Modelling of freezing of large cryogenic pellets for the ITER Shattered Pellet Injector

S. Zoletnik[1], M. Vécsei[1], S. Jachmich

[1] *Centre for Energy Research, Budapest, Hungary*

[2] *ITER Organization, St Paul Lez Durance, Cedex, France*

The disruption mitigation concept of ITER is based on the injection of small fragments originating from large cryogenic pellets made of hydrogen, deuterium, neon or mixtures thereof[1]. The foreseen sizes are up to 28.5 mm diameter and 57 mm long cylinders. These are planned to be desublimated in a barrel, accelerated up to 600-800 m/s velocity with a high pressure gas impulse, broken into small pieces on a shatter plate, and enter the plasma as a spray of small pellet fragments.

The above Shattered Pellet Injection (SPI) technique[2] has been developed and tested on several tokamak experiments. In order to develop the ITER-relevant SPI technology a Disruption Mitigation Test Laboratory is being set up at the Centre for Energy Research in the framework of an ITER contract.

In preparation for testing a modelling code has been developed for the pellet freezing process. Axial symmetry is assumed around the barrel centerline and mirror symmetry to the center plane of the cold section. Heat propagation is calculated both in the pellet and the barrel wall numerically on a two-dimensional (radial-axial, z-r) mesh. The radius of the pellet-gas boundary (pellet-surface) is described by a discrete $r_i(z)$ function and in the pellet a moving radial mesh is set up between the barrel inner wall and the pellet surface. The heat load, desublimation flux and gas surface temperature on the pellet surface are calculated self-consistently by analytically solving the convective-conductive heat transfer in the gas in the presence of a desublimation flux, and fitting the heat flow in the gas to the heat flow from the gas to the pellet surface.

The results show that the pellet production time is set primarily by the heat conduction both in the pellet material and the barrel wall. Parametric studies will be presented on the pellet production time and freezing strategy for various pellet materials.

The work has been performed as part of the ITER DMS Task Force programme. The DMS Support Laboratory has received funding from the ITER Organization. The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

[1] M. Lehnen, et al, *Journal of Nuclear Materials* **463** 39 (2015)

[2] L.R. Baylor, *et , Nucl. Fusion* **59** 066008 (2019)