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The Concept of Hybrid Reactor-Tokamak with Molten-Salt Thorium Blanket for Producing 233U out of Neutron Field

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A conceptual facility of tokamak and molten-salt thorium blanket with direct-contacted liquid-metal mass-exchanger which allows uninterrupted extracting protactinium from the blanket and accumulating it in a cascade salt trap separately from fission products.
It is supposed to use only the outer blanken without placing near the central column of the tokamak toroidal coil protection from neutron irradiation. It will allow to have a sufficiently large volume of plasma at the moderate size of facility (R = 1.7 m, a = 0.77 m). Then, the central column of the toroidal tokamak coil can be made of copper and other parts of the electromagnetic system are the superconductor ones.
At the stage of induction input of the current, the plasma has diverter configuration and then, the plasma current increases to demanded value by means of neutral injection. Numerical calculations by a code of "DYNE" have shown that one can obtain a neutron flux with power of ~15 MW and its density in the blanket of ~0.2 MW/m^2 that will provide a rate of protactinium production in the salt composition, 0.7FLiNaK+0.3ThF_4, at the level of ⊠4•10^-7 mol/s at the injection of double-weight hydrogen by power of 23 MW and ECR heating by power of 2.5 MW.
At the uninterrupted extraction of protactinium from the blanket with the same rate, such the facility can become attractive to industrial production of nuclear fuel (233U) from thorium. For extraction of protactinium and others radio-nuclides (lanthanides) from the blanket, it is offered using a reduction extraction of these elements into the liquid-metal carrier (direct-contacting liquid salt) by management RedOx potential (Fermi level) of the salt composition, 0.7FLiNaK+0.3ThF_4.
Further, establishing Fermi level in the molten salt of a first cascade of salt trap (direct- contacting the liquid-metal carrier only for protactinium oxidation allows desorbing only it from the liquid metal. In the second cascade of the trap with higher oxidation potential, one can extract the all radio-nuclides including lanthanides. At correct setup of the trap cascades, a protactinium portion in the second cascade will be 0.01 % of the first one and a portion of other radio-nuclides in the first cascade will be four orders less than in the second one. Thus, one can organize effective producing 233U from thorium as a nuclear fuel for thermal reactors.

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