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ScienceDirect
Progress in Nuclear Energy 50 (2008) 71–74
PROGRESS IN NUCLEAR ENERGY
An International Review Journal
www.elsevier.com/locate/pnucene

Progress in "COE-INES"

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Abstract

In the year 2002 and 2003, the Japanese Ministry of Education, Culture, Sports, Science and Technology started the " The 21st Century Center of Excellence (COE) Program", which is planned to continue for 5 years. A program proposed by Tokyo Institute of Technology "Innovative Nuclear Energy Systems for Sustainable Development of the World" simply called as COE-INES was selected as only one program in nuclear engineering field. The program consists of four main activities: research, education, society and internationalism. The research will be performed on the innovative nuclear energy systems, which include innovative nuclear reactors and innovative fuel cycles. Both free thinking and overall vision are taken on the research, and stressed on education also. In the education, COE-INES Captainship Program is promoted by integrating research with education, and we will foster creative researchers and engineers. Society is also a very important issue for nuclear energy. We try to coevolve nuclear energy with society and to strive towards the fulfillment of SR as well as to research innovative nuclear energy systems. We believe these ideas are occupied by many scientists in various countries. Then we are promoting the international collaboration for research and education on innovative nuclear energy systems.

Keywords: 21st Century COE Program; COE-INES; Innovative nuclear energy system; Education; Society; Internationalism

1. Introduction

In the year 2002 and 2003 in Japan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) started the "Priority Assistance for the Formation of Worldwide Renowned Centres of Research – The 21st Century Centre of Excellence (COE) Program." This program is based on the competitive principle that selection for support by the program relies on third party evaluation, and by giving priority support to the formation of world-class centres of research it aims to promote the creation of internationally competitive universities that answer to the world's highest standards. The Ministry makes a selection from proposals sent by universities from all over Japan for the formation of centres of research and education on a graduate school specialization level. From 10 fields of study covering medical science to social science, 246 centres were selected from a total of 1075 applications. Each proposal adopted as a COE receives support for 5 years to form a research base at the highest level in the world.

Half a century has passed since peaceful use of nuclear energy began. Recently, international cooperative activities, such as Generation IV International Forum (GIF) and Global Nuclear Energy Partnership (GNEP) initiated by USA and International Project of Innovative Nuclear Reactors and Fuel Cycles (INPRO) initiated by IAEA, have increased to search for a next generation of innovative reactors.

More than 10 years ago at Tokyo Institute of Technology (Tokyo Tech), and long before these latest activities, a systematic research was started towards "Construction of Self-Consistent Nuclear Energy Systems". This research led to our intensive studies in separation and transmutation of radioactive wastes, small reactors, and lead–bismuth and carbon-dioxide cooling. It has also promoted intensive international collaborations.

A program proposed by Tokyo Tech "Innovative Nuclear Energy Systems for Sustainable Development of the World (COE-INES)" was selected as the only one program in nuclear engineering field (Sekimoto, 2005a). The objective is to establish a centre for creative research and education, social relations promotion, and international collaboration. This program is planned to continue for 5 years as already mentioned,

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0149-1970/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.pnucene.2007.10.008

and the monetary supports are 196M yens, 156M yens, 159M yens and 159M yens for the fiscal years (2003–2004), (2004–2005), (2005–2006), (2006–2007), respectively. Guiding the COE-INES program are research, education, society and internationalism as shown in Fig. 1.

2. Research

Nuclear energy development is sluggish because it has triggered social unrest by repeated accidents. Clearly, however, it has great potential in the future as a source of energy. To break the present deadlock and fully realize this potential, we must conduct lively research and education activities. Nuclear energy involves a wide variety of research areas. In the COE-INES program, these areas are grouped into two parts, i.e., nuclear reactors and the fuel cycle supporting them. We have considered that it is suitable for the university to study the frontiers of each of these areas. As shown in Fig. 2, we have decided to focus our studies on innovative nuclear reactors embodied as research on nuclear reactors, and innovative research in separation and transmutation aiming towards zero release of radioactive wastes as research on fuel cycle.

An example of an innovative nuclear energy system to be pursued in the COE-INES is shown in Fig. 3. We imagine a nuclear energy park, within which radioactive wastes are subjected to separation and transmutation. Innovative separation and nuclear transmutation with micro- or nano-technologies will be conducted here, aiming at reducing the toxicity associated with material taken out of the park to a level less than the toxicity associated with material brought into the park.

