Modelling of the Neutral Gas and Plasma Transport in the Scrape- off Layer and Divertor of ST40-Tokamak

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In ST40 (design parameters: R/a=0.4/0.25m, B_t=3T, I_{pl}=2MA flat top duration up to 1 sec, NBI-power 2MW, NBI-energy E_b=25-50 keV, ECRH - power 1-2 MW/1/) a double null poloidal divertor configuration is under investigation.

To compute the density and ionization rate of the neutral gas in the divertor of ST40, the pseudo-collision technique was applied /2/. A two-dimensional grid with radial and poloidal resolution is used to calculate the neutral gas density n_c, the temperature T_c and the deposition (absorption) profile d_c of the ionized neutrals. As neutral particles atoms and molecules arising from reflection and dissociation are considered. The backscattering model accounts for the correlation according the Behrisch matrix /2/ and a smooth transition between specular and diffuse reflection as in /2/. The potential sheath in front of the plate enforces a zero total charge flux of the incoming electrons, the released secondary electrons, and the incoming ions. The secondary electrons reduce the potential step thus the acceleration of the ions and therefore the sputter yield at the plate, an important input for the impurity module.

The description of the plasma transport /3/ accounts for parallel and perpendicular heat conduction, perpendicular particle diffusion, parallel convection, recycling of the neutral particles. The boundary conditions account for the symmetry with respect to the equatorial plane and for the temperture and density values at the separatrix (T_{es}=T_{is}=100eV, n_{ic}= 3 10^{12}/cm^3).

The main results are:

The deposition of the ionized neutrals d_c has a strong maximum at the separatrix, the density n_c has the opposite behaviour since $n_c \sim d_c/n_e$, similar as in /2/. The maximum density is n_{cmax}=2 10^{12}/cm^3 and falls off rapidly in the parallel direction. n_{cmax} is consistent with continuity at the plate.

The simulation of the plasma transport shows a radial $T_e(T_i)$-e-folding length of ~ 4 cm. The velocity has the maximum at the separatrix v_{max}=9 10^6 cm/sec.

Due to recycling, the density has a weak maximum in the vicinity of the divertor plate and the ion temperature has a minimum at the plate due to the cooling by the neutrals.

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