CALCULATION of TOKAMAK exhaust COMPOSITION, COMPARISON WITH THE EXPERIMENT [[1]](#footnote-1)\*)

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To simulate and develop a tritium-deuterium fuel cycle (FC) of a hybrid tokamak-based reactor DEMO-FNS, the FC-FNS electronic code created at the National Research Center "Kurchatov Institute" is used [1]. The fuel cycle model is developed in accordance with the changes and improvement of the DEMO-FNS project. In its current state, the FС-FNS code allows for consistent calculations of the fuel isotopes flows and their accumulation in all FC systems. The results of the simulation are necessary for the analysis, selection and substantiation of technologies for application in the fuel cycle of the DEMO-FNS reactor.

As part of FC-FNS code developing, it is planned to expand the range of components under consideration. For this, a module for calculating the composition of the tokamak exhaust was created. This will make possible to calculate the composition of the gas flow in the fuel cycle systems of the DEMO-FNS taking into account impurities (O2, N2, CO2, etc.) and hydrogen-containing compounds (H2O, CH4, NH3, etc.), including hydrogen isotopomers (H2, HD, D2, DT, T2) and other molecules. In the future, all calculation modules of the code will be supplemented with algorithms for calculating molecular compounds and transferred to a new software platform. This will simplify the integration of individual system modules, as well as provide a more convenient user interface.

For the calculations, a statistically equiprobable model of the chemical compounds formation applied based on the composition of gases injected into the plasma, impurity compounds entering the plasma and the pumping system, as well as atmospheric gas leakage. The calculation results were compared with the experimental data on the JET [2] and JT-60 [3] tokamaks and with the calculations performed for the ITER [4]. As a comparison result, it was shown that the exhaust composition of the JET and JT-60 tokamaks (experimental measurements) and ITER (calculated values) differs from the equiprobable ones by up to several tens of percent. To comply with the experimental data, it is necessary to select the correction factors, as well as the values of the atmospheric leakage and impurity gases flows. Such a normalization procedure is currently being carried out and will be continued in the course of experiments on the T-15MD tokamak and equipment for testing FC technologies. The obtained algorithm is planned to be used to analyze the influence of the gas injection, impurity and atmospheric gases on the operation of the tritium-deuterium fuel cycle systems of the DEMO-FNS facility, as well as on the accumulation of tritium in them.

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References

1. S.S. Ananyev, A.V. Spitsyn, and B.V. Kuteev, “Electronic model «FC-FNS» of the fusion neutron source DEMO-FNS fuel cycle and modeling hydrogen isotopes flows and inventories in fueling systems,” *Fusion Eng. Des.*, vol. 138, no. December 2018, pp. 289–293, Jan. 2019.
2. S. Grünhagen Romanelli *et al.*, “Gas analyses of the first complete JET cryopump regeneration with ITER-like wall,” *Phys. Scr.*, vol. T159, no. May 2013, p. 014068, 2014.
3. Y. Kobayashi *et al.*, “Analysis of exhaust gas in JT-60U tokamak operation,” *Proc. - Symp. Fusion Eng.*, vol. 00, no. C, pp. 1–4, 2005.
4. R.J.H. Pearce *et al.*, “Gas species, their evolution and segregation through the ITER vacuum systems,” *Vacuum*, vol. 86, no. 11, pp. 1725–1730, 2012.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/Mu/ru/BN-Ivanov.docx) [↑](#footnote-ref-1)