A “poor man’s” approach to topology optimization of natural convection problems

Topology optimization of natural convection problems is computationally expensive, due to the large number of degrees of freedom (DOFs) in the model and its two-way coupled nature. Herein, a method is presented to reduce the computational effort by use of a reduced-order model governed by simplified physics. The proposed method models the fluid flow using a potential flow model, which introduces an additional fluid property. This material property currently requires tuning of the model by comparison to numerical Navier-Stokes-based solutions. Despite the significant simplifications, hereunder neglecting viscous boundary layers, topology optimization based on the reduced-order model is shown to provide qualitatively similar designs, as those obtained using a full Navier-Stokes-based model. The number of DOFs is reduced by 50% in two dimensions and the computational complexity is evaluated to be approximately 12.5% of the full model. We further compare to optimized designs obtained utilizing Newton’s convection law.