Hydrogen Permeation Measurement in the Spherical Tokamak QUEST and its Numerical Modeling

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Particle retention and recycling are closely associated with the diffusion coefficients as well as the recombination coefficients of the plasma facing walls. In contrast to the diffusion coefficients, the recombination coefficients are highly scattered in the literature due to their dependency on the wall conditions and are mostly available for the non fusion devices. The accumulation of these data in fusion devices is important. Hence permeation measurements for hydrogen through a 30 μm thick Ni membrane heated at 400 – 575K have been carried out in the spherical tokamak QUEST. The permeated flux (Γ_{perm}) is being measured during the scan of different operating parameters like RF power, chamber pressure, discharge width and vertical magnetic field. A numerical analysis is conducted to simulate the time dependant permeation behaviour in different discharge conditions and to obtain the diffusion as well as recombination coefficients. Once these coefficients are obtained for the membrane probe, they are being utilised for measuring permeation probability and the incident atomic flux to the chamber wall for various operating parameters. It is being observed that the permeated flux along with diffusion coefficient increases with the temperature. Numerical analysis is also being extended to discuss the recycling from the thick plasma facing walls at different temperatures.

Additionally edge plasma density and various spectral intensities e.g. H_α and molecular (Fulcher band) have been compared with the permeation measurements to understand its dependency on the atomic flux. A linear relationship has been observed between the time integrated Γ_{perm} i.e. permeated fluence (Q_{perm}) and the time integrated H_α intensity i.e. H_α fluence. The obtained results recommend the use of permeation technique for measuring the atomic fluxes of hydrogen isotopes to the walls. It is also being concluded that the permeation of atomic hydrogen is dominant not only in the plasma facing components but also in the far plasma components.