It is desirable that the number of such parks is kept as small as possible. Nuclear energy is used by bringing small, long-life reactors manufactured here into relevant sites. If fuel is contained in the nuclear reactor without refueling, resistance to nuclear proliferation and safety will be greatly increased. We expect that this system will be particularly valuable in the future, when a large quantity of energy will be consumed in developing countries. To realize this scenario, the development of a small long-life reactor is inevitable. However, small long-life reactor requires high neutron economy, and high neutron economy is also very important to make support factor of small reactors by a central reactor large enough.

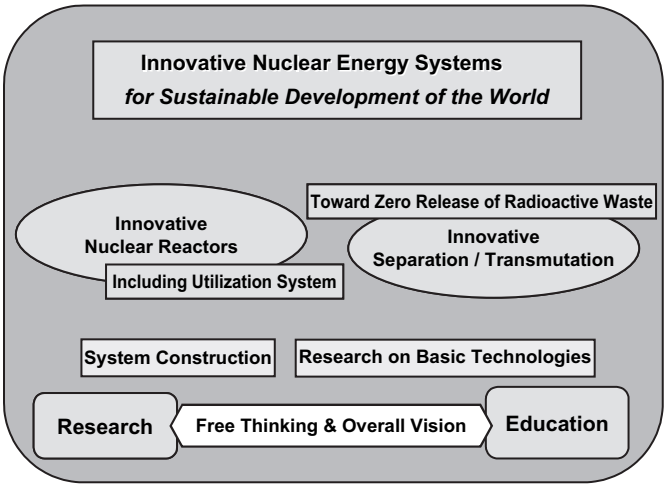

Fig. 2. Structure of COE-INES research and education.

A safe simple nuclear energy system without fuel enrichment and reprocessing (CANDLE) (Sekimoto, 2005b), denatured plutonium protected for proliferation (P^3), and other research programs are also promoted.

In the COE-INES program, research into nuclear energy will be pursued by viewing the current situation from the viewpoint of an ideal target. This viewpoint will enhance the possibility of discovering truly innovative technologies, as well as providing great opportunities for cultivating free thinking and overall vision.

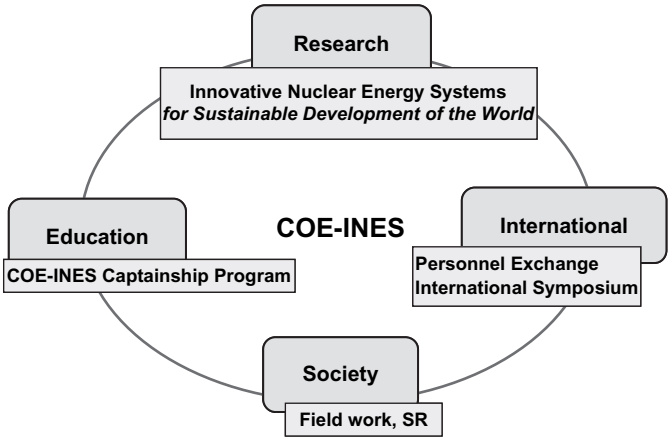

Fig. 1. Four pillars of COE-INES program.

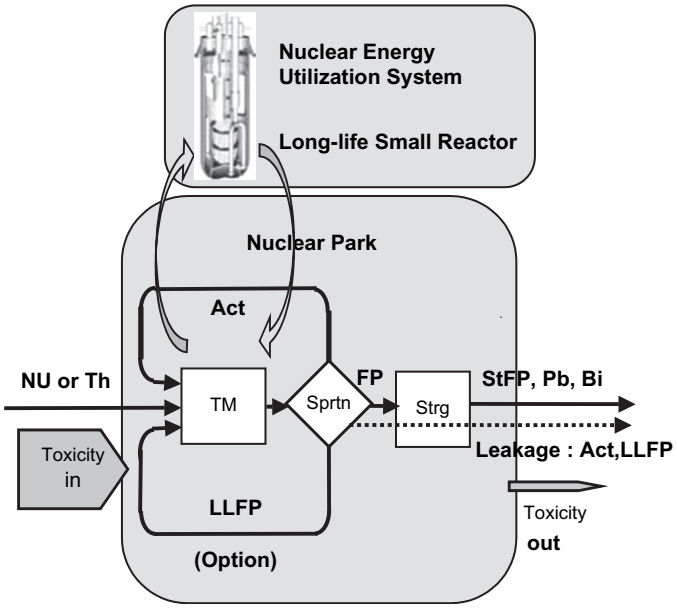

Fig. 3. Equilibrium nuclear system in the future. TM, transmutation; Sprtn, separation; Strg, storage; NU, natural uranium; Act, actinide; FP, fission product; StFP, stable fission product; LLFP, long-life fission product.