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Hydrogen isotopes distribution modeling by ”FC-FNS” code in fuel systems of fusion neutron source DEMO-FNS

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Tokamak-based fusion neutron source (FNS) [Kuteev B.V. et al 2010 Plasma Phys. Rep. 36 281, Kuteev B.V.et al Nucl. Fusion 55 (2015) 073035] is the centerpiece of the fusion-fission hybrid reactor (combining nuclear and thermonuclear technologies). In Russia, for the demonstration of stationary and hybrid technologies, the DEMO-FNS project has been developed, which should operate at least 5000 hours per year. The plasma operation in a tokamak requires the continuous injection of the fuel mixture containing hydrogen isotopes (deuterium and tritium) into the vacuum chamber, as well as its subsequent pumping out and processing. Calculation of the distribution of tritium (as well as deuterium and protium) in fuel systems is important for assessing safety features of the facility and for designing these systems. To simulate hydrogen isotope flows and inventories in the fuel systems of FNS, computer code FC-FNS [Ananyev S.S. et al Fusion Eng. Des. (2016), Volumes 109–111, Part A, pp 57–60] has been created that continues to be developed. This report describes capabilities of the code. The results of calculations are presented for the conceptual design of DEMO-FNS. The balance of three hydrogen isotopes is taken into account, the performance of deprotiation systems is calculated to maintain the required level of protium in the plasma tokamak and detritiation (for the variant of the neutral injection system - NBI). Three alternative scenarios for supplying gas to NBI system are simulated. It is shown that the proposed approach to NBI fueling allows reducing the total amount of tritium in FS up to 1.5 times, that leads to the initial loading for DEMO-FNS of 460 g. The time for tritium breeding up to the amount sufficient for starting a new similar device will be 2.5 - 4 years (for different scenarios for FS NBI).

Co-author: Dr ANANYEV, Sergey (NRC Kurchatov institute)

Presenter: Dr ANANYEV, Sergey (NRC Kurchatov institute)

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