Water-cooled solid breeding blanket design for DEMO

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Water-cooled solid breeding blanket is regarded as a conservative and less challenging blanket concept. However, the fact is that the concept still has difficult problems to be resolved. In this paper, we report the blanket design study for a compact low aspect ratio DEMO "SlimCS" and clarify the critical design issues.

The blanket of SlimCS consists of replaceable and permanent blanket. Based on the EM force analysis acting on disruption, the replaceable blanket is designed to have a toroidally-long casing made of reduced activation ferritic martensitic steel (RAFM). For vertical stability of elongated plasma and high beta access, a sector-wide conducting shell assembly is required at a near distance from plasma ($r_{shell}/a \sim 1.3$). The RAFM front and side plates of the permanent blanket are 0.07 m in thickness so that the plates have the function of the conducting shell assembly. Considering compatibility with RAFM, pressurized water is used as coolant. The temperature range and pressure of the coolant is one of the key design issues. The coolant temperature is required to be 300ºC at least so as to avoid corrosion by radiation-produced hydrogen peroxides and radiation embrittlement like light water reactors. However, use in the PWR conditions (285-325ºC, 15 MPa) may be problematic in that the required large amount of coolant in the blanket can detract the self-sufficient tritium production. In order to find a feasible blanket concept, thermal and neutronics analyses have been carried out for various combinations of materials and blanket structures, indicating that design options satisfying tritium self-sufficiency is scarce. The results and the remaining issues are also presented.

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