Simplified flow models for topology optimization of thermofluidic devices

C.S. Andreasen*, J. Alexandersen*, J.J. Asmussen*, X. Zhao†, M. Zhou†† and O. Sigmund*

* Department of Mechanical Engineering, Technical University of Denmark
e-mail: sigmund@mek.dtu.dk, web page: http://www.topopt.dtu.dk/

†Dalian University of Technology, Dalian, P.R. China

††Shanghai Jiao Tong University, P.R. China

ABSTRACT

Topology optimization of problems involving forced or natural convection is often performed based on simplified surface convection models, c.f. [1]. Such models are extremely efficient and may often work well but can also result in non-physical design with closed cavities. On the other hand, full-blown thermo-fluidic models are computationally heavy but result in optimized designs that take the real physical problem into account [2, 3].

The present works suggest a simplified fluid model based on a potential Darcy flow model that aims at providing better physical designs than the fixed surface convection model but at a much lower computational cost than than the full-blown thermo-fluidic model.

The proposed model is used as a basis for solving topology optimization problems subject to forced and free convection. The material properties including permeability, conductivity, density and specific heat capacity are interpolated using the Solid Isotropic Material with Penalization (SIMP) model. Manufacturable cooling-channel designs with clear topologies are obtained with the help of pressure drop constraint and geometric length-scale constraints [4]. An example of a CPU cooler design for natural convection is currently being produced. All designs are verified and evaluated for optimality based on full-blown thermo-fluidic analyses.

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