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D-T fuel system of DEMO-FNS tokamak with tritium breeding blanket

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As a part of the nuclear energy Research Center “Kurchatov Institute” development a program of creating a hybrid reactor combining nuclear and thermonuclear technologies was developed and proposed. The basis of a thermonuclear fusion reactor is neutron source (FNS) based on the tokamak [1]. The main difference from the FNS DEMO demonstration fusion reactor is that FNS is not necessary to achieve fusion plasma ignition conditions, and sufficient to obtain the neutron yield comparable to injected power auxiliary heating. The required power of thermonuclear reaction can be up to 100 times less due to the fact that most of the energy comes in a subcritical blanket due to fission reactions, which significantly reduces the requirements for the parameters of the tokamak plasma and materials.

FNS is a key system and hybrid reactor should provide steady flow of fusion neutrons with a capacity of 10-50 MW, which reached close to the pulse values of existing installations JET and JT-60U. Fuel cycle technologies (FC) is one of the key elements for the FNS. These technologies have to be developed significantly, because the technical solutions chosen ITER project can be used in FNS is only partially due to steady state operation of the plant, the higher neutron fluxes and fluxes of tritium fuel cycle elements.

To assess the distribution of tritium in fusion reactor systems and components “tritium plant” is necessary to carry out a dynamic simulation of all system elements allowing for the operation of the tokamak. Such calculations are now performed using the code «FC-FNS» [2]. The code allows the calculation of tritium flows and stocks in tokamak fusion systems. To close the FC processes of tritium in the hybrid blanket was considered.

The report is a conceptual diagram of a stationary fuel cycle FNS with 3-50 MW of fusion power, given current estimates of the distribution of tritium in fusion reactor systems and components “tritium plant.” The calculations for the neutral injection systems TC module and tritium breeding.

[1]. B.V. Kuteev, at al. // Published 26 June 2015 © 2015 IAEA, Vienna Nuclear Fusion, Volume 55, Number 7.

[2]. Anan’ev S.S. et al. Concept of DT fuel cycle for a fusion neutron source // Fusion science and technology vol. 67 mar. 2015

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