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DENSITY-BASED TOPOLOGY OPTIMIZATION FOR HEAT CONDUCTION WITH CONVECTION BOUNDARY CONDITIONS

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Abstract. Topology optimization refers to the problem of designing a structure by distributing a limited volume of material inside a fixed domain (the so-called design domain) in order to optimally accomplish a certain objective (frequently, to maximize the stiffness of the structure). In most cases, the loads on the structure are assumed to be given. However, in the case of self-weight and surface pressure, the loads are design-dependent. In thermal problems, design-dependent loads appear with boundary heat flux and convection. Until today, design-dependent boundary conditions thermal problems are mostly dealt by regularization of the heat flux through the solid/void interface, leading to large errors in typical topology optimization thermal problems like the design of heat exchangers where the optimal design has a high surface/volume ratio. In this work, we introduce a density-based topology optimization method for the solution of heat conduction problems with boundary convection, avoiding the regularization of the thermal loads along the solid/void interface. The conductivity of the material in a finite element of the design domain is defined as a function of a volume density that is continuous in the interval [0,1], which is the design variable of the optimization problem, following the classical SIMP method. Then, the contribution to boundary convection of each element interface is determined by a Surface density, continuous in [0,1] as well as the classical volume density. This new density is completely determined by the volume densities of the neighbor elements, so that the treatment of boundary convection does not require additional design variables. Finally, we provide examples to highlight the advantages of the current method with respect to the existing topology optimization method with regularized thermal loads.