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Topology optimization of turbulent flow manifolds

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The efficiency of heat exchangers depends on the correct flow rates through the different tubes. The control of these flow rates can be achieved by using fluid manifolds [1]. These devices are tasked with the achievement of a certain velocity distribution at a range of different flow rates, while keeping a low energy dissipation.

Topology optimization has been applied to a variety of problems involving fluids, species transport and heat transfer [2]. In previous studies on topology optimization of turbulent flows it was shown that utilizing a full turbulence model, rather than a frozen one, is advantageous [3].

This work focuses on the optimization of fluid manifolds under the assumption of incompressible turbulent flow in a large scale parallel framework. The Reynolds Averaged Navier Stokes equations are discretized using the Finite Element Method and coupled with various turbulence models. The sensitivities are obtained with the adjoint method, where the full turbulence model is used in the adjoint equations. Studies on the accuracy of the Brinkman penalization as boundary representation of the turbulence model are conducted and compared to results obtained on body fitted meshes. Another study on the parameters needed to obtain a discrete design is also conducted.

The optimization aims at achieving velocity profiles close to the desired ones over a range of flow rates. A constraint on the maximum dissipated power is enforced. The optimized designs show velocity profiles close to the desired ones, depending on the chosen admissible dissipated power.

REFERENCES

[1] Acrivos, A., Babcock, B. D. & Pigford, R. L. *Flow distributions in manifolds.* Chemical Engineering Science (1959), 10(1–2), 112–124.

[2] Alexandersen, J. & Andreasen, C. S. *A Review of Topology Optimisation for Fluid-based Problems.* Fluids (2020), 5(1), 1–32.

[3] Dilgen, C. B., Dilgen, S. B., Fuhrman, D. R., Sigmund, O. & Lazarov, B. S. *Topology optimization of turbulent flows.* Computer Methods in Applied Mechanics and Engineering (2018), 331, 363–393.