IN-BORE TOOLS FOR BLANKET REPLACEMENT IN THE DEMO FUSION REACTOR

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Studies for the integration of a blanket in a fusion reactor have been performed during the last year in FZK. In these investigations a maintenance concept based on the replacement of large blanket modules and a lay-out for a helium coolant manifold have been addressed. The proposed concepts assume that about 350 blanket modules with a weight of about 10 t have to be replaced through the equatorial ports of the reactor. The mechanical connecting /disconnecting and the transport of the modules to the ports will be carried out with an in-vessel remote handling system, while the hydraulic connecting/disconnecting will be performed with special in-bore tools to be inserted into the pipes. This paper describes the design of the He cooling pipe system and the requirements and strategies for the in-bore welding and cutting tools for (re-)placing a blanket module.

The Helium cooled fusion reactor requires a pipe system (internal ∅150-250mm thickness ranging from about 8 to 15 mm) inside the-vacuum vessel which has to be welded, cut and re-welded with in-bore tools. The overall length of one pipe section and thus the distance the tool has to pass, could be larger than several 10x m. The pipes are fixed radial behind the shield modules which are lifetime components and constitute the segmentations for the pipes compensators. The connection to the cooling manifold for each blanket module is made with a radial hot shield key which is part of the blanket module and includes an approximately 90° pipe bending. The design of the in-bore tools is similar the ones used in pipelines. The requirements for cutting and (re)-welding with high accuracy is realised through a combined arc welding and beam process. Additional requirements are path detection and position detection as well as inspection of the weld. Therefore different in bore tool modules are required to execute such different tasks.

The pipes of the shield- and the blanket modules cannot be positioned with constant gaps. Thus the tool must be able to build these gaps up in order to realise a seam forming. In addition the problem of welding dust had to be addressed to achieve the high cleanliness required for the He cooling loops.

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