Study of the transport coefficient dependence on the heating power in self-organized plasma in the T-10 tokamak

N.V. Kasyanova[1,2], K.A. Razumova[1], A.A. Borschegovskij[1], M.M. Dremin[1], N.A. Kirneva[1,3], S.V. Krylov[1], T.B. Myalton[1], G.E. Notkin[1], Yu.D. Pavlov[1], D.V. Ryzhakov[1], D.V. Sarychev[1], D.S. Sergeev[1], M.V. Chukanov[1]

[1] *National Research Center "Kurchatov Institute", Moscow, Russia*

[2] *Moscow Institute of Physics and Technology, Dolgoprudny, Russia*

[3] *National Research Nuclear University MEPhI, Moscow, Russia*

Effect of the energy confinement enhancement during impurity gas puffing in the T-10 tokamak is studied. Experiments were carried out with Ne and He puffing in various regimes with ohmic heating (OH) and on- and off-axis ECR heating (I_{pl}=230 kA, B_z= 1.9 - 2.3 T, n_e=1.5-4x10^{19} m^{-3}, P_{ECRH}=0.45-1.3 MW). It was shown that in both OH and ECRH regimes the stored energy first increased with growth of the radiation losses in the plasma edge due to the impurity gas puffing and then it reached a saturation level W_{sat}. It is found that for on-axis ECRH deposited in a narrow area in the center of the plasma the energy saturation level depends only on ECRH power and doesn't depend on the kind of impurity.

In this work, the explanation of the observed effect from a plasma self-organization position is offered. This approach assumes that the plasma pressure profile is self-consistent. Relaxation of the pressure profile distorted by external impact is described by the energy balance equation obtained in [1]. In this equation the transport coefficient χ can be written as follows: $\chi = \theta(\chi_0+\chi_1)$. The first term χ_0 corresponds to the undistorted self-consistent pressure profile, the second term $\chi_1(\Gamma_1)$ depends on the radial heat flux Γ_1 disturbing the pressure profile. During impurity gas puffing the radiation losses in the plasma periphery increase resulting in decrease of the radial heat flux Γ_1, hence the transport coefficient χ in the plasma edge reduces until it reaches the minimum value χ_0. As a result the stored energy of plasma increases and reaches the saturation level. The value χ_0 doesn't depend on the heating power and can be determined from the energy saturation level W_{sat}. The value χ_1 is obtained from dependence of the stored energy on the power of OH and ECR heating. The dependence of W_{sat} on plasma parameters is defined by the coefficient $\theta \sim p_0\beta_0/q_L$.

[1] K.S. Dyabilin and K.A. Razumova. Nucl. Fusion 55 (2015) 053023