2-4. Safety Management in Fusion Facilities and Environment

Researches and developments on the safety and environment are the major issues for fusion facilities. The variety of issues should be surveyed not only in the field of radiation safety management and radiation protection but also in the field of general safety science, health and environment. Topics of these activities during FY 2012 are summarized below. And it should be pointed out that some of these scientific investigations have been successfully carried out as collaboration with researchers of many universities, research institutes and companies.

(i) Hydrogen isotope separation and removal technology

Tritium treatment is a main issue for fusion facilities. Isotope separation is one of key technologies for the fueling cycle, tritium decontamination, and tritium removal from exhaust to keep environmental safety. To evaluate the hydrogen isotope retention in the fusion device is also important issue from viewpoint of fuel control and safety. Many researches and developments are carried out by the collaboration with many universities. The research in the multi-column pressure swing adsorption system was carried out by Kyushu University. The new apparatus has been made to give a contribution to the R & D project of DT fuel cycle for the FFHR, with valuable results from experiments of continuous hydrogen isotope separation. The research in the proton conducting oxide for the hydrogen isotope separation and sensing was carried out by IFRC in Kyushu University. The existence of the suitable combination of the proton-conducting base oxide and transition metals was revealed experimentally. The research in the hydrogen isotope separation on poresize-controlled mesoporous materials was carried out by HIRC in University of Toyama. The effect of silanol on the tritium adsorption ability has been investigated. The research in the regeneration of honeycomb type synthetic Zeolite by the μ-wave was carried out by NIFS. It was found that the dielectric heating by the μ-wave was more effective than the magnetic field heating.

(ii) Tritium recovering and fuel cycle

One of the critical issues for nuclear fusion reactors is tritium and tritiated carbon recovering in the reactor building. Instead of present method, using metal catalyst, plasma combustion method in an atmospheric pressure has been investigated by Nagano National College of Technology. By this method, hydrogen and oxygen radicals are easily generated by high-energy electron and ion impacts in the plasma. Good hydrogen conversion efficiency over 80% at 100W input μ-wave power was achieved.

To reduce tritium inventory in the fusion facilities is a key issue for economy and for tritium safety. For this purpose, concept of simplified fuel cycle system adapting the cryogenic engineering was proposed for a helical-type fusion reactor by NIFS.

(iii) Biological effect of low level tritium radiation and safety strategy

Although tritium is a radioactive hydrogen isotope, maximum emitting energy of beta particle is 18.6 keV and it is obstructed at skin surface. To estimate the low level tritium risk, following three items have been investigated by the collaboration represented by Dr. M. Sasatani (RIRBM, Hiroshima University): i) analysis of biological effects of tritium by using genetically engineered animal model, ii) analysis of the biological effects of tritium by using culture cell line, iii) analysis of the molecular mechanism of tritium radiation-induced DNA damage response.

Discussion items for optimization on radioactive discharges from facilities using radioactive materials were listed up in order to establish safety strategy by the University of Tokyo. In Japan, the Environment Basic Law was revised after the accident of the Fukushima Dai-ichi nuclear power reactor. After that, exclusion of application on measures for prevention of environmental contamination of radioactive materials, the Atmospheric Pollution Prevention Act and the Water Pollution Prevention Act were revised in June of 2013. Environmental assessment on radiation was also requested by the related act and discussion on concrete measure on the assessment has just been started. The purpose of regulatory control of radioactive discharges should be more clearly defined.

(Nishimura, K.)

List of Reports

1. “Design Problems of Cryogenic Pressure Swing Adsorption System for Hydrogen Isotope Separation in Fusion Fuel Cycle”, Kotoh, K. (Fac. Eng., Kyushu Univ.)
2. “Hydrogen isotope separation using proton-conducting oxide”, Matsumoto, H. (I2CNER, Kyushu Univ.)
3. “Hydrogen Isotope Separation on Pore-Size-Controlled Mesoporous Silica”, Taguchi, A. (HIRC, Univ. of Toyama)
4. “Regeneration of Honeycomb Type Synthetic Zeolite by Means of Microwave Magnetic Field Heating”, Tanaka, M. (NIFS)
5. “Hydrogen and Hydrocarbon Combustion in Atmospheric Pressure Plasma”, Ezumi, N. (Nagano National College of Tech.)
6. “Concept of Simplified Fuel Cycle System Adapting the Cryogenic Engineering for Helical-type Fusion Reactor”, Tanaka, M. (NIFS)
7. “Safety strategy and optimization on radioactive discharges”, Iimoto, T. (The Univ. of Tokyo)