STUDIES OF IN-VESSEL COMPONENT INTEGRATION FOR A HELIUM-COOLED DEMO FUSION REACTOR

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In the European Power Plant Reactor Study, three reactor models make use of the helium cooling technology for in vessel components, namely Model B with a solid breeder, Model AB with a stagnant PbLi liquid breeder and Model C with a He/PbLi Dual Coolant blanket. These concepts use high pressure – high temperature Helium as main coolant for the blanket (8 MPa, max. 500°C) and divertor (10 MPa, max. 700-800°C) systems. The integration of these systems into the vacuum vessel of a DEMO reactor (including a neutron shield and cooling manifolds) was the subject of a recent study performed at FZK. A maintenance scheme similar to the ITER "in vessel transporter", assuming relatively large blanket modules (~10 t) has been developed. This system is complemented by a "cassette" maintenance concept for the divertor again similar to ITER and an analogous concept for the upper portion of the blanket which has also a cassette form for simpler handling.

For the helium-cooled reactor concepts the main integration issue is the accommodation of 2 large pipes for each blanket module (150-250 mm of internal diameter and wall thickness ranging from about 8 to 15 mm) inside the vessel and to develop a remote handling strategy for cutting/welding of these pipes. The paper presents and discusses an in-vessel lay out based on helium pipes as permanent components integrated into a modular water-cooled low temperature shield, which is mounted on the vacuum vessel and is cooled by vacuum vessel water. The blanket modules as well as the divertor and the blanket cassettes are mounted on this shield. For cutting/welding the pipes at the connections to each blanket module, a concept based on in-bore tools is considered. Furthermore, a strategy of mitigation of thermal stresses due to differential thermal expansion (the module pipes reach high temperatures of 300-500°C compared to 150°C in case of the vacuum vessel and the water shield) is discussed based on the use of compensators. The above integration concept promises the exchange of the full blanket system within two months when considering 2 in-vessel transporters and 20 in-bore pipe cutting and welding trains.

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