CANDIDATE TECHNOLOGIES FOR THE NEUTRAL INJECTION SYSTEM OF DEMO RF REACTOR [[1]](#footnote-1)\*)

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In currently designed power plants for controlled thermonuclear fusion (FR) with plasma confinement in a magnetic field in vacuum chambers with a toroidal configuration (tokamak), it is assumed that powerful beams of hydrogen isotope atoms are injected to heat the plasma to conditions that ensure efficient fusion reactions and to ensure conditions for stable current maintenance in the plasma core (see, for example, the well-known international project ITER, as well as many national projects in Europe, China, Japan and et al.). The atoms energy of the beam is largely determined by the plasma parameters and the dimensions of the plasma core. For a power plant, it will be from 500 to 1000 keV per nucleon. With such particle energy, it is advisable to use a beam of negative ions (NI) to effectively accelerate to the required energy and subsequent neutralization, since the efficiency of obtaining atoms from positive ions becomes negligible even at energies above 150 keV per nucleon.

At the moment, the most representative is the injector developed by the international team for more than 25 years as part of ITER, which we will consider as the basic concept for the DEMO of the Russian Federation. The main parts of the injector will always be the source of the NI, the NI beam accelerator, the stripping target — the neutralizer, the receiver of the residual NI and generated positive ions, the absolute gate valve at the entrance to the atomic duct through which the atomic beam passes to the exit window to the tokamak. As well as the main auxiliary systems: a system for pumping the gas released in the injector, a magnetic system that reduces the magnetic field from the tokamak to acceptable levels along the beam path in the form of an NI, and a cooling system for the tract surfaces to which energetic particle particles fall.

For the operation of NBI as part of a power plant, its efficiency is of great importance, which is largely determined by the efficiency of the conversion of NI to atoms in the neutralizers and the loss of a neutral beam (NB) when it moves along the path to the input window of the tokamak. So for the ITER NBI system, in the injectors of which neutralization of NI in gas neutralizers is provided, numerous estimates of the total efficiency of the system give values ​​of no more than 30%. Moreover, more than 40% of NB power losses are related to neutralization efficiency (Fmax), which is less than 60%. In addition, the gas flowing out of the neutralizer creates an increased background pressure along the path, at which up to 10% of the NB power is lost due to the process of atom re-ionization. Since it is difficult to expect a noticeable increase in the efficiency of systems that ensure the operation of NBI, the main task lies in increasing the efficiency of the entire beam path.

The report provides an analysis of technologies that can be used in various elements of the injection path in order to increase Fmax and the efficiency of transporting NB into the plasma. The advantages and disadvantages of various circuits with converters are considered: gas, plasma, photon and based on a supersonic jet of lithium vapor.

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Mu/ru/AK-Anan'ev.docx) [↑](#footnote-ref-1)