Numerical analyses of steady-state and inductive JT-60SA scenarios with the COREDIV code

Roman Zagórski(1), Gerardo Giruzzi(2), Irena Ivanova-Stanik(1), Michele Romanelli(3), Włodzimierz Stępniewski(1), Roman Stankiewicz(1)

(1) Institute of Plasma Physics and Laser Microfusion, Hery 23,
(2) CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France
(3) CCFE, Culham Science Centre, Abingdon, Oxon, OX14 3DB, UK

In this paper, several JT-60SA design scenarios [1] have been analysed with the help of the self-consistent core-edge COREDIV code [2], with the aim to assess the influence of impurities on the plasma parameters and tokamak performance. In particular, the reduction of divertor target power load due to radiation of sputtered and externally seeded impurities has been investigated.

The COREDIV code describes self consistently the core and the scrape off layer with the divertor regions of tokamak plasmas. The coupling between core and edge is imposed by continuity condition at separatrix of values and fluxes of temperatures and densities. In the core the 1D transport equations with semi- empirical transport coefficients for densities and temperatures are used. Transport coefficients included the anomalous and neoclassical transport and its profiles have been modified for describing the transport barrier.

In the SOL, the 2D boundary layer code EPIT is used which is primarily based on Braginskii-like equations for the background plasma and on rate equations for each ionization state of each impurity species. The sputtering processes of target material are included in the model.

Calculations have been performed for JT-60SA scenarios with carbon walls and nitrogen (N) seeding. It has been found that N and C radiates predominantly in the SOL region. For the high density scenarios #3, 4_1 the regime of detachment on divertor plates has been achieved for N seeding . For all scenarios, the gradual replacement of carbon by nitrogen is observed as the N influx increases. For high auxiliary power and low density scenarios, the carbon and nitrogen radiation does not effectively reduce power to plate. Consequently, results with very high Z_{EFF} (about 4.5) and nitrogen concentrations (> 7.8%) are observed. For these scenarios, influence of the different impurity seeding: neon (Ne) and argon (Ar) will be studied.

[1] JT60SA – RP v3.1, http://www.jt60sa.org/pdfs/JT -60SA_Res_Plan.pdf

[2] Zagórski, R., et al., Nucl. Fusion **53** (2013) 073030