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FUEL CYCLE OF TOKAMAKS CREATED AND DESIGNED IN THE RUSSIAN FEDERATION *)

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According to the project "Thermonuclear Fusion Technologies" (as part of the national project "New Nuclear and Energy Technologies") passport, it is planned to build a tokamak with reactor technologies (TRT) by 2030 as a step towards a hybrid reactor facility (HRF). At the same time, it is also planned to retrofit the T-15MD tokamak, created at the National Research Center Kurchatov Institute, and bring it to full design capacity. All facilities created and designed in the Russian Federation will solve various problems and will differ from each other. In fact, the created TRT facility will have to "intercept" the baton/relay from the T-15MD in relation to modern physics and technology of tokamaks and their further development. The hybrid facility of the next generation of HRF will have to produce neutrons for testing all tokamak technologies under neutron irradiation conditions and solving problems of materials science (including for fusion reactors) [1, 2].

The operation of the T-15MD involves the use of protium and helium as working gases, excluding deuterium (however, allowing its admixture - for diagnostic purposes). The TRT plans to work with deuterium and trace amounts of tritium - as a fuel component and a product of the D-D reaction. The HRF should be designed to work with large inventories of fusion fuel (D and T), sufficient for the systems steady-state operation mode and the blanket modules testing [3].

To create a HRF, it will be necessary to develop, integrate into a single complex (tokamak) and conduct a trial operation of all key technologies and systems of the FC. For this purpose, a system for handling hydrogen isotopes as fuel is planned at the TRT facility - a prototype of a fusion (tritium) fuel cycle (FC).

The principles and technologies/components for the FC of the TRT and HRF facilities can be tested at the T-15MD tokamak, competencies in handling hydrogen isotopes (non-radioactive) and modeling processes both in the main/divertor plasma and in the FC systems can be developed. Carrying out these works is an important stage for ensuring the safe operation of the controlled thermonuclear fusion facility (CTFF) and the corresponding licensing (for CTFF, safety requirements specific to nuclear facilities must be met, according to the upcoming amendments to Federal Law No. 170-FZ). The report describes an approach to organizing the tokamak infrastructure - gas pumping, injection and processing systems for the T-15MD, TRT and HRF facilities, and also proposes solutions for the composition of the FC systems for each facility and a roadmap for the development of FC technologies, ensuring their readiness for the creation of a HRF. The composition of the FC systems and their parameters are selected based on the expected scientific and physical tasks, plasma parameters and operating scenarios of the facility. Previously, a similar approach was applied to the FNS-ST and DEMO-FNS tokamak projects, which made it possible to develop and optimize the structure and technologies of the FC for them in order to reduce tritium reserves at the facility site and intensify the neutron flux.

References

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^{*)} abstracts of this report in Russian