

Thermal-hydraulics and Structural analyses of LLCB TBM set

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India is developing Lead-Lithium cooled Ceramic Breeder (LLCB) Test Blanket Module (TBM) for testing in ITER for the validation of fusion blanket design tools, tritium breeding performance and high grade heat extraction capability relevant to Indian DEMO. The LLCBTBM will be tested from the first phase of ITER operation (H-H phase) in one half of the ITER port no-2. LLCB TBM set consists of TBM and its shield along with supports and piping. The LLCB TBM consists of U shaped helium cooled first wall (FW) with back plate enclosing internal components covered by top and bottom plates. The TBM internals consist of four ceramic breeder canisters (Li_2TiO_3) in the form of pebble bed with Pb-Li flowing around these canisters to cool the internal structure. The TBM is supported at TBM shield by supports. The back side of Shield is welded to TBM set flange, which is bolted to the ITER port plug frame. TBM Shield made of SS 316 L (N)-IG located behind the TBM is composed of steel and water with a combination of 50:50 to shield neutrons. It consists of two symmetrical parts that have grooves to accommodate pipes. The neutronic heat generated inside shield structure is extracted by water flowing inside the shield.

The detailed thermal-hydraulics of TBM set has been performed based on the heat flux on FW and neutronic heat generation on TBM set. The temperature distribution obtained from thermal analysis has been used for thermo-structural analysis. CFD analysis of helium flow inside the FW channels and manifolds has been carried out to estimate temperature, pressure drop and heat transfer coefficient. The distribution of flow inside the different flow circuits of FW from manifolds and water flow in TBM Shield will also be described in this paper. Structural analysis has been performed on TBM set based on load combinations as per ITER load specifications. RCC-MR 2007 code has been used for the structural assessment for the prevention of p-type and s-type damages and calculation of safety margins. The structural analysis results of different components of TBM set which include TBM, back plate, supports, process pipes and TBM shield will be discussed in detail in this paper.

Country or International Organization

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