Summary of Chapter 16: Tritium

The tritium recovery systems for different breeding materials have been reviewed and the most promising concept for each breeding materials have been recommended. The recovery method has to limit the tritium inventory below the deisgn limit by safety consideration. ITER set the maximum allowable releasable tritium inventory in each component to less than 200 g. Also, the tritium recovery system, together with the system design, has to lmit than tritium leakage rate to less than 10 Ci/d. The allowable tritium inventory goal can be reached for most of the breeding material. However, the goal To limit tritium leakage rate to lower than 10 Ci/d is much more difficult to reach, especially for high temperature systems such as the APEX options.

Many tritium recovery system from lithium have been proposed. The most attractive one is the one based on cold trap(1). Cold trap has been demonstrated to be able to recover tritium from Li, Na and NaK. The tritium solubility in lithium is 440 appm at the cold trap temperature of 200C, which is far above the design goal of 1 appm. This design concept is to add protium in the lithium to increase the total hydrogen concentration. The cold trap will reduce the total hydrogen concentration to 440 appm, while the 1 appm tritium concentration can be reached.

The tritium solubility in flibe is very low. A very efficient tritium recovery system will be required to reduce the tritium permeation rate to below 10 Ci/d. A two stage vacuum disengager was proposed by the HYLIFE design(2). This design forces hot flibe into small droplets and letting them fall through a vacuum chamber. The tritium will diffuse out of the flibe and being removed. The calculate tritium recovery efficiency is 99.7% for each stage, results a combined efficiency of 99.999%. There has been no experimental verification of this process.

Many tritium recovery processes have been proposed to recover tritium from LiPb. The most attractive one is based on permeation to NaK and cold trap recover tritium from the NaK(3). The process involves the following three steps: (1) Tritium permeation into NaK gap of a double walled steam generator, (2) Tritium recovery from NaK by precipitation as potassium tritide in a cold trap, and (3) Tritium recovery by thermal decomposition of the tritide. The entire process has been demonstrated in a laboratory scale experiment.

There is no theoretical or experimental work on tritium recovery from Sn-Li. The tritium colubility in Sn-Li is not available.

References

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