Tritium Fuel System Assessment on Economics and CO_2 Emissions in DT Fusion Reactors

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Fission and fusion reactors are expected as abundant electric power generation systems reducing global warming greenhouse gas (GHG) emission amounts. Different from fossil-fuel thermal power plants, the fuel cost fraction of nuclear plants is small. However, fission reactors with oversea gaseous diffusion uranium-enrichment system lead to rather high GHG emissions in comparison with those of domestic centrifuge enrichment system, because of its large electricity consumption. Here, we investigate the effects of the tritium fuel cycle system on the cost of electricity (COE) and the life-cycle CO_2 emissions in fusion reactors.

The system design assessments of magnetic confinement fusion (MCF) and inertial confinement fusion (ICF) reactors have been performed using PEC (Physics Engineering and Cost) system code [1-2]. In the physics design, the reactor plasma performance can be determined by fusion output power, beta limit, density limit and so on. As for engineering design, important parameters to realize compact DT fusion reactors are the MCF maximum magnetic field strength or ICF driver energy, the blanket and shield thickness, the neutron wall loading, etc. The cost accounting analysis is based on unit cost per weight or power, and life-cycle GHG emissions are evaluated using the input-output table.

In this analysis, we estimate 5 M$ and 2.4×10^4 t-CO_2 as initial tritium fuel installation, and the tritium fuel can be supplied by the fuel handling and storage system consisting of pellet injector, fuel processing system, atmospheric tritium recovery and water detritiation system. The pellet purification system in ICF is assumed as a function of driver frequency.

The contribution of tritium fuel system to the global COE and the life-cycle GHG emissions is less than a few percents in the present model, but GHG emissions from ICF fuel system is slightly higher than those from MCF. Detailed assessment models and results are shown in the conference.

[1] K. Yamazaki, S. Uemura, T. Oishi et al., Nucl. Fusion 49 (2009) 055017.
[2] S. Uemura, K. Yamazaki et al., Trans. At. Energy Soc. Japan 8 (2009) 34 (in Japanese).