INFLUENCE OF source location OF MASSIVE GAZ INJECTION on evolution of discharge disruption in T-10 tokamak

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Operation of modern machines with magnetic confinement of high temperature plasma depends essentially on the prevention of disruption of the plasma shot and the ability to smooth and control output of energy stored in the plasma.

Experiments on a massive gas injection into T-10 tokamak were performed in May 2014, to continue research presented in [1, 2]. A positionable valve was used during the experiments to inject argon and it were varied different parameters such as the position of the gas jet source relatively to plasma edge, the amount of gas and/or its pressure. As a result, the first data on the influence of the valve position of the positionable massive gas injection system (PMGI) on the parameters of the discharge disruption in the T-10 tokamak were obtained.

The ability of positioning of the valve relatively to the plasma edge makes the PMGI system unique due to the possibility of scanning the distance up to the plasma what does not have any other system of massive gas injection. Using this advantage in the experiments, it was measured a dependence of disruption evolution on the valve nozzle position relatively the plasma edge.

Experiments demonstrated, as expected, that than closer valve is positioned to the plasma, then faster and more intense thermal quench occurred because supersonic gas jet reaches the plasma is denser and more directed. It was also noted that the integral amount of energy radiated during the thermal quench has an equal value in identical discharges, in spite of different distance to the valve in these and, as a consequence, the different evolution of the radiative losses.

Valve position affects not only the character of thermal quench, but also the subsequent quench of the plasma current: the farther is the valve from the plasma, the slower is current ramp down during the quench. Dependence has two characteristic regions. In the near region - the distance r from the valve to the center of the plasma discharge is not more than twice the minor radius of the plasma column (a < r < 2a) – the dependence is strong. In the near region a shift of the valve on 1 cm straight to the plasma increases the rate of current quench at nearly 1000 A/s. In the far region - the distance from the valve to the center more than twice the minor radius of the plasma column (r > 2a) – the dependence is weak. In the far region a shift of the valve on 1 cm straight to the plasma increases the rate of the current quench on 5 A/s only, i.e. 200 times less than in the near region. This is accordingly changes the duration of the current quench. The propagation time of the gas from nozzle of PMGI up to plasma was less than 1 ms at a location of the valve in the near region, and from 1 to 3 ms in the far region.

The report provides a comparison with earlier experiments in which was found the possibility of transition from a slow current quench to a fast one using a massive gas injection during the discharge disruption [2].

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References

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2. Dremin M.M. et al., Problems of Atomic Science and Technology, Ser. Thermonuclear Fusion, 2012, issue 4, pp. 58—70.