§34. Comparative Assessment of Economics and CO_2 Emissions in Inertial and Magnetic Fusion Reactors

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Nuclear fission and fusion reactors are expected as abundant electric power generation systems reducing human 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 foreign gaseous diffusion uranium enrichment system in Japan lead to rather high GHG emissions in comparison with those of domestic centrifuge enrichment system, because of the large electricity consumption in the gaseous diffusion system.

In order to search for economically and environmentally optimized reactor designs, the system analyses of fusion reactors on physics, engineering, cost and CO_2 emission amounts have been carried out for toroidal magnetic confinement fusion (MCF) reactor designs, and some comparative studies among conventional electric power generation systems were carried out. Here, we extend this to the inertial confinement fusion (ICF) system, and include the effect of CO_2 tax. Various blanket designs including fission-fusion (F-F) hybrid and D-3He reactor designs are assessed with respect to the cost of electricity (COE) and the life-cycle CO_2 emission amounts.

Recently, we had compared the CO_2 emissions from the life-cycle of several fusion reactors[1-5]. The magnetic confinement systems evaluated here are the tokamak reactor (TR), helical reactor (HR), and spherical tokamak reactor (ST). These models are calculated by the Physics-Engineering-Cost (PEC) code. The inertial confinement fusion reactor (IR) is also evaluated, assuming its driver energy and driver efficiency. In addition, different blanket modules and fuels are considered in the TR designs. To calculate life-cycle CO_2 emission from fusion reactors defined by plasma parameters and radial build, we used a basic unit for CO_2 weights (kt-CO_2/t-material).

Figure 1 shows schematic models of various fusion reactor systems and their calculation results on COE and CO_2 emission rate.

Calculation results indicate that CO_2 is emitted mainly in the construction stage of superconducting magnet systems for magnetic confinement fusion reactors. For the IR design, the driver system construction and pellet fabrication stages involve considerable CO_2 emission. By comparing fusion reactors with other electric power generation systems in terms of CO_2 emission, we confirmed that fusion reactors emit less CO_2. Therefore, introducing a carbon tax has little effect on the economics of fusion reactors, and the cost of electricity (COE) from fusion reactors might be lower than that of oil-fired electric power plants when a carbon tax of around several hundred yen/t- CO_2 is introduced.

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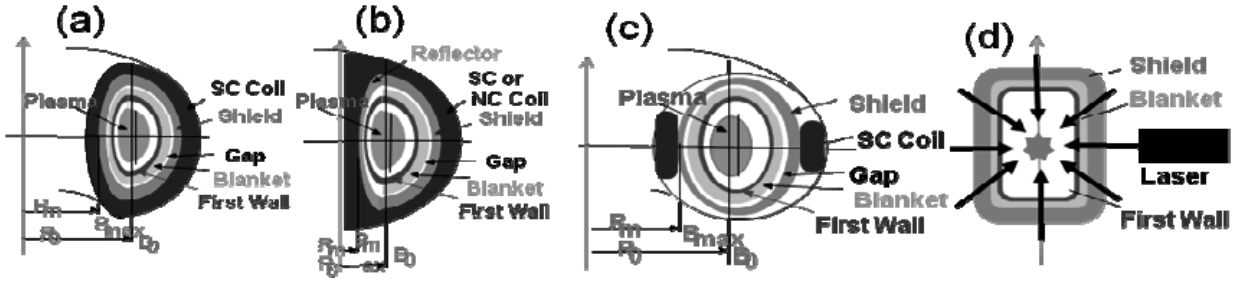

Tokamak Reactor	Spherical Torus	Helical Reactor	Inertial Reactor
9.8 ¢/kWh	10.4 ¢/kWh	11.1 ¢/kWh	10.7 ¢/kWh
9.2 g-CO_2/kWh	9.1 g-CO_2/kWh	9.9 g-CO_2/kWh	12.9 g-CO_2/kWh

Fig.1 Schematic drawing of reactor core models and their assessment results on COE and CO_2 emission rate.