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CALCULATION OF TORQUE APPLIED TO PLASMA IN NBI INJECTION EXPERIMENTS ON THE TUMAN-3M TOKAMAK *)

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Injection of high-energy neutral atoms is an effective method for plasma heating, generating of rotation and radial electric field in modern magnetic fusion devices. Toroidal rotation of the plasma generated by fast ions, as well as by fast ions losses, can lead to strong spatial inhomogeneity of the radial electric field. The spatial distribution of the velocity of toroidal rotation and the associated radial electric field depend not only on the parameters of the background plasma and the NBI power, but also on the geometry of the injection, in particular, on whether the velocity of the injected atoms is co-directed with the plasma current (co-injection) or counter-directed to the current (counter-injection). The generation of toroidal rotation during NBI is of interest from the point of view of its influence on the possibility of suppressing magnetohydrodynamic instabilities. It is worth noting that the generation of a non-uniform electric field at the periphery of the plasma can contribute to the triggering of the L-H transition.

The report is devoted to the calculation of the torque generated in plasma by a fast ion beam under various injection scenarios in the TUMAN-3M tokamak. The calculations were carried out using the ASTRA transport code [1] and NUBEAM code [2].

The calculation results indicate that for the NBI experiments in the TUMAN-3M geometry there exists an optimal plasma concentration $n_e(0) = 3\cdot10^{19}$ m^{-3}, at which the value M_T^{core} reaches maximum. In addition, the calculations have shown a strong dependence of M_T^{core} on the beam power P_b. An increase in P_b from 190 kW to 350 kW leads to an increase in $M_T^{core}$by 65%, but the increase in M_T^{core} with increasing P_b is slower than expected in the absence of direct beam power losses. After taking into account the direct beam power losses, the change in M_T^{core} is in good agreement with the change in the absorbed beam power. The calculations revealed a change in $M_T^{core}$with a change in the isotopic composition of the target plasma and the beam. The calculation results allowed selecting the optimal isotopic composition of the plasma and the injected beam for generation the torque. When a hydrogen beam is injected into the hydrogen plasma, the M_T^{core} value in the central region of the plasma has a maximum, compared to the other injection scenarios.

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*) abstracts of this report in Russian