2-4. Research on Fusion System and Safety Management

Researches on the safety management are the essential issues for fusion system, and researches on the integrated system also important issues. The variety of issues on these fields 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 2014 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

One of the critical issues for nuclear fusion reactors is Recovering of tritium, tritiated water and tritiated carbon in the buildings at the reactor site.

In the case of the water-hydrogen chemical exchange, which is one of the promising method for the detritiation, the use of isotope exchange catalyst is indispensable. However such a catalyst (known as the Kogel catalyst) is difficult to produce and relatively expensive. Therefore, there still is a need to develop a novel inexpensive catalyst with good reproducibility. Although a crucial requirement for an isotope exchange catalyst is appropriate porosity and hydrophobicity, there is small database about its characteristics. To get such data, three types of DVB polymer were investigated. Although activation energy was estimated to be about 30 kJ/mol for all catalysts, TEM study revealed that Pt particles loaded into DVB polymer were distributed mostly in the diameter range of about 2 nm. It, therefore, seems that the Pt particles are existed within the micropores in the polymer walls, not facing the macropores. The control of microporosity thus should be a future step in the development of the Pt/DVB catalyst.

To remove tritium from materials, tritium is oxidized and absorbed by the molecular sieve. Although this system offers adequate efficiency, a high-pressure drop, the use of a large amount of precious metals, and inefficient heating occur when the processing throughput is quite large. To reduce such problems, plasma combustion at atmospheric pressure is proposed and investigated. The hydrogen conversion efficiency raises with increasing input power and has reached over 80% at 100W for input microwave power, and it was found that input energy density is one of key parameters for combustion processes in atmospheric pressure plasma and the high neutral gas temperature would affect to the combustion reaction.

(ii) Lithium isotope separation for tritium fueling

Tritium is used as fusion fuel, but natural abundance among hydrogen isotopes is too low. Thus, the tritium must be produced artificially. The $^{6}Li(n,\alpha)T$ reaction is a most well-known tritium breeding method. For the effective breeding the tritium, the enrichment of lithium-6 is necessary, since the natural ratio of lithium-6 is about 7.5%. The lithium-6 enrichment method by using the ion exchange are proposed and researched. The lithium isotope separation by the cation exchange chromatography and the cross-linkage effect on the isotope fractionation are investigated. And the synthesis of new cation exchange resin is also reported.

(iii) Safety strategy for radiation facilities

Discussion items for optimization of safety strategy on radiological environmental assessment for radiation facilities including tritium users are listed up in order to establish safety strategy by the University of Tokyo.

Three examples of discussion points in Japan are indicated as follows;

(1) problem on approval of discharges on diffusion of radioactive materials over the national border line,
(2) confusion between environment protection and environment preservation,
(3) definition, scope and purpose of environmental assessment.

These three are still complicated in Japan responding to the relating international movement and discussion.

(Nishimura, K.)

List of Reports

1. “Preparation and Characterization of Porous “, Taguchi, A. (HRC, Univ. Toyama)
2. “Hydrocarbon Combustion in Atmospheric Pressure Plasma”, Ezumi, N. (Nagano National College of Tech.)
3. “Lithium Isotope Fractionation on Ion Exchange Reaction and its Application to Isotope Separation”, Suzuki, T. (Nagaoka Univ. Tech.)
4. “Safety Strategy on Radiological Environmental Assessment for Radiation Facilities”, Iimoto, T. (The Univ. of Tokyo)