

ENGINEERING DESIGN OF THE ITER INVESSEL NEUTRON MONOTOR USING MICRO FISSION CHAMBERS

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An invessel neutron monitor using micro-fission chambers is one of the most important diagnostics to measure the fusion power in ITER. In the previous work, the micro-fission chamber only for high power operation has been designed. In this work, a micro-fission chamber bundle is proposed as a higher sensitive detector for low fusion power operations in ITER. The engineering design such as the nuclear heating and the heat transport analyses have been carried out. In ITER, neutron monitor has to measure the total neutron emission rate in the range of fusion power from 1 kW to 1 GW with a temporal resolution of 1ms. A single micro fission chamber with 10 mg of U235 to be installed in a gap between a shielding blanket module and a vacuum vessel can cover the range of the fusion power from 100 kW to 1 GW. For the low fusion power operation, a micro fission chamber bundle consisting of 13 micro fission chamber units with a diameter of 14 mm and a length of 400 mm has been designed. The micro fission chamber bundle is mounted in the stainless steel housing, of which thickness is 210 mm and the size is 24 mm in width and 450 mm in length. The assembly can be installed in the gap between a shielding blanket module and the vacuum vessel with a minor modification of the shielding blanket module. The total amount of U235 is 750 mg for the micro fission chamber bundle. The estimated dynamic range of the micro fission chamber bundle is 1kW – 400 kW in fusion power. Micro fission chamber units are connected in parallel to reduce the amount of cables. Nuclear heating of the micro-fission chamber for high power operations and the micro fission chamber bundle for low power operation were analyzed by neutron transport calculations. It is found that the gamma heating is 5-6 times larger than neutron heating and the total nuclear heating rate is $\sim 1.5 \times 10^5$ W/m³ for the chamber housing of SS316L at the 500 MW operation. Heat transport analyses for the micro fission chambers were carried out with a general purpose Finite Element Method code ANSYS 8.1. We assumed the detector would be cooled by the heat conduction to the vacuum vessel without active cooling system such as a water cooling loop. The analyses indicated that the detector temperature might be kept less than 250°C by the thermal conduction to the vacuum vessel with the conduction rate of 100W/m²K or higher. The conduction can be realized by the roughness of the contact surface less than 400 μm.