6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

HOMOGENIZATION BASED MODELLING OF THE PERFUSED LIVER TISSUE

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Keywords: *Homogenization, Double Porosity, Liver Tissue, Perfusion*

The liver parenchyma forms the lobular structure which is constituted by the sinusoidal porosity separating the so-called vertex and central veins. In the paper, we compare two homogenized models relying on different assumptions and upscaling approaches.

The first model is derived by the homogenization of the mesoscopic structure with the double-porosity medium represented by the Biot model with large contrasts in the permeability. In the sinusoidal porosity, the scaling of the permeability leads to the macroscopic model involving two pressure fields associated with the portal and hepatic vascular compartments. The poro-viscoelastic coefficients involved in the time convolution integrals are obtained by the homogenization of the quasistatic Biot model, cf. [1, 2].

The second perfusion model is an extension of our recent work [3], to account for deformations and the 3 compartment mesoscopic topology. Two-level homogenization of the fluid-structure interaction with a scaling ansatz related to the viscosity is applied. The macroscopic model is defined in terms of the pressure field associated with flow in the liver sinusoids, and the two velocity fields associated with the precapillary vessels of the portal and hepatic vein systems. Interface conditions conditions are discussed.

We illustrate and compare the properties of the two models using selected examples with the representative periodic cell describing the lobulus of the liver tissue. A sensitivity study related to the mesoscopic geometry is reported. The numerical results are computed using the FE method implemented in the SfePy software (see `http://sfepy.org`).

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