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P2.167 Numerical study and experimental verification of protium permeation through Pd/Ag membranes for fusion applications

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Pd/Ag membranes are one of the reference technologies for the fuel cycle of deuterium-tritium fusion machines. This technology is proposed to be implemented in tritium recovery systems, due to their exclusive selectivity towards molecular hydrogen isotopes. For instance, these membranes are proposed to process and separate Q2 (Q = H, D, T) species from impurities (e.g., inert gases) coming from the plasma exhaust. In addition, the combination of Pd/Ag membranes with catalyst beds allow the decontamination of tritiated compounds (like Q2O, CQ4, NQ3, etc.) as a result of permeation and catalytic reactions. For these peculiarities, the Pd/Ag membrane reactor was proposed to continuously separate tritiated species (mainly HT and HTO) from helium in the tritium extraction system of the solid blanket.
ENEA has recently developed Pd/Ag single-tube membrane reactors, which have been tested for the separation of H2/He mixtures (by permeation) and decontamination of D2O/He streams (permeation plus reaction). In view of up-scaling this technology to a DEMO-relevant case, a one-dimensional simulation code was developed to first predict H2 permeation efficiencies. In this contribution, a numerical code which computes the permeation efficiency of protium through Pd/Ag membranes at different conditions is presented. Geometrical (i.e., length, inner diameter, thickness), operational (i.e., pressures, temperatures) and membrane (i.e., permeability) parameters, as well as the initial feeding gas compositions, are given as input. A sensitivity analysis is presented for an understanding of the most impacting parameters in the membrane's performance. Furthermore, the very good correlation between numerical outcomes with actual experimental results obtained at ENEA is highlighted and discussed.

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