EXPLORATION OF OPTIMIZED BLANKET CONFIGURATION FOR AN ICF HYBRID REACTOR WITH A HELIUM-COOLED PEBBLE-BED TYPE BLANKET

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Evaluation of the neurotic performance of any nuclear system harnessing nuclear chain reaction is of great importance for the substantiation of the economic and safe operation of the system. The same applies to the prospective hybrid reactors where advantages and disadvantages of well-established fission reactors technologies and developing technologies of the future pure fusion reactors are capitalized to reach a midterm solution for the growing worldwide energy demand, shortening the road toward pure fusion energy, and alleviating concerns over long-lived nuclear waste, proliferation issues of fission fuel cycle back-end, and support the fissile fuel supply for fission reactors [1-5]. In this study, with the help of general-purpose Monte Carlo code MCNPX 2.6 [6], neutronic parameters of an ICF D-T driven hybrid fusion-fission reactor is investigated to evaluate key parameters such as tritium breeding ratio (TBR), fissile fuel breeding ratio (FFBR), neutron leakage and energy multiplication factor. The blanket of the investigated reactor is a helium-cooled pebble-bed (HCPB) type, that uses SiC as the structural material, moderator and reflector; and helium as the coolant medium. The neutron energy spectrum of the ICF target was selected based on the SIRIUS pure fusion reactor design [7]. Using two different ceramic tritium breeder materials namely Li_2O and Li_4SiO_4 and six fissile breeder materials with natural occurring isotopic compositions including ThC, ThO_2, UC, UN, U_3Si_2 and UO_2, the impact of material choice on neutronic performance as well as the optimal ^{6}Li enrichment in each case is examined to propose the best candidate configuration for the reactor blanket. The calculation results show a good agreement with previous works based on deterministic approach. Finally, based on the end-user first priority which would be either energy production or fissile fuel production, two configurations are proposed. One of the main advantages of these configuration is elimination of beryllium neutron multiplier which in turn leads to simpler manufacturing of blanket modules and bypass issues associated with beryllium such as sensitivity to radiation damage, intense gas production, high cost, toxicity and its limited resources.

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