The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

TOPOLOGY OPTIMIZATION OF PARTICLE-LADEN FLOW PROBLEMS

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Key Words: *Particle-laden flows, topology optimization, active transport, Brinkman model*

Topology optimization is applied to the design of microfluidic components for shaping particle-laden fluid flow in order to obtain a target concentration profile. I most works the transported matter is passively transported by the fluid and these cases are well investigated in the literature [1,2]. However, the transported matter may influence the flow actively introducing spatially varying properties, which influence the fluid flow and the designs synthesized using topology optimization. The methodology can be applied to a range of problems where the optimization of components manipulating a mixture of different fluids/phases or transport of particles/bubbles in the fluid [3] is of interest.

A monolithic formulation based on the Brinkman model capable of representing fluids with varying properties is presented [4]. The necessary interpolation functions to represent the physics reasonably well along with the modeling of the transported matter near the interfaces of the solid material is investigated. The representation of the physics is compared towards a body-fitted model (commercial software) to validate specific cases and differences and needs to facilitate an effective optimization are discussed.

By the use of a min-max formulation, a robust performance across a range of Reynolds numbers facilitates applicability of the procedure to design devices that can manipulate particle-laden flows. Optimized designs of advanced flow components are presented and the performance of these are validated by means of post-evaluations of the design using a body-fitted model.

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