specific FEATURES OF DISCHARGE DISRUPTION initiated BY MASSIVE GAS INJECTION inTO THE T-10 tokamak

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One of the key problems of modern large facilities with magnetic confinement of high temperature plasma, and in particular, under construction tokamak reactor ITER, is the selection of the optimal scenario of controlled quench of the discharge and reduction to the minimum of probability of uncontrolled plasma disruptions.

T-10 tokamak has active systems to control the plasma column, allow both to develop scenario of controlled quench of the plasma and to study the various options of the quench and the suppression of plasma runaway electron beams. Except of regular monitoring systems of the plasma current, the control system of currents in the main and controlling coils of a tokamak and system of piezovalves for the working gas puff, in the experiments on the plasma quench can be involved hydrogen pellet injector, as well as positioning and stationary pulsed gas valves for the massive gas injection [1].

The massive gas injection can be applied both before plasma breakdown and during it. In the first case the gas puffing initiates plasma disruption and can be used for selection scenario of optimal quench of the plasma. In the second case, a massive gas injection used to prevent formation and suppress arisen runaway electron beams.

Since 2011 at the T-10 tokamak a unique positioning valve for massive gas injection (PMGI) is used [2]. Its advantages are the ability to be set in the wide range from the edge of the plasma column (nozzle – gas source – can be located both close to the plasma, and at distances up to 1 m from the plasma boundary), the work at the high gas pressure (in the experiment was reached pressure of 47 bar, a further rise in pressure is followed by overload of tokamak pumping system), the sharp front of the gas pulse (about 300 µs) and short activation times (about 3 ms from the front of the electrical trigger to the gas reaches the plasma boundary).

The report presents the characteristics of disruption by a massive gas injection via both fixed and positioning pulsed gas valves. The possibility of regulation of the disruption hardness both by changing the position of the valve with respect to the plasma boundary, and with the pressure change for different sorts of the injected gas. It has been demonstrated the possibilities to suppress runaway electron beams using PMGI. We propose a scenario of plasma discharge mitigation using a gradual reduction of the plasma current by the control system of the tokamak, followed by injection of gas with the stationary valve initiating thermal disruption and finally gas injection with PMGI at the plasma edge to suppress the runaway electron beams.

This work was supported by grants of RFBR №13-02-01409-№14-02-00697-a and a. The authors thank the staff of the T-10 for the data and support.

References

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