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Tritium Transport Modelling: First Achievements on ITER Test Blanket Systems Simulation and Perspectives for DEMO Breeding Blanket

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The European TBM Programme will generate experimental data for development and validation of tritium transport simulation tools which are essential for predicting the tritium processing performance of a breeding blanket in DEMO or power reactor. In this ambit, two European TBS (Test Blanket Systems)will be tested in ITER under a wide range of operative conditions and neutron irradiation scenarios.
The modelling tool, developed in the frame of a contractual collaboration between F4E and CIEMAT/Empresarios Agrupados, is based on the customization of the EcosimPro simulation platform. It implements a 1D dynamic mathematical model, without including any multiphysics coupling effect (e.g. MHD, heat generation and temperature variation over the time, thermal-hydraulics etc.). The physics of tritium transport is comprehensive, as it fully takes into account the phenomena of tritium transport at gas-metal interface and at the liquid metal boundary layer. For any selected operating scenario and for a selected time window, the simulation tool gives an output consisting of: a) the amount of tritium permeated from the TBM breeding region into the main coolant; b) the amount of tritium solubilized inside the functional and structural materials of the TBM as well as in all TBS ancillary systems; c) the tritium permeation rate through the piping of the ancillary systems into the ITER rooms; d) the percentage of tritium accounted at the end of the TBS chain and sent to the ITER Tritium Systems over the tritium generated in the TBM per unit time.
The paper describes first the characteristics and main equations of the simulation tool. Then, it presents and discusses the preliminary simulation results covering a wide interval of TBS operating conditions and plasma irradiation scenarios isolated inductive pulses, back to back plasma pulses, long pulses). The test matrix has been arranged to make possible a check of the internal consistency of the code and, at the same time, to have a preliminary performance prediction of the two TBS in terms of tritium recovery capability and inventory distribution. Last but not least, the paper provides the main lines of development of tritium transport modelling from this preliminary phase up to the final one when the predictive capabilities have to be exploited at the maximum extent in support of the DEMO breeding blanket design.

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