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DEVELOPMENT OF A TOPOLOGICAL OPTIMIZATION FRAMEWORK FOR 2D PROBLEMS USING OPENFOAM

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Abstract: Proton-Exchange Membrane Fuel Cells (PEMFC) are systems that directly convert chemicals into electricity by means of an electro-chemical reaction between hydrogen and oxygen. Following the concerns related to climate change and the search for cleaner, safer and more efficient power sources, Hydrogen PEMFC looks like a promising option. Indeed, PEMFC have the silent operation, high reliability, low working temperature and they only produce water as waste. Nevertheless, to rival the Internal Combustion Engine (ICE), PEMFC shall decrease their manufacturing cost, increase their lifetime and their efficiency as well as improve the thermal management. To achieve such revolution, Topology Optimization techniques are used to propose innovative designs of the gas channel network of bipolar plates made by steel forming. This work defines the channel network layout of a Fuel Cell using Fluid Flow Topology Optimization (FFTO) subject to design constraints. To achieve this goal, a simulation environment has been developed to couple OpenFOAM (to simulate the fluid flow) with Optimization Algorithms. The mathematical framework considers the simulation of the flow using the Stokes equations in steady-state condition. These equations combined with Darcy's law by means of the Brinkman penalization results in a density-based method which is used to perform the topology optimization. The state equations are completed with the continuity equation and a constraint on the volume. We present two different results: first, a minimization problem of the dissipated power subject to a volume constraint is performed in order to validate the coupling between OpenFOAM and the Optimization Algorithms in 2D applications. This part aims at comparing the results with the vastly available literature, following the version of the objective function proposed in [1]. The second part considers the implementation of manufacturing constraints into the previously solved optimization problem such as minimum gap and maximum size, which will help us to better reflect the practical and industrial applications that can be obtained with the proposed method [2].

References

[1] Niels Aage, Thomas H. Poulsen, Allan Gersborg- Hansen, and Ole Sigmund. Topology optimization of large scale stokes flow problems. Structural and Multidisciplinary Optimization, 35(2):175–180, 2008.

[2] Fernández E., Collet M., Bauduin S., Lemaire E., Duysinx P. Contributions to Handle Maximum Size Constraints in Density-Based Topology Optimization. Advances in Structural and Multidisciplinary Optimization. WCSMO 2017.