Safety and environmental research and development are important to design and construction of a future nuclear fusion reactor and to secure sufficient safety. Major issues are as follows.

(1) Fundamental concept to secure safety in fusion reactor.
Safety analysis presuming a helical type power reactor had been made considering engineering safety systems, functions, and sequential schemes presuming abnormal events.

(2) Safety consideration of tritium fuel cycle.
The fusion reactor system includes large amount of tritium in the vacuum vessel and fuel cycle. Major safety issues are to prevent tritium release accident and to recovery of the released tritium.

(3) Biological shields and radiation monitoring.
Much induced radioactive materials are produced in a nuclear fusion reactor. Shielding analysis of neutron and radiation from the radioactive materials are required. Also radiation measurements and monitoring are important for radiation protection.

(4) Radioactive waste management.
Waste management of tritium containing gas, liquid and contaminated solid are important problems. Major issues are recovery of tritium, decontamination or volume reduction of the wastes.

(5) Safety and public consent.
Comprehensive safety analysis and risk analysis should be made and the accountability is required.

Results of some collaborating studies are shown as follows. They will be useful not only for the DD experiment of LHD, but also for a future fusion reactor.

(a) Tritium behavior in cooling pipe of stainless steel
This basic study has been carried out as collaborations with Shizuoka University. The fundamental permeation experiments in SS-316 have just started using the deuterium at the temperature up to 673K. It was found that the major chemical form of deuterium was HD and D2. Deuterium experimental results also indicate that the permeation behavior of tritium below 373K would be measurable by the present experimental setup.

(b) Hydrogen retention in deposition layers
The basic study about the hydrogen trapping behaviors in the re-deposition layer of SS316 or the metal-carbon mixed deposition layer has been carried out as collaborations with Kyushu University. In the present study, the release behavior of hydrogen isotope from the deposition layer was investigated by a thermal desorption method. An experimental apparatus for formation of metal-carbon mixed deposition layer was just constructed and operated on a trial basis.

(c) Hydrogen isotope separation system in gas phase
Gaseous hydrogen isotope separation and purification system by pressure swing adsorption (PSA) has been carried out as collaborations with Kyushu University. The experimental and analytical results obtained till now have indicated that this PSA process is promising for practical use. As the next step, the performance of successive deuterium enriching process and successive purified-hydrogen producing process were investigated. A successive increase in the overall enrichment factor and the overall volume reduction factor were demonstrated up to 5 cycles.

(d) Hydrogen isotope separation system in liquid phase
Hydrogen isotope separation by a **C**ombined **E**lectrolysis **C**atalytic **E**xchange (CECE) is planning to apply in ITER for the tritium recovery from tritiated waste water. The purpose of the present study collaborated with Nagoya University is to demonstrate separation of tritium from hydrogen using a CECE device on the basis of the previous results for deuterium and hydrogen and to show the validity of the channeling stage model for separative analyses of a chemical exchange column. At present experiments, very large separation factors of hydrogen and tritium isotope separation were obtained. It was also shown that the values of separation factors predicted by the channeling stage model represented the measured values very well.

(e) Tritium recovery in air
As the collaboration with Akita University, the applicability of honeycomb catalysts has been studied. The test fabrication of honeycomb catalyst was carried out and their catalytic performances for oxidation of hydrogen were examined.

The basic study about the hydrogen isotope oxidation process using atmospheric pressure plasma has been carried out as the collaborations with Nagano National College of Technology and Kanazawa University. It was indicated that hydrogen oxidation is induced with increasing the input microwave power.

(f) Basic technology for tritium monitoring
As the collaboration with Tohoku University and Ishinomaki University, the applicability of an imaging plate (IP) in the field of Co-60 gamma radiation has been studied. It was demonstrated that the effect of Co-60 gamma irradiation was negligible up to the dose rate of 4.38 μ Gy/m and the IP method can be a promising candidate to measure tritium in high radiation fields.

The basic study about application of proton-conducting oxide to the hydrogen isotope separation and sensing in the nuclear fusion reactor has been carried out as collaborations with Kyushu University. The combination of the CaZr03-based electrolyte and Pd electrode was selected and the optimum preparation condition of the electrode was examined.

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