Two-dimensional Modelling of Disruption Mitigation by Massive Gas Injection

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Abstract

In the future tokamak ITER the damage to the wall after the disruptions can be mitigated using preventive massive gas injection (MGI) of noble gases into confined plasma during the thermal quench. The gas gets ionized in the plasma, and then the ions dump into the scrape-off layer (SOL) and impact on the target. The contamination of core plasma results in fast loss of plasma energy by radiation. The radiation distributes over the first wall which decreases the damage to divertor plasma facing components. However, enhanced radiation load in e.g. vicinity of gas jet entry is an issue for ITER design that can be addressed numerically.

For the modelling the tokamak code TOKES is applied. Preliminary results on modelling of MGI with TOKES have been presented in [1]. The code was upgraded with simplified toroidally symmetric two-dimensional plasma model, which allowed estimations of radiation fluxes and the expansion of noble ions both across and along the magnetic surfaces. However, a simplified quasi-stationary radiation model employed in [1] does not allow validation of numerical results against tokamak experiments. The processes only in the confined region inside the tokamak separatrix were taken into account and the plasma surface interaction neglected.

In this work non-stationary radiation model for two-dimensional plasma implemented in TOKES is described. Improved 2D modelling of plasma and neutrals in the whole tokamak vessel with account of wall processes is achieved. Due to this the contribution of atoms eroded and emitted from the wall surface during MGI to the plasma contamination is numerically estimated. Comparisons of elaborated modelling results for the injection of neon and argon into deuterium confined plasma with the experiments at DIII-D and JET are done and predictive simulations for ITER with assessments of radiation fluxes from the contaminated plasma onto the beryllium wall are performed.

[1] I.S. Landman et al., Modelling of Wall and SOL Processes and Contamination of ITER Plasma after Impurity Injection with the Tokamak Code TOKES. ISFNT-9, 11-16 Oct 2009, Dalian, China, paper PO3-149.