



IAEA FEC 2014

Contribution ID: 309

Type: **Poster**

Concept of Fuel Cycle for a Fusion Neutron Source

Friday 17 October 2014 08:30 (4 hours)

This report will describe conceptual design of the fusion DT fuel cycle for steady-state facility DEMO-FNS project in comparison with fuel cycle for FNS-ST and with engineering design of fuel cycle for T-15 tokamak which is considered as mockup of the fuel cycle without tritium.

Project DEMO-FNS is developed for demonstration of fusion and hybrid technologies and it requires technologies with resource up to 5000 hours/year, remote maintenance, significant amount of tritium involved in the fuel cycle.

Optimization of the fuel cycle characteristics was aimed at integration of the blanket in the tokamak design, pumping systems, fuel feed systems and fueling of additional heating systems, water and gas detritiation waste, reduced flows and inventory of hydrogen isotopes and tritium in the fuel cycle subsystems. Special attention was paid to safety issues. Distribution of hydrogen isotopes in technological systems and rooms, possibilities and consequences of explosions and fires at the facility, the maximum emissions of radiotoxicity in case of any accident were estimated.

In the concepts of the fuel cycles the following new provisions are used:

- noncomplete separation of D/T mixture and using equal shares of D and T;
- choice of turbomolecular pumps for a ~1 MW level facility and cryogenic pump for a higher than 10 MW facility;
- small fraction of fuel (0.5-5%) delivering to the hydrogen isotope separation system;

Studies confirm feasibility of the fuel cycles for the facilities considered. Tasks on technology life time, as well as problems of safety and licensing require a significant R&D program. Consistent implementation of the fuel cycles systems for T-15 and then for DEMO-FNS will provide the opportunity for fuel cycle of the next level facilities like pilot hybrid reactor and DEMO.

Country or International Organisation

Russian Federation

Paper Number

FIP/P7-13

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Session Classification: Poster 7