EU Blanket Design Activities and Neutronics Support Efforts

U. Fischer[1], P. Batistoni[2], L. Boccaccini[1], L. Giancarli[3], S. Hermsmeyer[1], Y. Poitevin[3]

[1]*Association FZK-Euratom, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany, e-mail: ulrich.fischer@irs.fzk.*de
[2]*ENEA Fusion Division, Via E. Fermi 27, I-00044 Frascati, Italy*
[3]*CEA Saclay, Direction de l'Energie Nucléaire, F-91191 Gif sur Yvette, France*

An overview is provided of the design activities conducted in the European Union for the development of breeder blankets for future fusion power reactors. The focus is on the related neutronics support efforts.

The European Fusion Technology Programme considers two development lines of a breeding blanket: one employing a Lithium ceramics as breeder and the other the Lithium–lead liquid metal alloy. To minimise the development costs, the blanket design and the related R&D efforts have been recently based on the use of the same coolant (high pressure Helium gas) and the same modular blanket structure, a box with a stiffening grid that can withstand the high pressure of the coolant gas in the case of an internal leak. With this design concept, the open cells of the stiffening grid accommodate small breeder units. The Helium-Cooled Pebble Bed (HCPB) blanket makes use of Li_4SiO_4 as breeder material and beryllium as neutron multiplier in the form of pebble beds. The breeder unit of the HCPB type consists of a back plate with two breeder canisters attached, each providing space for two shallow ceramic breeder pebble beds. The space between the canisters and the stiffening plates is filled with Beryllium pebbles. The Helium-Cooled Lithium-Lead (HCLL) employs the Pb-Li eutectic alloy as breeder and neutron multiplier. Breeder units of the HCLL type consist of a few cooling plates and the backplate with the Helium inlet/outlet manifolds. The Lithium-lead fills the entire space between the cooling and the stiffening plates.

The neutronic support efforts include design analyses for the layout and optimization of the modular HCPB/HCLL blankets based on detailed three-dimensional Monte Carlo calculations with the MCNP code. The related power reactor models were devised on the basis of parameters specified in the European Power Plant Conceptual Study (PPCS). The major neutronics features of the modular HCPB/HCLL blanket concepts will be presented in the paper and the main neutronics results will be discussed.

The neutronics support efforts in the European Union also include the development works conducted in the frame of the European Fusion and Activation File (EFF/EAF) projects. The main objective of these activities is to provide well qualified nuclear data and computational tools as required for reliable neutronics design calculations. This includes the development of nuclear cross-section data for neutron transport and activation calculations and their validation through benchmark experiments. The paper presents a brief overview of these activities including the neutronics benchmark experiment on a HCPB breeder blanket mock-up which is currently under preparation at the Frascati Neutron Generator.