# Finite Volume Based Topology Optimization of Coupled Fluid Dynamic and Thermal Conduction Systems

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A system consisting of thermal conductivity coupled to heat transport arising from fluid flow is investigated using adjoint based optimization. The idea is to find an optimum of a given object function in the system by placing solid material in a space with advective transport. Fluid should be directed by the solid material in such a way that e.g. maximal heat transfer is achieved in a cooling or heating device. The strategy is to consider a porous media with porosity varying from an inpenetrable solid to complete absence of material allowing for free fluid flow. For this purpose a design variable $\gamma$ is introduced which enters both the thermal conductivity and the Darcy friction force which is added to the Navier Stokes equation for the porous media. The design field $\gamma$ varies continuously from zero to unity, where vanishing $\gamma$ corresponds to the limit of a pure solid, and $\gamma=1$ is the limit of a pure fluid. The intermediate values of $\gamma$ represent a mixture of solid and fluid. The method has been implemented numerically using the finite volume method (OpenFOAM) for solving the direct problem and the associated adjoint problem. Results from topology optimization of simple 2D systems are presented. The potential of the method for use in the automotive industry is discussed.