Progress in the Modeling of the ITER Negative Ion Source

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We present results from a 2D fluid model[1,2] of the driver, expansion chamber and magnetic filter for an H_2 plasma in the conditions of the ITER negative ion source. We discuss the general plasma properties: plasma density, electron and neutral particle temperatures, ion composition (H^+, H_2^+, H_3^+), dissociation degree of H_2, and the effect of the magnetic filter, in a large range of input power (10-80 kW) and source pressure (0.2-0.8 Pa). The results show a decrease of the gas density when the plasma is turned on, due to gas heating and to the neutral gas depletion induced by ionization. The low gas density leads to high electron temperature in the driver, and to saturation of the plasma density growth with power for pressure below 0.3-0.4 Pa. The H_2 temperature is in the 0.1 eV range while the H temperature is much larger (up to 1 eV) because hydrogen atoms are generated at high energies by dissocation of H_2 or ion recombination at the wall surface. The negative ion current density extracted from the caesium coated plasma grid is deduced from the calculated fluxes of H and H^+ and is consistent with experiments provided that most negative ions produced on the grid surface are extracted.
Comparisons between model predictions and experimental results[3] will be presented and remaining questions (transport across the magnetic filter, poor knowledge of surface reaction rates and consequences, large difference between H and H_2 temperatures, meaning of the measured pressure) will be discussed.

[1] G.J.M. Hagelaar, G. Fubiani, J.P. Boeuf, "Self-consistent model of an inductively coupled negative ion source for neutral beam injection – I General model description", submitted Plasma Sources, Sci. Technol. (2010)
[2] J. P. Boeuf, G. J. M. Hagelaar, P. Sarrailh, G. Fubiani, N. Kohen, Plasma Sources Sci. Technol.,, "Self-consistent model of an inductively coupled negative ion source for neutral beam injection – II Application to the ITER source", submitted Plasma Sources, Sci. Technol. (2010)
[3] P. McNeely, S. V. Dudin, S. Christ-Koch, U. Fantz and the NNBI Team, Plasma Sources Sci. Technol. **18** 014011 (2009)