Concept of Tritium Processing and Confinement in Fuel Cycle of Ignitor

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This work presents further development of engineering assessment for the joint Italian and Russian project IGNITOR. One of the key tasks among initial tasks for execution of the project is to determine different types of the engineering systems which will be required to support the engineering infrastructure of IGNITOR tokamak. One of the most important systems will be tritium fuel cycle and detritiation systems, which provides tritium reprocessing and confinement during performance of the scientific program.

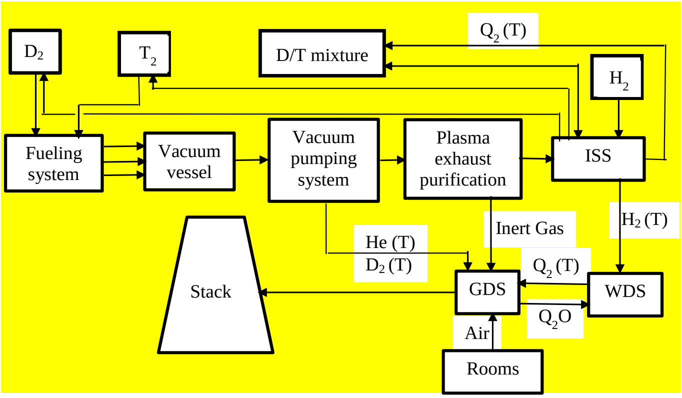

FIG.1. Block Diagram of Fuel Cycle

TABLE 1. MAIN DESIGN PARAMETERS OF TRITIUM HANDLING AND DETRITIATION SYSTEMS

System	Main design parameters
Tritium Storage	Gas cylinder of 10 L volume at operation pressure of 0.4 MPa
Deuterium Storage	Gas cylinder of 60 L volume at operation pressure of 0.4 MPa
Storage of Deuterium and Tritium Mixture	Gas cylinder of 60 L volume at operation pressure of 0.4 MPa
Plasma Exhaust Purification System	Processing capacity up to 10 mol/h, chemical purity of molecular hydrogen 99.9 % or higher
Isotope Separation System	Isotopic purity of deuterium and tritium products above 99 %
Water Detritiation System	Processing capacity of 10 kg/h of tritiated water; electrolyser of 25 Nm^3/h of hydrogen production capacity; detritiation factor to be provided by LPCE column $10^5 – 10^6$ depending on tritium concentration in electrolyser
Gas Detritiation System	Processing capacity of 500 m^3/h; detritiation factor $10^3 – 10^4$ depending on tritium concentration at inlet

Conclusion

Based on review of the technologies and arrangements for fuel cycles of experimental fusion reactors, such as JET, TFTR, ITER, an optimized arrangement for fuel cycle of the reactor Ignitor is proposed. This includes:

- ***Storage of pure tritium, deuterium and their mixtures in for of compressed gas in vessels of volume around 10 to 40 liters at pressure of 0.4MPa.***
- ***Chemical purification of plasma exhaust from gaseous impurities using method of hot getters, eg uranium.***
- ***Separation of hydrogen isotopes by method of replacement gas chromatography.***
- ***Detritiation of gaseous effluents and air using catalytic conversion of hydrogen containing gases to water vapour followed by detritiation of produced water vapour in wet scrubber.***
- ***Use of CECE (Combined Electrolyser Catalytic Exchange) technology for detritiation of water streams.***

All technologies listed above are well developed in Russia, in authors point of view their application in an integrated matter would ensure good protection of workers, public and environment against exposure to tritium, and construction and operation of the fuel cycle and detritiation systems in a cost effective way.