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EX/P5-35: A Global Particle-balance Model for Wall Interaction Analysis Associated with Open- and Closed-loop Density Control Experiments in KSTAR

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Based on successful experiments of open- and closed-loop density control in 300kA circular Ohmic discharges in KSTAR 2011, a 0-D global particle model has been developed. Starting from the Maddison's multi-reservoir model with the parameters for KSTAR, an outgassing-like term was added into the wall inventory equation so that the particular behaviors of KSTAR plasmas can be reproduced. The model enables quantifying the particle confinement time t_i and external fuelling efficiency f_ex from the particular discharges with fuelling modulation. The total recycling coefficient R can be also determined by the model. The value was roughly from 0.97 to 0.99 in the particular low density plasmas of up to 2.5x10ˆ19 m-3, which seems reasonable in this full carbon machine. Furthermore the particle flux to the main chamber was calculated as 1-3x10ˆ22D/s and to limiter was estimated as 0.5-1.5x10ˆ22D/s during the particular period in the discharges of interest. Again these values are very reasonable comparing with other carbon devices such as TEXTOR (1x10ˆ22 for limiter), Tore Supra (1x10ˆ22 for limiter) and JET (1-3x10ˆ22 for main chamber). The other obtained parameters (⊠i, fex and others) were further applied to the density feedback experiments and the calculated density by the multi-reservoir model is in great agreement with the measured density. In these first feedback control experiments, only proportional gains were applied in order to avoid any unexpected risk due to slow response of the integral gains and to focus on the assessment of the integrated density control system that was quite successful. However, as expected, this simple controller led to clear undershoots of the density from the reference target. While the undershoots will be compensated by the integral gains in future experiment, it enabled quantifying the recycling coefficient R quite accurately by a solution of simple balance equation adjoined with the fuelling formula. In the particular feedback experiment, R was determined as 0.97 which is similar value obtained by the model in the open-loop experiment. The whole experimental scheme will be expanded to the other discharges such as H-modes.

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