Contribution ID: **378** Type: **Poster**

FTP/P7-05: Neutronic Calculation of Radiation Damage in First Wall of a Fusion-Fission Reactor

Friday, 12 October 2012 08:30 (4 hours)

A fusion–fission (hybrid) is a combination of the fusion and fission processes. The fusion plasma is surrounded with a multi-layered cylindrical blanket made of the fertile materials (238U or 232Th) to convert them into fissile materials (239Pu or 233U) by transmutation through the capture of the high-yield fusion neutrons and neutron multiplier and coolant zone made of LiPb. A hybrid reactor is based on either magnetic fusion energy (MFE) or inertial fusion energy (IFE). The neutron source is volumetric in MFE systems, whereas the target represents a point neutron source in IFE plants.
In this study, the (D, T) fusion neutron driver of MFE for the hybrid reactor has been carried out. The temporal neutronic performance of the hybrid blanket have been evaluated for the NWL of 2.25 MW/m2 by full reactor power (plant factor PF=100%). Hence, this corresponds to the fusion neutron flux of 1014 (14.1 MeV) n/cm2s at FW for conventional (D,T) driven hybrid reactor. Neutronic calculations were performed by Monte Carlo Neutron-Particle Transport code MCNP5 version 1.40 in three-dimensions using three different data libraries; ENDF/B-V, ENDF/B-VI and CLAW-IV for comparing neutronic parameters. The nuclear heat deposition in the first wall (FW), tritium breeding ratio (TBR) in the blanket and radiation damage such as displacement per atom (DPA), He-production (n, α), H-production (n, p); (n, d); (n, t) for composed of FW made of different materials, namely, ferritic/martensitic steels, vanadium alloy, silicon carbide, copper alloy, and stainless steel as a lifetime of one full power year (FPY) have been calculated based on different data libraries.
In this concept, a line neutron source in a cylindrical cavity simulates the fusion plasma chamber. The latter is surrounded by a FW which various materials will be used for investigation. In this study, some different materials were considered as FW and fuel clad material. The fissile zone is composed of typical LWRs spend fuel which contain natural uranium dioxide (UO2) in hexagonal geometry as 10 rows having pitch length = 1.25 cm in the radical direction.

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Session Classification: Poster: P7

Track Classification: FTP - Fusion Technology and Power Plant Design