Leakage of tritium through heat cycles of conceptual-design, laser-fusion reactor KOYO-F

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We estimated steady-state, tritium leakage to environment through heat cycles of laser fusion power plant KOYO-F to make reliable scenario for tritium control. KOYO-F is a commercial laser fusion power plant whose electric output power is 1200MW. Fusion yield in one reactor is 200MJ at 4 Hz. The heat cycle of KOYO-F consists of 3 loops. The first loop is a liquid LiPb loop connecting blankets and a boiler. The second loop is filled with pressurized water and circulates through the boiler, a turbine and a condenser. The third loop is filled with water and circulates through the condenser and a radiator. The third loop was installed to reduce the tritium leakage to environment without spoiling the system efficiency.

To estimate tritium diffusion through the wall of the boiler, we assume existence of a virtual gas gap with zero volume between liquid LiPb and the stainless wall / the stainless wall and water. The Sievert law was assumed between the concentration of hydrogen in (liquid) metal and the partial pressure of hydrogen in the virtual gap. The Henry's law was assumed between the hydrogen concentration in water and the partial pressure in the gap.

The tritium leakage to environment through the radiator wall is estimated to be 85pg/s (about 1000Ci/year). If we had to reduce this release rate similar to that of a general fission plant (100Ci/year), we need some in-loop tritium recovery system that can reduce the tritium concentration to 1/10 of current level. In the 2nd and 3rd water loop, the concentration of tritiated water may increase with elapse of time. Some remove system of tritiated water would be necessary in view point of risk management.

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