Self-consistent plasma parameters simulation via ion transport equations and gas flows in tritium fuel cycle for DEMO-FNS [[1]](#footnote-1)\*)

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The progress of an integrated modelling of particle flows in the tritium fuel cycle (FC) systems for a fusion neutron source based on a tokamak [1] is described. An indirect combination of ASTRA, SOLPS4.3 and FC-FNS codes [2] is used. A feedback between the pumping and injection systems is implemented in the form of the isotopic composition change in core and divertor (near-wall) plasma. The ASTRA code solves particle transport equations for ions instead of electrons. This makes it possible to estimate the partial confinement times of ions in plasma from different sources (neutral injection, pellets, gas injection, recycling) more correctly. In the range of confinement parameters τp/τE = 0.75–2.5, the partial confinement times of particles from different sources —beams of fast atoms, pellets, and neutrals through the separatrix—are calculated. Using them the D/T fuel component flows, which should be provided by injection and gas support systems, were found. Fuel pellet fluxes must be up to 1022 particles/s to provide a given plasma density. The fuel flow increases from 2 to 3 times depending on the value of αELM to compensate the particles losses due to ELMs [3]. It is less than previously estimated. The value of gas puffing is analyzed taking into account the probable gas desorption from the vacuum chamber walls [4]. The limitations due to the chosen engineering solutions are shown. Over most of the operating range, additional ELMs pace making (with pellets ~ 1 mm with LFS) must be applied to maintain controlled energy loss δWELM ~ 0.5 MJ. About 500 g of tritium will be required for the initial loading of the fuel cycle and steady-state operation of the facility, including losses due to radioactive decay. Tritium inventories at the facility site (excluding long-term storage) for the convective ELMs scenario will increase to 600 g.

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References

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