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Neutron spectra in hybrid fusion-fission nuclear reactors

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The Hybrid Fusion-Fission Reactors (FFHR) are arrangements formed by a nuclear-fusion device and a subcritical-fission-set. The function of the fusion device is to provide neutrons to drive the subcritical assembly which then, uses those neutrons to generate energy. These parts are arranged concentrically forming a three-layer system to optimize the use of neutrons.

Nevertheless, achieving a reasonable neutron yield, in order to drive an FFHR, is difficult with current fusion devices, which is why the use of so-called multiplier cascades has been proposed [1]. These cascades consist of concentric shells where the fissile material is placed, separated by a very large empty space. The dimensions, shape, and fuel of the shells and the size of the empty space between them, determine the multiplying capacity of the system. A distinctive feature of the hybrid reactor is that, since it is actually made up of two reactors, it requires two different fuels: in addition to the fissile material, the use of Deuterium and Tritium is required. Deuterium is a reasonably readily available gas, but Tritium, given the complications involved in storage and transportation, is preferred to be generated on-site. For this reason, a hybrid reactor while using fusion technology, will need to be fitted with a Tritium Generating Shell (TGS). This shell is usually made of a Lithium compound, which generates Tritium by means of the $^6\mathrm{Li}(n,t)^4\mathrm{He}$ and $^7\mathrm{Li}(n,n't)^4\mathrm{He}$ channels. In this work we analyze a model of FFHR following theses principles, where two shells of 8% enriched Uranium are placed as fuel, a Lithium silicate is used as TGS, and a Tungsten layer plays the role of reflector and shielding. This arrangement was simulated using MCNP5 to find the spectra of the whole system [2].

The spectra obtained show that the neutron spectra are quite similar to that expected in conventional fast reactors, and therefore, compatible with actinide burn.

References

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