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TOPIC: H - Fuel Cycle and Breeding Blankets

Adaptation of the HCPB DEMO TBM as breeding blanket for ITER : Neutronic and thermal analyses (P4-H-260)

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Two breeding blanket are presently developed in Europe for the DEMO reactor: the first one, the Helium Cooled Lithium Lead (HCLL) uses a liquid breeder while the other , the Helium Cooled Pebble Bed (HCPB), uses a solid breeder in form of pebble bed. The modules of these blankets, called Test Blanket Modules (TBM) will be located in correspondence of the equatorial ports of ITER in order to be tested.

ITER FEAT was designed with shielding blankets, therefore in the final stage of the experiment, in the foreseen tritium -deuterium operation phase, the tritium will be supplied to the reactor and not produced inside it. Since the production of tritium is of main importance for the feasibility of a nuclear fusion reactor, perhaps in the ITER final stage, the shielding blanket could be substituted by means of a breeding blanket. The geometry and composition of this breeding blanket would be, of course, similar to that of TBM which demonstrated to have the best performances. This paper illustrates a neutronic and thermal analysis of an hypothetical triziogen blanket for ITER FEAT made similar to a HCPB test module. The main aims of the performed analyses are to determine the Tritium Breeding Ratio (TBR) considering different solid breeders (Li4SiO4 and Li2TiO3) with different enrichment in 6Li and different structural materials (a 9%CRWVTa reduced activation ferritic martensitic steel (EUROFER) or ceramic matric composites like SiCf/SiC). The breeding blanket design is compared considering the highest value of TBR and the verification of the temperature constraints (550°C for the steel, 950° C for the breeder and 650°C for the Beryllium).

The neutronic analyses have been performed by means of MCNP-4C code and the thermal analyses using the MSC-MARC code. A TBR about equal 1 was obtained with a SiCf/SiC structural material and a Li4SiO4 breeder.

The performed analyses have to be considered preliminary and an academic exercise, nevertheless they could give useful information in order to optimize the breeding blanket design from a neutronic and thermal point of view.