

Engineering Aspects of the Development of a Reactor Concept for DEMO

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Abstract

On the way to the first commercial nuclear fusion reactor conceptual studies addressing the design of the in-vessel components, namely the breeding blankets, the helium supply unit or manifold and the hot ring shield, are underway. Of particular importance is the development of an appropriate concept to integrate these components into the reactor. As part of the European DEMO effort different blanket concepts and segmentations have been investigated. The Helium Cooled Pebble Bed (HCPB) as well as the Helium Cooled Lithium Lead (HCLL) blanket concept are quite advanced and no matter what type of blanket is favoured the so-called vertical ‘Multi-Module-Segment’ (MMS) integration concept has been identified to be promising. An advantageous handling of the MMS can be expected if blanket and manifold constitute vertical non-permanent, banana shaped segments to be installed and dismantled with remote handling tools through the upper port of the reactor. Besides the obvious challenge to extract the thermal power from the fusion reactor most efficiently, breeding blankets need to provide an adequate margin of tritium self-sufficiency and appropriate shielding whereas the radial build of the blanket has to be limited. At Forschungszentrum Karlsruhe the development of the blanket concept employing ceramic breeder material- the HCPB blanket- has been promoted since many years. Based on this continuous long-term development, the present contribution explains engineering aspects of the development of a HCPB reactor concept for DEMO. The present report gives an overview of the integration of the HCPB blanket into the reactor in which the MMS concept is applied. The required mechanical attachments need to be flexible to compensate different thermal expansions, but also need to withstand the loads during normal as well as off-normal operating conditions, e.g. plasma disruptions. A possible design is introduced and certain engineering aspects are highlighted. Implications of the chosen blanket integration concept on maintenance are described to provide, with respect to the current state of development, a complete picture.

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