Overview of the Tritium Handling within the ITER Vacuum Pumping System

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Many ITER systems are vacuum pumped, e.g. the main plasma chamber to assist the plasma confinement and impurities removal; the neutral injection systems to control the ion neutralisation and re-ionization; the cryostat for thermal insulation of cryogenic components (super conducting coils); large numbers of interspaces and guard volumes ; electron cyclotron waveguides for wave transmission and diagnostic for various purposes. The vacuum clients will either be fuelled with significant quantities of tritium, or be connected periodically to other tritium containing volumes, or need to be managed to avoid tritium contamination.

In this paper the current status of the ITER vacuum system with respect to tritium is outlined. The measures used for the effective confinement of tritium are described. The expected distribution of tritium and its tracking in operations is analysed.

The paper overviews the handling of tritium in the components of the tokamak exhaust line, which have challenging working conditions: cyclic operation; efficient pumping of light gases with high pumping speed; compliance with hydrogen safety; operation in magnetic fields, neutron and gamma radiation.

The heat load from tritium decay on the 4.3K circuits of the charcoal covered cryo-panels are analysed and the feasibility of using this as an inventory measurement on loaded cryo-panels assessed. Details are given of work performed to validate the stability in a tritium environment of the ceramic cement used to bond activated charcoal sorbent of the cryopumps to the hydro-formed stainless panels of the pumps.
Tritium specific challenges in the roughing system are dictated by required high capacities and the need for these capacities over a wide range of pressures. Tritium compatible mechanical pumps exist commercially (typically scroll or metal bellows) But ITER tritium throughputs of average 100 $Pa \cdot m^3/s$ commercially available pumping solutions do not exist. Hence R&D has been performed over many years to develop bespoke pumping solutions for ITER. This paper summaries this past R&D on mechanical pumps.