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PLASMA POTENTIAL EVOLUTION IN THE SCENARIOS WITH CRYOGENIC PELLET INJECTION IN TUMAN-3M TOKAMAK *)

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Pellet injection in the tokamak plasma is one of the methods of plasma confinement control. Fuel cryogenic pellets provide the effective deposition of large number of particles in the central area of plasma column. Peripheral evaporation of the pellet leads to the formation of the area with steep gradients of electron and ion pressure, which directly affects plasma confinement and could facilitate the initiation of H-mode – the improved confinement regime.

In TUMAN-3M tokamak (R=0.55 m, a=0.22 m, $B_T < 1$ T, $I_p < 180$ kA) the series of experiments with fuel cryogenic pellet was carried out. In the experiments the evolution of plasma potential in the central and peripheral areas was studied by means of heavy ion beam probe (HIBP) and Langmuir probes [1].

Pneumatic injector designed by PELIN [2] on TUMAN-3M tokamak provides tangential injection (impact parameter R_p = 54 cm) of up to four cryogenic fuel pellets with velocity of 200-600 m/s; evaporation is localized in peripheral area r/a < 0.4. Optical detector of H_α/D_α line emission with directivity pattern along the pellet trajectory was used to observe pellet evaporation curve in plasma.

Evolution of plasma parameters observed in the experiments could show that pellet evaporation in the present experimental design leads to temporal (up to several ms) confinement improvement, which is characterized by the formation of peripheral transport barrier, after which plasma returns to usual Ohmic confinement regime. Observed signs of peripheral transport barrier formation are: a) decrease of local peripheral density (outside the transport barrier) with simultaneous increase of line average density; b) decrease of peripheral Dα line emission; c) decrease of high frequency fluctuations intensity, including the ones observed by fast magnetic probes (which is regularly observed in TUMAN-3M tokamak during L-H transition). Transport barrier formation is followed by the generation of peripheral negative Er, which is observed as the evolution of plasma potential in the direction of negative values. HIBP measurements sow that pellet evaporation yields potential decrease of about 200 V relatively to the reference discharge without pellet injection.

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References

[1]. Belokurov A.A. et al // Tech. Phys. Lett. (Russian version) 2024 50 21 51
[2]. Vinyar I. V. et al // Instr. and Experimental Techniques 2006 49 5 717

*) abstracts of this report in Russian