KIT INDUCED ACTIVITIES TO SUPPORT FABRICATION, ASSEMBLY AND QUALIFICATION OF TECHNOLOGY FOR THE HCPB-TBM

H. Neuberger, J. Rey, Dr. A. v.d. Weth

Karlsruhe Institute of Technology (KIT), Institute for Neutron Physics and Reactor Technology (INR)

Corresponding author: heiko.neuberger@kit.edu

Sub-component manufacturing and assembly concepts for the fabrication of the Helium Cooled Pebble Bed Test Blanket Module have been developed since more than one decade in the KIT. In accordance with the progressing design verification, the fabrication and assembly technology needs to be transferred from experimental scale to industrial application taking into account the requirements for qualification of processes according to the codes and standards applied in ITER.

The main task with regard to the sub-component fabrication is the realization of TBM relevant structural plates (e.g. for the first wall, grid, caps and breeder zone cooling plates) including an appropriate pattern of cooling channels in order to remove the heat load on the plasma facing part and the internal structures of the blanket. After several series of lab scale mock ups partly financed by EFDA two relevant scale components have been realized on KIT initiative: A full scale breeder zone cooling plate (concept with meandering cooling channels) and one prototypical mock up of the first wall with outer dimensions equal to ¼ of a TBM FW. Both mock ups passed pressurization as well as leak tightness tests. But the plastic deformations surrounding the bonding zone turned out to be beyond the acceptable limits. Therefore a series of measures have been defined and summarized in a KIT patent in order to minimize the deformations by design optimizations for HIP bonding surfaces. Currently the experiences gained in present experiments are transferred to commercial industry in order to determine reproducible fabrication routes and process parameters of the HIP process for TBM relevant size components. This will be realized by a series of mock ups starting with another ¼ scale first wall to investigate the impact of the design modifications implemented in order to limit plastic deformations. Subsequently ½ scaled first wall mock up including 90° bending will be fabricated followed by the full scale component.

Also the assembly of the TBM sub-components is an issue where additional R&D will be required. An integral assembly strategy has been proposed for the TBM basing on different conventional welding processes (e.g. TIG and Laser). But there is also the intention to replace TIG welds for the TBM box assembly by high energy beam welding technology in order to minimize heat induced distortion. Analysis and test welds including investigation of the materials micro structure will support the selection of the reference procedure. Also the development of automatic welding devices for the box assembly requires additional effort (e.g. in all TBM box corner sections).

For both main fields of the TBM fabrication development, the sub-component fabrication as well as the assembly technology development, all the processes which are presently not included in the design codes need to be implemented in ITER relevant codes, especially the next generation adapted French RCC-MRX. This paper summarizes the results of the effort of the KIT in order to support the qualification of manufacturing technology for an ITER HCPB TBM.