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

HEAT TRANSFER MAXIMIZATION IN A DIFFERENTIALLY HEATED CAVITY BY MEANS OF TOPOLOGY OPTIMIZATION

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Key words: *Topology Optimization, Conjugate Heat Transfer, Natural Convection*

Many industrial applications (*e.g.* in telecommunications) consider natural convection cooling as a viable as well as attractive solution for durable and reliable systems. Therefore, there is a large interest in the development of new techniques that can enhance the heat transfer without the need of moving parts. Here, we apply a state-of-the-art material distribution topology optimization approach to generate innovative designs of heat sinks in differentially heated cavities (a 2D example is shown in Fig. 1). The geometry of these structures is computed as the solution of an optimization problem that maximizes the heat transfer and whose sensitivity depends on the presence or absence of the material in each computational point.

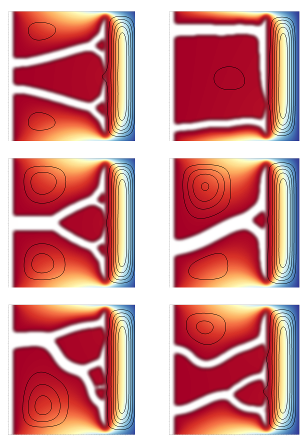

Figure 1: Optimized heat sink topologies obtained with different initial material distributions.

This method has also been recently used by Alexandersen et al. [1] for similar conjugate heat transfer problems driven by natural convection at low Rayleigh numbers. For the present contribution, we focus on two and three dimensional test cases in laminar condition but at higher Rayleigh numbers that are simulated using the spectral element code `Nek5000`. The physics of the problem is governed by the steady state incompressible Navier–Stokes and energy conservation equations; the buoyancy force driving the flow is computed by using the Boussinesq approximation, and the presence of the solid is described by means of a localized Brinkman friction term. Moreover, the resulting nonlinear optimization problem is relaxed and made mesh independent by introducing a nonlinear $fW-$mean filter [2] based on the harmonic mean to limit the amount of intermediate densities at the solid–fluid interface, while imposing a minimum length scale of the solid material. The design is updated by the gradient-based optimization algorithm MMA (method of moving asymptotes [3]); the required gradients are computed by means of continuous adjoint.

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