Neutronics experiment on a HCLL tritium breeder blanket mock-up

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Following a previous experiment on a mock up of the Test Blanket Module (TBM) based on the Helium Cooled Pebble Bed (HCPB) concept, a new neutronics experiment has been carried out on a mock-up of the TBM based on the second concept developed in the EU, the Helium Cooled Lithium Lead (HCLL) blanket, with the objective to validate the capability of the neutronics codes and nuclear data to predict the tritium production rate (TPR) and other nuclear responses with qualified uncertainties.

The mock-up, consisting of a block of PbLi and Eurofer materials, replicating all the TBM features, has been irradiated by 14 MeV neutrons at the FNG (Frascati Neutron Generator) facility, and the tritium production has been recorded in several Li_2CO_3 pellets (containing both natural and ^{6}Li-enriched lithium) located at various positions and depths inside the mock-up. Three independent measuring techniques were employed by ENEA, KIT/TUD and JAEA to measure the tritium in the irradiated Li_2CO_3 pellets. Other independent techniques were also used, such as thermoluminescence detectors (TLDs), through distinct measurements of the absorbed dose due to both the energy released in the (n,t) reaction and in the decay of tritium after irradiation, diamond detectors covered with ^{6}LiF, and direct measurement of tritium production in PbLi. The neutron flux attenuation in the PbLi was also measured using the activation foil technique.

The mock up has been then irradiated at the neutron generator of the Technical University Dresden (TUD) to measure fast neutron and gamma ray spectra inside the assembly as well as time-of-arrival spectra of slow neutrons

The measured quantities (E) have been compared with calculated ones (C) using a very detailed model of the assembly and of the experimental set up, and nuclear data from the JEFF-3.1 and FENDL-2.1 libraries. The paper presents a detailed analysis of the experiment including results of the C/E ratios of tcalculated (C) and measured quantities (E), together with the related uncertainties derived from experimental data and computational (uncertainty) analyses.

The conclusions regarding the accuracy of the tritium production in the HCLL blanket are derived and discussed.

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