in summer with alternative contents. The summary of the workshops is shown in Table 2. The schedule and contents of the workshops were shown in Table 3, 4 and 5.

Table 2. Summary of training workshop for teachers held in the academic year 2018.

No	workshop	date	participants
1	Training workshop for science teachers（co-hosted by KAC）	July 30-31	13
2	Training workshop for science teachers（co-hosted by JAIF）	August 1-2	15
3	Workshop for teaching license renewal（hosted by Kindai University）	August 5-6	20
4	Training workshop for science teachers（co-hosted by JAIF）	August 21-22	14
5	Training workshop for science teachers（co-hosted by KAC）	August 23-24	11
	total		73

KAC: Kansai Atomic Conference, JAIF: Japan Atomic Industrial Forum

Table 3. The schedule of training workshop for science teachers（co-hosted by JAIF）.

day	time		contents
1	12:00		Opening Ceremony（15 min）
	12:15	LEC	Safety Instruction（30 min）+ Break（10 min）
	12:55	LEC	Tour to UTR-KINKI（45 min）+ Break（10 min）
	13:50	LEC	Nuclear Reactor Basics（60 min）+Break（10 min）
	15:00	EXP	Measurement of Radioactivity in Food（90 min）
	16:30	EXP	X-ray Radiography（60 min）
	17:30		Free Discussion（60 min）
2	9:30	LEC	Radiation Basics（60 min）+ Break（10 min）
	10:40	EXP	Environmental Radiation Measurement（90 min）
	12:10		Lunch
	13:00	EXP	Nature of Radiation（90 min）+ Break（10 min） （radiation shielding, inverse square law）
	14:40	LEC	Radiation Applications（60 min）+ Break（10 min）
	15:50	LEC	Health Effect of Radiation（60 min）
	16:50		Closing Ceremony（30 min）

Table 4. The schedule of training workshop for science teachers（co-hosted by KAC）.

day	time		contents
1	10:00		Opening Ceremony（15 min）
	10:15	LEC	Radiation Basics（60 min）+ Break（10 min）"
	11:25	LEC	Safety Instruction（30 min）
	11:55		Lunch
	12:45	LEC	Tour to UTR-KINKI（60 min）+ Break（10 min）
	13:55	LEC	Nuclear Reactor Basics（60 min）+ Break（10 min）
	15:05	EXP	Nature of Radiation（90 min）+ Break（10 min） （radiation shielding,inverse square law）
	16:45	EXP	X-ray Radiography（60 min）
	17:45		Free Discussion（45 min）
2	9:30	LEC	Radiation Applications（60 min）+ Break（10 min）
	10:40	EXP	Environmental Radiation Measurement（90 min）
	12:10		Lunch
	13:00	EXP	Measurement of Radioactivity in Food（75 min）+ Break（10 min）
	14:25	LEC	Health Effect of Radiation（60 min）+ Break（10 min）
	15:35		Discussion on Radiation Education（Presentation of practical examples by participating teachers）（70 min）
	16:45		Closing Ceremony（15 min）

Table 5. The schedule of workshop for teaching license renewal.

day	Time		contents
1	9:20		Opening Ceremony（10 min）
	9:30	LEC	Nuclear Reactor Basics（60 min）
	10:30	LEC	Safety Instruction and Tour to UTR-KINKI（60 min）
	11:30		Lunch
	12:40	EXP	Measurement of Radioactivity in Food and Environmental Sample（150 min）
	15:10		Break（20 min）
	15:30	EXP	Neutron Radiography（90 min）
2	9:30	LEC	Radiation Properties and Radiation Applications（60 min）
	10:30	EXP	Radiation Measurement（120 min）
	12:30		Lunch
	13:40	EXP	Cloud Chamber（60 min）
	14:40		Break（10 min）
	14:50	LEC	Health Effect of Radiation（60 min）
	15:50		Break（10 min）
	16:00		Examination（60 min）
	17:00		Closing Ceremony（15 min）

3．2 Workshop for High School Students

Two workshops were held for high school students to encourage young generation to pursue careers in nuclear science and technology. The contents of the workshop included lectures and experiments without using UTR-KINKI because the reactor was not available. The summary of workshop for high school students is shown in Table 6.

Table 6. The summary of the workshops held for high school students.

No.	High School	Date	Students	Contents
1	Kainan Senior High School	November 13-14	40	Safety instruction Environmental radiation measurement Tour of UTR-KINKI Lecture "Principles of Nuclear Reactor" X-ray radiography Measurement of radiation and radioactivity
2	Otemae Senior High School	December 6	13	Safety instruction Tour to UTR-KINKI Radiation measurement Lecture "Radiation basics" Lecture "Nuclear reactor basics" Lecture "Future of nuclear energy and fusion"

4．Other Educational Activities

4．1 New Employee Training

The only educational activity conducted using UTR-KINKI was a two-day workshop for the training of new employees of Chiyoda Technol Corporation, which was held from April 19 to 20. The workshop aimed to give all around knowledge on nuclear reactor and radiation from principles to applications through lectures and experiments. Nineteen trainees participated in the workshop. The schedule of the workshop is shown in Table 7.

Table 7. The schedule of the workshop for new employee training of Chiyoda Technol Corp.

day	Time		contents	
1	13:00		Opening Ceremony (10 min)	
	13:15	LEC	Basic Reactor Physics (60 min)	
	14:15	LEC	Safety Instruction (30 min)	
	14:45	LEC	Tour to UTR-KINKI (45 min)	
	15:30	EXP	(Group A)	(Group B)
			Reactor Operation (120 min)	Neutron Radiography (120 min)
	17:30		Workshop Reception	
2	9:00	LEC	Radiation Basics (60 min)	
	10:00	EXP	(Group A)	(Group B)
			Neutron Radiography (120 min)	Reactor Operation (120 min)
	12:00		Lunch	
	13:00	EXP	Environmental Radiation Measurement (90 min)	
	14:30	EXP	Radiation Properties (radiation shielding, inverse square law) (90 min)	
	16:00	LEC	Health Effect of Radiation (60 min)	
	17:00		Closing Ceremony (15 min)	

4．2　International Seminar

Participants from Asian countries toured UTR-KINKI and experienced experiments and lectures on radiation measurement and applications.

A two-day international seminar was held at Kindai University as part of Instructor Training Program of Nuclear Human Resource Development Center, Japan Atomic Energy Agency (JAEA). Eleven trainees from Asian countries participated in the seminar that included the tour to UTR-KINKI, the measurement of radionuclides in food, X-ray radiography and related lectures. All the lectures and experiments were given in English.

5．Summary

In June 2018, the malfunction of a motor to drive the regulating rod of UTR-KINKI was found, and the operation of the reactor was consequently suspended until the end of the academic year 2018 for the replacement of the motor and regulatory procedures. Since the reactor was not available after June, the planned activities for education and training using UTR-KINKI were canceled or replaced with other contents without operating the reactor. With the aging of the reactor, similar troubles may occur in the future. We need to carry out preventive maintenance systematically and make preparations so that education is not interrupted by unexpected troubles.