Testing of a large Non-Evaporable Getter pump mock-up in view of application in modern Neutral Beam Injectors

Fabrizio Siviero[1,*], Michele Mura[1], Beatrice Busetto[1], Enrico Maccallini[1], Paolo Manini[1], Emanuele Sartori[2], Marco Siragusa[2], Piergiorgio Sonato[2], Stefan Hanke[3], Christian Day[3]

[1]*SAES Getters S.p.A., Viale Italia 77, 20020 Lainate, MI, Italy*
[2]*Consorzio RFX, Corso Stati Uniti 4, 35127 Padova, PD, Italy*
[3] *Karlsruhe Institute of Technology (KIT), Institute for Technical Physics (ITEP), 76344 Eggenstein-Leopoldshafen, Germany*

*corresponding author: fabrizio_siviero@saes-group.com

Neutral Beam Injectors (NBI) are key subsystems of facilities for nuclear fusion research. These machines need effective pumping systems for hydrogen and its isotopes, up to several hundreds of m^3/s. In addition, the future use in demonstrator plants like DEMO poses further requirements related to availability, maintenance and safety. To face these technical challenges, some years ago a collaboration started between SAES, Consorzio RFX and KIT aimed at investigating the performances of very large Non-Evaporable Getter (NEG) pumps for this purpose.

SAES selected a Zr-based alloy named ZAO®, in the form of porous sintered disks, as getter material. Its fundamental strengths are the high affinity for hydrogenic species, the large sorption capacity and the high mechanical resistance to repeated H_2/D_2 loading and unloading [1]. Different pumps of increasing size from 0.1 to 1 m^3/s were studied by simulations and experimental campaigns with RFX before designing and assembling a large-scale mockup, featuring nearly 20 m^3/s for hydrogen. The SAES NEG pump was successfully tested in the TIMO facility at KIT with both hydrogen and deuterium. In particular, the results include: i) a characterization of the pumping speed vs H_2/D_2 concentration at different throughput and getter temperatures; ii) a study of the regeneration process, i.e. hydrogen extraction; iii) the thermal management of an array of cartridges.

These data will act as guidance for the design of full-size pumps for fusion research facilities, taking advantage of the modularity of the NEG pumping system, which simplifies the scale-up and allows distributing the pumping speed according to the available space.

[1] F. Siviero et al., *Fusion Engineering and Design*, (2019), DOI 10.1016/j.fusengdes.2019.03.026