Parametric neutronic analysis of HCLL blanket for DEMO

J. Jordanova[1], U. Fischer[2], P. Pereslavtsev[2], Y. Poitevin[3], A. Li Puma[3], N. Nikolova-Todorova[4]

[1]Institute for Nuclear Research and Nuclear Energy, 1784 Sofia,Bulgaria, [2]Forschungszentrum Karlsruhe, Postfach 3640, 76021 Karlsruhe, Germany, [3]CEA Saclay, DEN/DM2S/SERMA/LCA, 91191 Gif-sur-Yvette, France, [4]University of Shumen "Ep.Konst. Preslavski", 9700 Shumen, Bulgaria

e-mail: jordanaj@inrne.bas.bg

The Helium Cooled Lithium Lead (HCLL) blanket concept is one of the two research lines considered in the European Fusion Technology Programme for DEMO reactor specification along with the Helium Cooled Pebble Bed (HCBP) concept. To reduce the R&D costs both blankets share some common design issues, i.e. they feature the same modular blanket arrangement and radial steel structure but HCLL uses specific breeder unit inserts. Both blanket concepts are based on low activation ferritic steel Eurofer structure and use the same coolant (high-pressure He gas), the HCLL employing the Pb-Li eutectic alloy as breeder and neutron multiplier. Breeder units of the HCLL type are made of cooling plates and the backplate with the Helium inlet/outlet manifolds. The Lithium-lead is slowly floating in the space between the cooling and the stiffening plates.

The work presents the parametric neutronic study of the HCLL blanket whose objectives are reducing the blanket radial depth as much as possible without reducing significantly the TBR or shielding performances at the inboard torus mid-plane regarding the radiation load to the super-conducting toroidal field coils. Three-dimensional 9^0 sector model representing the modular HCLL breeder blanket developed by FZK [1] has been used in the analyses utilizing the MCNP Monte Carlo transport code. The model is based on the reactor parameters of model B of the European Power Plant Conceptual Study (PPCS) and is developed by integrating HCLL blanket modules into neutronic model of a DEMO-type reactor derived from PPCS by CEA and FZK. Several parametric studies have been performed considering different Li-6 enrichment, radial length of the breeder zone, as well as different composition of VV and of the in-vessel shield at the inboard torus mid-plane. The cases provided tritium self-sufficiency and sufficient shielding of the TF-coils have been identified.

[1] Y. Chen, U.Fischer, P.Pereslavtsev, F. Wasastjerna, The EU Power Plant Conceptual Study – Neutronic Design Analyses for Near Term and Advanced Reactor Models, FZKA 6763, (April 2003)