§5. Preliminary Design of Tritium Cleanup System for the Large Helical Device

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When DD experiments are carried out in the LHD, tritium is bound to be generated, though the amount may be slight. Since the disposal of generated tritium within the Laboratory is our policy, it is necessary to develop a tritium cleanup system. To recover tritium discharged from a fusion experimental facility, it it usual to employ a system (referred to as "wet system" hereafter) by which the entirety of gas including tritium is converted to water vapor by catalytic oxidation so as to let a molecular sieve adsorb the vapor. However, it is not rational to deliberately convert the discharged tritium which is almost in the elemental (atomic) state into water vapor which affects human body 15,000 times more strongly. Besides, in the wet system the device generally tends to become in size. In view of this, we have developed a tritium cleanup system (referred to as "dry system" hereafter) by which the elemental tritium is fixed directly to hydrogen absorbing alloys which have not so far been developed at any other place.

The main constituent of the exhaust of the experimental facility for DD experiments is deuterium, but there are also mixed a trace of helium and tritium compounds and a variety of impurities. It is an easy task to remove elemental hydrogen isotopes, namely, protium, deuterium and tritium (referred to simply as "hydrogen" hereafter), from the mixture of hydrogen and helium if one employs hydrogen absorbing alloys. However, it will no longer be a simple matter if there are mixed water vapor, methane and the like even in a small amount. Such impurities are actually included in the exhaust of a fusion experimental facility. We have completed a conceptual design for a tritium cleanup system in which a nonvolatile getter material is employed to let it adsorb carbon and oxygen generated by the decomposition of these impurities caused by the getter material, and hydrogen absorbing alloys employed to let it adsorb the elemental hydrogen, where these materials may be stored or disposed of as deemed necessary.

We have examined the case where tritium which has a low equilibrium hydrogen pressure and is inexpensive used as a hydrogen absorbing alloys, and Al_3Zr_2 alloy of which there is available a report as to its action on methane is used as a nonvolatile getter material. The result of design, of a tritium cleanup system according to the dry system, for the exhaust system in the LHD revealed that the outlet concentrations are 0.0mBq/cm^3 for water vapor tritium and 0.3mBq/cm^3 for elemental tritium contrast to the outlet concentrations, according to the wet system previously designed, of 64.9mBq/cm^3 for water vapor tritium and 1.4mBq/cm^3 for elemental tritium, so that it is obvious that the dry system is far more advantageous from the viewpoint of safety. In fig.1 is shown the flow sheet of the system.

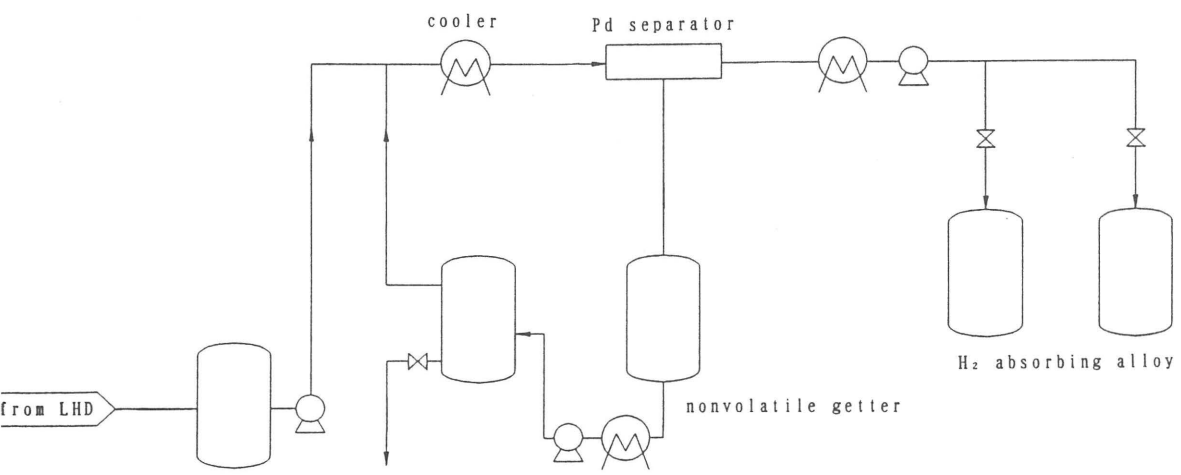

Fig.1. Flow sheet of dry system