Metal Foam Tube Flow Characterisation

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Abstract

The characterisation of the flow through open-cell metal foam structures is an active field of research as it provides important implications for their performance potential as transfer-process enhancing structures. CFD is a particularly useful form of investigation as it allows for the analysis of inner-pore flow field that could only be carried out experimentally with great difficulty.

In this study the flow through a tube filled with highly porous aluminium foam of three different pore sizes is analysed by means of mathematical modelling using COMSOL Multiphysics® CFD Module and compared to experimentally determined pressure drop data. The three-dimensional laminar flow through the pores is modelled by solving the Navier-Stokes-Equations for an array of pores. The analysis of the resulting flow fields, exemplary depicted in (Figure 1), allow the deduction of characteristic flow parameters, namely the permeability and a form drag coefficient, that are utilized in a 2D-axissymmetric Forchheimer-extended Brinkman-porous-medium model to predict the flow profile and pressure drop for the flow through the metal foam filled tube.

The effect of the confining channel walls are quantified and characteristic parameters are compared to ones determined by a best-fit of modelling parameters to experimental pressure drop data. An exemplary comparison of the overall pressure drop data determined experimentally and the modelling results for one of the test objects is given in (Figure 2).

The modelling approach taken in this study of combining micro-scale flow field calculations and macro-scale porous-medium flow calculations provides as it allows for both the investigation of driving factors such as the pore and ligament size on the characteristic parameters and the comparison to experimental findings to the impact such changes have on the pressure drop over the entire structure.
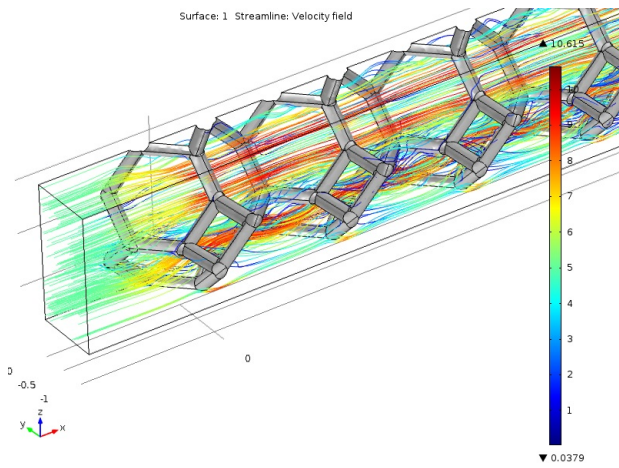
Figures used in the abstract

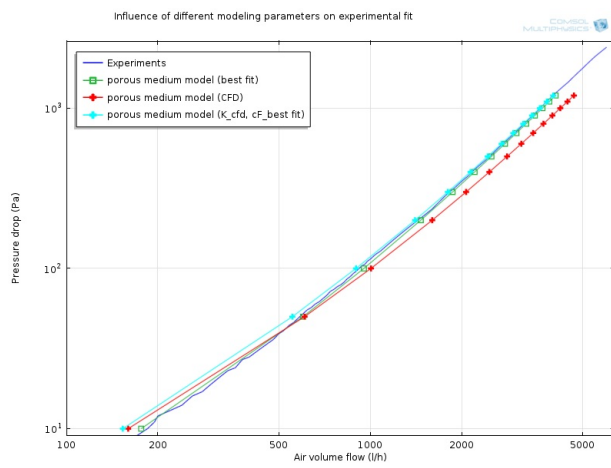**Figure 1**: Examplary extract of the flow field through an array of cells

Figure 2: Comparison of experimental data to porous medium modeling results