TECHNOLOGIES FOR PROCESSING AND HANDLING OF DEUTERIUM-TRITIUM FUEL IN A FUSION/HYBRID REACTOR

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Fusion reactors and hybrid fusion-fission systems (FFHS) [1, 2], using hydrogen isotopes as a main fuel, are promising in the electricity production, the fissile nuclides for fission reactors production as well as fundamental and applied research using intense neutron fluxes [3]. It will require the organization a fuel cycle in such facilities, which ensures the fusion burning plasma by hydrogen isotopes as well as fuel mixtures processing and the tritium breeding. Today, prototypes of the fuel cycle system for fusion facilities have been created both in Russia and abroad. An example of a domestic project is the tritium plant of the TSP tokamak (JSC "TRINITI") as well as tritium plant of the long-term tritium fuel pellets injection at VNIIEF [4].

Tritium systems were created and successfully operated on the TFTR (USA) and JET (England) tokamaks, which use different approaches when working with tritium and operating experience, these facilities can be useful in creating future fusion reactors. The efforts of the world community in recent years have been aimed at designing the fuel cycle of the ITER tokamak, which plans to begin experiments with deuterium-tritium plasma in 2034. The experiments will include testing tritium breeding technologies.

The possibilities of expanded tritium breeding in the FFHS are also being discussed. The hybrid plant will be able to reproduce fuel both for self-sulfficient work and for external consumers. In the FFHS due to a significant tritium production coefficient increasing by one fusion neutron, it is possible to produce fuel for the first load of thermonuclear reactors. In the considered facilities the fuel systems architecture will have its own specifics with a common ideology. Steady-state operating conditions will require optimization of fuel systems and technologies, an increase the fuel mixture processing efficiency and a maximum reduction in the tritium amount in the fuel cycle.

The report provides an overview of various fuel cycle concepts for fusion facilities, which have been discussed by the international community over the past 30 years. Methods for modeling fuel flows and the tritium amount in facility used by their designers are discussed. The analysis results of candidate technologies that can be used in the design of the fuel cycle basic systems for fusion facilities are presented [5].

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