Topology optimisation of natural convection problems

This paper demonstrates the application of the density-based topology optimisation approach for the design of heat sinks and micropumps based on natural convection effects. The problems are modelled under the assumptions of steady-state laminar flow using the incompressible Navier-Stokes equations coupled to the convection-diffusion equation through the Boussinesq approximation. In order to facilitate topology optimisation, the Brinkman approach is taken to penalise velocities inside the solid domain and the effective thermal conductivity is interpolated in order to accommodate differences in thermal conductivity of the solid and fluid phases. The governing equations are discretised using stabilised finite elements and topology optimisation is performed for two different problems using discrete adjoint sensitivity analysis. The study shows that topology optimisation is a viable approach for designing heat sink geometries cooled by natural convection and micropumps powered by natural convection. Copyright © 2013 John Wiley & Sons, Ltd.
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