Compact tokamak plasma - neutron source for hybrid reactor for producing fuel 233U

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Analysis of development of neutron sources and hybrid reactors conducted in Russia and in the world has stimulated the choice of the project, which is qualitatively different from the previous ones. It combines the required power of generated neutrons, moderate size, and the blanket convenient for continuous production of U-Pu and Th-U fuels at moderate operating costs. The main difference of the projected thermonuclear neutron source on liquid salts (TNC-LS) is to choose a plant concept with an outer blanket, lacking the inside neutron shielding of the central pillar of the toroidal coil. This makes it possible to organize the plasma column with a volume sufficient to generate the required amount of neutrons at a moderate setting (R = 1.7 m, a = 0.77 m). For this it is supposed to use the central pillar of the tokamak toroidal coil made of copper, while the rest of the EMS to be superconductors (or HTS) in a single cryostat at a temperature of 4 K. The choice of this configuration allows the use of the inductor sufficient for induction input of plasma current above which it is possible to “switch on” the maintenance of current with a beam of fast deutons. There appear some restrictions for the plasma parameters: the maximum permissible level of specific power input to the plasma, the limit on losses of fast particles in the neutrals beam, the maximum value of $\beta_N H_{y,2}$. The calculations were performed using plasmaphysical code DINA. In the calculations of the scenarios the models with free boundary and the fixed boundary were used. The energy confinement time is normalized to the energy time defined by the model IPB98(y,2) with the factor $H_{y,2}$ = 1.4. Two deuteron beams of energy of 200 keV and a power of 15 MW and 12 MW with different impact parameters 2.0 and 1.9 m were used. Heating of the electrons and additional input current of 500 kA by ECR 2.5 MW is also expected. Within 5 s the power of neutron generation reaches the correct value of P_f = 15 MW, and the flux density on the blanket ~ 0.2 MW m^{-2}. The calculations of partial substitution of deuterium beam injection by helicons for generating noninductive currents in TSN-LS have showed the ineffectiveness of such replacement. From the point of view of a given power of neutron generation, the factor of internal transport barriers leads to a decrease in power by approximately 13%. The liquid salts blanket scheme involving the electron potential, summarizing the impact of all impurities on the redox potential of the melt FLINAK + ThF4, allows us to organize the effective and continuous production of fuel for thermal reactors from thorium. The rate of accumulation of protactinium is 4 kg m^{-2} per year.