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Permeability of austenitic steel ChS-68

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A GDP installation for measurements permeability of materials in gas-driven permeation experiments have been constructed. A membrane separates gas-loading and registration chambers. In the first chamber an inlet membrane surface is exposed in extra pure deuterium gas. In the registration chamber deuterium flux permeating through the membrane is measured via quadruple mass-spectrometer (QMS). A constant pressure at inlet surface is maintained with an accuracy better than $\pm 0.5\%$P at a gas flow through the gas-loading chamber. Two methods of QMS calibration to gas fluxes were used: permeation to known volume and a flux through calibrated leak.

For approving the methodic permeability of tube of austenite steel ChS-68 with wall thickness of 0.4 mm was investigated. Measurements were performed in a pressure range of $10^2 \div 5 \times 10^4$ Pa and in a temperature range of $573 \div 873$ K. Permeation regime was found to be diffusion limited. Diffusion coefficient was obtained by fitting breakout permeating curve with well-known formula describing time dependence of permeation flux in DLR regime.

$$J_{\mathrm{DLR}} = \frac{DS\sqrt{p}}{L}\left[1 + 2\sum_{n=1}^{\infty}(-1)^n \exp\left(-\frac{D\pi^2 n^2}{L^2}t\right)\right]$$

where D – diffusion coefficient, L – membrane thickness, p – pressure at inlet surface, S – solubility coefficient.

The obtained temperature dependence of diffusion coefficient D(T) perfectly agrees with the D(T) for the same material obtained in gas-driven permeation measurements at lower pressures at PIM installation [1]. The results obtained prove the correctness of the methodology.

Further plan include investigation of permeability of reduced activation ferritic-martencitic steels (RAFMS), oxidized RAFMS, ITER CuCrZr bronzes.

References

[1] A.V. Golubeva, D.I. Cherkez et al., Instruments. & Experimental Technique, Vol. 60 No. 6 2017, p. 843-852

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