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APPROACH TO DETERMINING PARAMETERS OF TOKAMAK INFRASTRUCTURE – GAS PUMPING, INJECTION AND TREATMENT SYSTEMS (FUEL CYCLE) BASED ON PLASMA PARAMETERS *)

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Almost all candidate nuclear fusion reactions involve the use of hydrogen isotopes as one or more fuel components. Tritium will be present (as a fuel component and product) in the D-T and D-D reactions. Any promising fusion facilities or reactor using tritium requires a tritium fuel cycle (hereinafter referred to as FC) [1, 2], capable of processing all tritium that did not participate in the fusion reaction, releasing tritium and deuterium and removing impurities, as well as providing separation deuterium and tritium to isolate fuel components of sufficient purity and quality to support plasma operations. The complex of FC systems is also a necessary component of any tokamak facilities, even if it operates with non-radioactive hydrogen isotopes. In this case, the composition and architecture of the FC will differ from the case of tritium design, however, all the key laws and principles of organization will remain the same.

The approaches and solutions used in the TFTR and JET facilities, INTOR and ITER projects cannot be fully used due to the pulse-periodic operating mode and experimental purpose of these facilities. In a steady-state operating facilities using tritium as a fuel component, it is necessary to continuously process significant quantities of it, avoiding excessive accumulation and losses in each individual system, and also take into account the influence of the combustion modes of fusion plasma in the tokamak and plasma-wall interaction parameters. This requires the selection of technological solutions based on information about gas flows and its isotopic composition, their integration and optimization to ensure target plasma parameters in various plant operating scenarios.

To date, the authors are not aware of any published simulation method that could relate plasma discharge parameters to the applied fuel cycle technologies. The report describes an approach to determining the parameters of the tokamak infrastructure - gas pumping, injection and processing systems (fuel cycle) based on plasma parameters and processes occurring in the vacuum chamber of the facility. The approach was applied to the FNS-ST and DEMO-FNS projects being developed at the «Kurchatov Institute» Research Center. The proposed solutions may make it possible to design the infrastructure of a tokamak with reactor technologies TRT and steady-state operation facility for controlled fusion with magnetic confinement (within the framework of federal project 3 "Development of thermonuclear and innovative plasma technologies" of the complex program of the State Corporation Rosatom "Development of equipment, technologies and scientific research in the field of use of atomic energy in the Russian Federation"). Federation for the period up to 2030"), and coordinate these systems with plasma discharge scenarios and the operation of the facility itself.

Further development of the approach proposed by the author using more complex and accurate models and codes is the subject of future work (not so much for the authors themselves, but in the interests of developing the direction in the Russian Federation), requiring the involvement of a significant number of high-level specialists and the creation of a team.

References

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