# 2-4. Safety mangement in Fusion Facilities and Environment

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-2015 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

Critical issues for nuclear fusion reactors are recovering of tritium (HT, HTO, $CH_3T$, etc.) and the isotope separation to recycle the tritium as a fuel.

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 catalyst is difficult to produce and relatively expensive. It still needs to develop a novel inexpensive catalyst with good reproducibility. A porous styrene divinylbenzene (SDVB) polymer was investigated as the catalyst support. The dependence on the pore size and the catalytic activities in H-T chemical exchange were investigated. The dependence of the overall mass transfer coefficient between HT and HTO on the pore diameter was derived experimentally and found the optimum size.

The steam electrolysis using proton conducting oxide as a method of hydrogen isotope separation was expected to the future nuclear fusion reactor. The transition metal (e.g. Co, Fe, Mn and Ni) doped oxides are used as electrode and investigated.

Although tritium recovering system using the molecular sieve 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. The plasma combustions of hydrogen and hydrocarbon at atmospheric pressure are proposed to reduce such problems. By these experiments, the importance of OH radical and the effectiveness of this method to remove tritium from materials are found.

(ii) Lithium isotope separation

The $^6Li(n,\alpha)T$ reaction is the most well-known tritium breeding method. To increase the tritium breeding efficiency, the enrichment of lithium-6 is necessary, since the natural ratio of lithium-6 is about 7.5%. For this purpose, ion exchange method are proposed and researched. The lithium isotope separation by the cation exchange chromatography and the cross-linkage effect on the isotope fractionation are investigated. In FY-2015, the sulfo-type strongly acidic cation exchange resin with 50% degree of cross-linkage was proposed and the lithium isotope separation chromatography experiment using this synthesized resin was carried out. The highest separation coefficient of Li-7/ Li-6 was obtained.

(iii) Safety management

The current limits in Japan on the radionuclide contamination of food were established in 2012 to mitigate the internal exposure of the general public to radiation from ingestion of contaminated food due to the Fukushima Daiichi Nuclear Power Plant (FDNPP) accident in 2011. The validity of the current limits by using recent monitoring data on tritium concentrations in the FDNPP harbor was investigated. The extra dose for safety margin in one year after the FDNPP accidents was calculated to be 0.2mSv/y. The dose due to daily ingestion of its fish was calculated to be 0.055mSv/y, which was below the extra dose for safety margin (0.2 mSv/y).

The optimization of safety management for the protection of people and the environment in use of radioactive materials was discussed. It must be paid attention to the difference in the implications of environmental impact assessment between the ICRP/IAEA, etc. and the Environmental Basic Law in Japan.

(iv) Plasma facing material

The droplet of the plasma facing material (W) leads a serious contamination in plasmas, and it is a big concerns in large fusion devices such as ITER. The experimental study of dynamics of W droplet splashing with including the effect of the magnetic field was carried out in the magnetized coaxial plasma gun SPICA facility at NIFS. The difference of the time evolution with the magnetic field is explained by the damping of the surface waves with imposing magnetic field parallel to the W-melt flow if there is no plasma stream.

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List of Reports


1. “Preparation and Characterization of Porous polymer supported Pt catalyst“, Taguchi, A. (Univ. Toyama)
2. “Hydrogen isotope recovery by use of proton conductor steam electrolysis performed at high temperature”, Matsumoto, H. (Kyushu Univ. I2CNER.)
3. “Comparison between hydrogen and hydrocarbon combustion processes in atmospheric pressure microwave plasma”, Ezumi, N. (Univ. Tsukuba)
4. “Lithium Isotope Fractionation on Ion Exchange Reaction and its Application to Isotope Separation”, Suzuki, T. (Nagaoka Univ. Tech.)
5. “Validity of the limits for radionuclides in foods, Japan – From the aspect of tritium”, Iwaoka, K. (Hirosaki Univ.)
6. “Future Scope of Safety Management on Radiological Protection of Human and Environments in Japan”, Iimoto, T. (The Univ. of Tokyo)
7. “Observation of Tungsten Droplet Splashing by Pulsed High Heat Load Irradiation by using the SPICA Plasma Gun Facility”, Nagata, M. (Univ. Hyogo)