Analysis of Tokamak Fueling by Time- and Space-Dependent Recycling*

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In magnetic fusion devices most of the plasma fueling is secondary fueling resulting from recycling of particles from the walls. In tokamaks, for example, this recycling particle flux from the walls is very non-uniform in time and space. Therefore, using just a single and constant global recycling coefficient for modeling simulations is a very coarse approach to plasma boundary calculations. Without analyzing the details of the plasma interaction with the wall components, it is impossible to decide which parts of the wall play a role in terms of processes such as fueling, L-H-mode transition, and other phenomena.

To study the details of the plasma-wall interaction, we have calculated the particle fluxes to about 100 zones of a tokamak vacuum vessel (DIII-D) with the DEGAS Monte Carlo code, constrainted by measured plasma parameters. The recycling coefficient was then represented by an analytical formula correctly reproducing its dependence on the trapped particle fluence. It was validated with results from TRIM calculations on the interaction of deuterium with graphite [1]. Using the local particle fluxes, we were able to use the validated formula for the recycling coefficient and calculate the local recycling coefficients for each zone of the vacuum vessel as a function of time. The results indicate which parts of the vacuum vessel are pumping particles and which are saturated and fully recycling the incident flux as a function of time.

The goal of this analysis is to understand the importance of the various parts of the vacuum vessel in terms of wall conditioning, recycling, fueling, etc. The model allows one to evaluate the importance of various parts of the vacuum vessel at given times during the discharge. Whereas the model has been discussed before, this paper describes a specific application for a particular discharge in DIII-D.

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[1] W. Eckstein, Garching Report IPP 9/33, October 1980.