Multi-physics hydrogen diffusion and trapping model of a Water-Cooled Lithium Lead (WCLL) breeding blanket

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The key purpose of DEMO is to provide electricity from fusion power. An integral part to this design will be the tritium breeding blanket. Accurate modelling of hydrogen transport and inventories within the breeder blanket component will be of predominant importance regarding safety issues [1] and economic sustainability [2]. The modelling of hydrogen isotopes in breeding blanket components can be challenging due to the complexity of their geometries and the presence of multiple materials and fluids. The WCLL_2020 [3] design has been considered in this work.

With the use of the hydrogen transport code FESTIM [4], multi-material, multi-dimensional and multi-physics simulations of the WCLL design have been performed. The code is coupled with heat transfer and accounts for thermally activated processes such as trapping, diffusion and surface recombination. Fluid dynamics techniques are implemented to simulate the flow of LiPb in the WCLL design. The associated velocity field was applied to FESTIM to accurately simulate hydrogen transport in both the liquid and structural parts of the blanket. Literature concerning hydrogen solubility and diffusivity in LiPb provide a variety of temperature dependent values from experimentation. Parametric testing is conducted to investigate the impact of such a variation, along with other parameters with published variation.

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