Contribution ID: **3245** Type: **not specified**

P2.1038 Investigating the influence of molecules on power/particle/momentum balance in the detached TCV divertor

Tuesday, 9 July 2019 14:00 (2 hours)

See full abstract here
http://ocs.ciemat.es/EPS2019ABS/pdf/P2.1038.pdf

The process of divertor detachment, whereby heat and particle fluxes to divertor surfaces are strongly mitigated, is required to reduce heat loading and erosion in a magnetic fusion reactor.
In previous research [1] we have provided a full interpretation of particle/power balance in the TCV (L-mode) divertor using spectroscopic techniques assuming atomic reactions alone, showing that the detachment sequence starts with power limitation of the ionisation source (~ 5 eV) limiting the ion target current. As the divertor becomes more strongly detached, momentum (< 5 eV) and eventually ion sinks (<1.5 eV) develop in the divertor volume. During this development, the molecular contribution to the D emission, obtained spectroscopically [1], increases from 20% to 85% - in quantitative agreement with SOLPS modelling. We use this measurement, together with SOLPS simulations [2], to investigate the influence of molecules on power, particle and momentum balance during detachment. An increased concentration of H2+ and H- is required to explain the observed D emissivity, according to SOLPS/AMJUEL. This leads to significant radiative losses by up to 60 % of the hydrogenic excitation radiation in a region localised near the target and can also add to the effective ion sinks (MAR). SOLPS modelling for TCV also indicates that momentum loss through ion-molecule collisions can dominate over other momentum sinks at strongly detached states with low target temperatures (< 0.5 eV). Molecularly-enhanced D is not observed during N2 seeded detachment, likely due to higher observed divertor temperatures during N2 seeded (compared to density ramped) detachment & lower molecular/ion densities in qualitative agreement with MAST-U SOLPS simulations [3]. This also explains the lower volumetric recombination observed during N2 seeded detachment.
These observations are used to explore the validity of current treatments of molecules in SOLPS.

[1] K.Verhaegh, et al. Preprint https://doi.org/10.13140/RG.2.2.24292.48005/1
[2] A.Fil, et al. 2018, Contrib. Plasma Physics, vol. 58, issue 5-6
[3] O.Myatra, et al. PSI Conference 2018.

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Session Classification: Poster P2

Track Classification: MCF