DESIGN PROGRESS FOR THE ITER TORUS AND NEUTRAL BEAM CRYOPUMPS

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The ITER Vacuum Pumping Systems include 8 torus and 3 Heating Neutral Beam Injection (NBI) cryopumps. Although they are completely different in many aspects such as design details, cryogenic routing, functional requirements, pumping speed, geometry and size, they do follow the same concepts of stagewise regeneration at different temperature levels and of cryosorption pumping on activated charcoal at 4.5 K, which have been extensively validated in the last decade at Karlsruhe Institute of Technology (KIT) on the scale of a model cryopump. Both pumps have to be provided with a Build-to-Print (B-t-P) design which is under work and has seen significant progress. Furthermore, both pumps will face a stage of prototypical testing.

The torus exhaust cryopumps are especially challenging because they incorporate an integral inlet valve to control the incoming gas flow from the divertor and because they have to provide significant helium pumping capability, which necessitates to maintain the cryogenic conditions of the cryopanels in a very accurate way. The detailed design will be based on a full mechanical thermal and stress analysis of the pump as well as an optimisation of the internal cryogenic pipe routing. Special emphasis is given to the development of the valve which is the only moving component of the pump. Design supporting tests are being performed to characterise the forces needed to ensure the leak rates requested from the inlet valve in its closed position. The final B-t-P design will then be confirmed with a pre-production cryopump, which will be built and checked in a strong validation test programme at KIT, before the serial pumps are being manufactured.

The neutral beam cryopumps are especially challenging due to their very large size and the resulting efforts needed to stay within the maximum allowable pressure losses along the cryogenic circuits of the cryopump. Design supporting R&D is performed in a dedicated facility at KIT to directly measure pressure losses of the hydroformed components. In a follow-up step, the final B-t-P design of the ITER Heating Neutral Beam cryopump will be adapted to the needs of the NBI testbed on site of Consorzio RFX, Italy. The pump for this testbed will be the first NBI pump to be manufactured and the testbed operation also serves the purpose to confirm and validate the design for ITER.

This paper addresses the current status of the ongoing design efforts. It summarizes the operational requirements, delineates how they have been taken into account, and illustrates how the design supporting activities have provided solutions to the design issues.