PREDICTIVE TOKES SIMULATION OF MASSIVE GAS INJECTION IN ITER

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The plasma disruptions, that is undesirable abrupt discharge termination are inavoidable feature of tokamak confinement. The uncontrolled disruption can considerably damage the first wall in the tokamak-reactor discharge. Modern tokamaks like JET, DIII-D, ASDEX-U and others have sussessfully used the massive gas injection (MGI) for mitigation of the divertor and limiters heat load and damage. For MGI the noble gases, Ne or Ar or a mixture of the noble gas with deuterium are used.

First estimations of the radiation heat flux to the ITER first wall has been already done in [1] using the TOKES code with rather rough model assumptions. Further development of the model is done in this paper. The feasibility of pre-emptive disruption initiation, for mitigation of the first wall damage, by MGI in ITER is discussed, paying main emphasize on the physics issues and the efficiency of the method. Energy balance in multi-component plasma after noble gas injection and the possibility of redistribution of the heat fluxes over a large wall surface during the thermal quench are analysed. The main question of energy balance is to assess the minimum necessary (but tolerable as regard to pumping system concerns) amount of injected impurity, needed for irradiation of substantial thermal energy amount during several ms after injection to avoid the material damage, that is melting or brittle destruction.

The importance of impurity dynamics in the tokamak plasma inside the separatrix, a non-equilibrium radiation (when cooling rate exceeds the ionization rate) and plasma rotation, including drifts are considered in view of the expected asymmetry of radiation power deposition on the first wall.

The generation of secondary runaway electrons in such complex plasma is considered by taking into account a non-Coulomb scattering of relativistic electrons in multi-component plasma, filling closed magnetic field surfaces after MGI of the noble gas inside the separatrix.

To solve these problems the model of disruption, mitigated with MGI in its thermal stage is developed and is under implementation in the TOKES code. First results of numerical modelling and their comparison with the experimental data from JET and other tokamaks are presented.

[1] I.S. Landman, S.E. Pestchanyi, Y. Igitkhanov, R. Pitts. Modelling of Wall and SOL Processes and Contamination of ITER Plasma after Impurity Injection with the Tokamak Code TOKES. ISFNT-9 conference, Oct 11-16 2009, Dalian, China, to be published in Fus. Eng. Des.