An Alternative Representation for Density Based Topology Optimization of Fluid Flows

Andreasen, Casper Schousboe

Publication date:
2018

Document Version
Peer reviewed version

EngOpt2018 - 6th International Conference on Engineering Optimization
Instituto Superior Técnico, Lisbon Portugal • 17-19 September, 2018
Editors: H.C. Rodrigues, J. Herskovits, C.M. Mota Soares, et al.

Abstract ID 1041

AN ALTERNATIVE REPRESENTATION FOR DENSITY BASED TOPOLOGY OPTIMIZATION OF FLUID FLOWS

Casper Andreasen

DTU Mechanical Engineering, Denmark
csan@mek.dtu.dk

Keywords: Topology Optimization,fluid flow,Navier-Stokes equations,density based

Abstract: Density based topology optimization for fluid flows is commonly modeled using a porous media approach i.e. either as a mixed Darcy-Stokes model or a Brinkman model. The solid material phase (wall) is modeled by considering a porous media with vanishing permeability penalizing the fluid velocity efficiently. The pressure is traditionally not represented equally well leading to problems with defining proper pressure loads on interfaces and leakage over thin solid structures[1]. Furthermore, the leakage is proportional to the permeability leading to ill-conditioning of the governing equation system. The optimization problem is also affected by the vanishing permeability which increase the non-linearity of response due to design changes. This paper presents an alternative to the porosity models in terms of representing the solid phase by imposing boundary conditions for all edges of the solid inclusion. The no-slip Dirichlet condition is imposed weakly using Nitsche's method[2] to model the solid phase and boundary. The influence of the stabilization parameter and design interpolation is investigated and the flow and pressure representation near the boundary is compared towards classical density based and boundary fitted methods. A benchmark using classical flow topology optimization problems posed in the literature is setup and the strength and weaknesses are studied in detail.

References:

[1] Kreissl, S., Pingen, G., & Maute, K. (2011). An explicit level set approach for generalized shape optimization of fluids with the lattice Boltzmann method. International Journal for Numerical Methods in Fluids, 65(5), 496–519. http://doi.org/10.1002/fld.2193

[2] Nitsche, J. (1971). Über ein Variationsprinzip zur Lösung von Dirichlet-Problemen bei Verwendung von Teilräumen, die keinen Randbedingungen unterworfen sind. Abhandlungen Aus Dem Mathematischen Seminar Der Universität Hamburg, 36(1), 9–15. http://doi.org/10.1007/BF02995904