DOI: 10.34854/ICPAF.51.2024.1.1.096

COMPARISON OF THE ENERGY BALANCE IN OHMMIC AND NEUTRAL BEAM HEATED PLASMA AT GLOBUS-M2 TOKAMAK *)

Zhiltsov N.S., Kurskiev G.S., Bakharev N.N., Gusev V.K., Kiselev E.O., Minaev V.B., Miroshnikov I.V., Mukhin E.E., Novokhatsky A.N., Petrov Yu.V., Sakharov N.V., Solokha V.V., Telnova A.Yu., Tkachenko E.E., Tolstyakov S.Yu., Tukhmeneva E.A., Shchegolev P.B.

Ioffe Institute, Saint-Petersburg, Russia nisovru@gmail.com

The work presents the heat conduction analysis, performed for the plasma of Globus-M2 tokamak. The Thomson scattering diagnostics provided the detailed measurement of electron temperature T_e and density n_e spatial distributions. However, direct comparison of T_e and n_e can only provide qualitative information on thermal confinement in these specific tokamak discharges. The joint analysis of energy and particles balance as well as poloidal magnetic field flux was performed in order to study thermal confinement generally and to compare results with other machines. The inverse problem was solved using ASTRA transport code, providing estimations of thermal conductivity, diffusion coefficients and energy confinement time.

The analysis was performed for a set of tokamak discharges in a wide range of electron densities of n_e 0.5-10·10^{19} m^{-3} with plasma current I_p = 0.4 MA and toroidal magnetic field B_T = 0.8 T. The presented work compares two scenarios of tokamak discharges. The first one is discharge with only ohmic heating applied to plasma. The second employs auxiliary plasma heating by neutral beam injection with energy E_{NBI} up to 40 keV. In the ohmic scenario electron temperature decreases with electron density rise from 1.2 keV at 1·10^{19} m^{-3} to 0.6 keV at 8·10^{19} m^{-3}. On contrary, for the neutral beam heating scenario electron temperature almost does not depend on density at high electron densities, reaching 1.2 keV at 8·10^{19} m^{-3}. The dependence of power $P_{e\text{-}i}$, transferred from electrons to ions, on electron density and dependence of energy confinement time τ_E on density were calculated in order to explain the difference in electron temperature in these scenarios. The obtained energy confinement time compared with well-established scaling laws both for classical and spherical tokamaks. The critical electron density, describing transition from linear ohmic confinement regime to saturated ohmic confinement, compared with neo-Alcator scaling.

The work was carried out at the Unique Scientific Facility «Spherical tokamak Globus-M», which is incorporated in the Federal Joint Research Center «Material science and characterization in advanced technology».

*) abstracts of this report in Russian