Modification of Canonical profiles transport model

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Standard version of the Canonical Profiles Transport Model (SCPTM) was presented in [1]. Its application to simulation of tokamak shots with NBI heating gave reasonable results. However, attempts to simulate the electron-cyclotron heating (ECH) lead to overestimations of the electron temperature *Te*. The problem is in strong peaking of the deposited EC heating power. We define the peaking of deposited power profile *g* as the ratio of *P*1/3, the power, deposited at radii *r*/*a*< 1/3, to the total deposited power *PEC*: *g* = *P*1/3/*PEC*. In the presented report we modify the Standard model to treat the deposited power profiles with arbitrary peaking.

The electron heating flux *q*e in SCPTM has a form:

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Here *H* is the Heaviside function, *Tc* is the canonical profile of temperature, the stiffness factor , in the SCPTM *h*= 0.5.

Figure 1 shows results of *Te* simulation for T-10 shot #66022 (*I*= 0.22 MA, *B* = 0.23 T, *n* ~ 4×1019 m-3) in Ohmic (OH) and ECH stages at *PEC* = 1.1 MW. We see that for OH stage of shot the calculations with Standard model (thin lines) and experiment (dashed lines) are close to each other, while for ECH stage the RMS error is large, *d*2*Te*= 56%. To diminish the error, we increase the stiffness *kePC* by increase the exponent *h* at the electron temperature. Figure 2 shows that the increase of *h* from 0.5 to 1.5 decreases the error from 50% to 20%. The reminded error is defined by narrower profile of simulated electron temperature in comparison with the experimental one. In its turn, this is linked with boundary condition for canonical profile of function μ*c* ( = 1/*q*). As a rule, we put μc(0) = 1 in SCPTM. Diminishing of the boundary value leads to flattening of canonical profiles and broadening of modeled *Te* profile.

The simplest modification of SCPTM consists of following steps:

1. Choose the initial value of *h* = 1.5.
2. Choose the relation c(0) = -*g* + 1.4 as the boundary condition for μc(0).

Calculation with the modified model is shown in Fig. 1 by the fat line. Calculations for six shots give the RMS error *d*2*Te*=12% for OH and *d*2*Te*=13.6% for ECH stages.

Reference

1. Dnestrovskij Yu.N., Connor J.W., et al., Plasma Phys. Control. Fusion, 2007, 49, 1477

 Fig. 1. Fig. 2.