Multi physic approach for membrane reactor modelling for wet gas detritiation

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Since many years, the use of the so-called PERMCAT reactors, combination of a permeator and a catalytic reactor, is investigated for the treatment of tritium contaminated gases in the frame of fusion fuel cycle and more especially as clean up final treatment for the Tokamak Exhaust Process (TEP) of the ITER project.

This paper presents the phenomena occurring in such apparatus like heat transfer, mass transfer, reaction kinetics and fluid dynamics. The associated finite elements models for the numerical simulation are exposed and justified. After the geometry definition, the choice of the equations and the optimisation of the meshing, a steady state and a time dependant analysis are carried out. A parametric study is performed in order to evaluate the evolution of the response of the detritiation factor (DF) and the concentration profiles for the various species along the membrane reactor.

Then, the numerical simulations and the experimental results reported in literature for the case of deuterated gas and pure water are compared and discussed. Furthermore, an experimental plan is proposed to validate the model when operating tritium contaminated gases.