Experimental determination of hydrogen transport parameters of 316L steel in the two-side purge permeation setup Q-PETE

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Quantitative analyses of hydrogen permeation in the breeder zone and other components of the fuel cycle (ferritic martensitic and austenitic steels) are relevant for safety and tritium self-sufficiency of future fusion power plants. The Q-PETE/D2 experimental setup has been planned and taken into service, with the aim to validate hydrogen transport models and to determine material data. The temperature-controlled permeator setup consists of two gas-purged volumes separated by a metal membrane. Hydrogen permeating through the membrane mixes into the purge gas flow and is measured by a mass spectrometer.

In the first series of experiments, a stainless steel (DIN 1.4404, AISI 316L) membrane of 1.14mm thickness was used. The hydrogen content in the purge gas on the feed side was at 3000 ppm. The investigated temperature range was 300 – 500 °C.

A solver based on the finite differences method allows the simulation of the expected permeation fluxes of the experiment, based on input of the temperature dependent Diffusion constant and Sieverts´ constant and experimental boundary conditions. An iterative optimization routine based on a Branch and Bound algorithm was used to extract the effective Diffusion and Sieverts´ constants as inverse problem of the conducted experimental permeation data.

In this paper, the effective Diffusion and Sieverts constants for the used membrane are presented. Sensitivity on analysis parameters is discussed. The obtained values are compared to literature data of the same steel grade.