Large scale three-dimensional topology optimisation of heat sinks cooled by natural convection - DTU Orbit (09/11/2017)

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This work presents the application of density-based topology optimisation to the design of three-dimensional heat sinks cooled by natural convection. The governing equations are the steady-state incompressible Navier-Stokes equations coupled to the thermal convection-diffusion equation through the Bousinessq approximation. The fully coupled non-linear multiphysics system is solved using stabilised trilinear equal-order finite elements in a parallel framework allowing for the optimisation of large scale problems with order of 20-330 million state degrees of freedom. The flow is assumed to be laminar and several optimised designs are presented for Grashof numbers between 10^3 and 10^6. Interestingly, it is observed that the number of branches in the optimised design increases with increasing Grashof numbers, which is opposite to two-dimensional topology optimised designs. Furthermore, the obtained topologies verify prior conclusions regarding fin length/thickness ratios and Biot numbers, but also indicate that carefully tailored and complex geometries may improve cooling behaviour considerably compared to simple heat fin geometries. (C) 2016 Elsevier Ltd. All rights reserved.

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