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Topology Optimization of Flow Machinery

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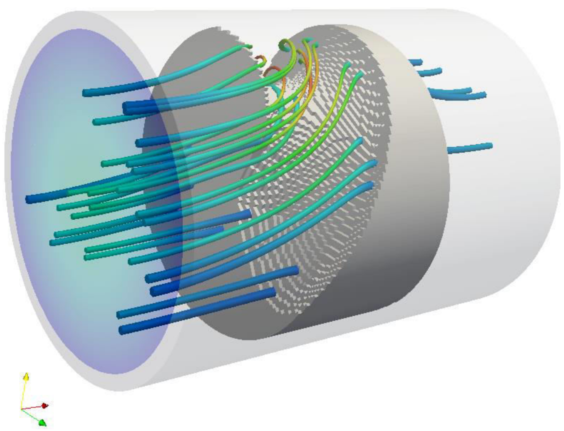
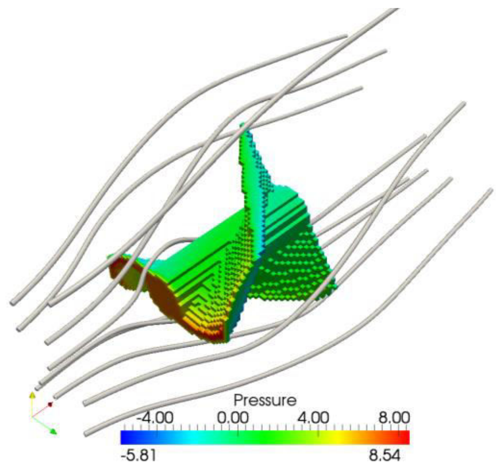
ABSTRACT

The design of flow machinery traditionally relies on experience and experiments. In recent years, the design process has been improved by the availability of numerical simulations, capable of analysing different flow phenomena and optimizing the performance of the machinery. However, the basic design of the flow machine, e.g. the impeller, is usually not changed much and mainly varies in the cross section layouts and blade numbers, which usually is determined by empirical data.

This paper presents a method to obtain an impeller design, which is free of a priori design considerations i.e. blade number / blade shape specifications. The method is a gradient-based topology optimization method utilizing the adjoint method for sensitivity computations. The objective formulation is inspired by the work published in [2] and is implemented in the in-house code DFEM [1]. The optimization procedure relies on a frozen rotor model of the impeller, which is optimized with respect to the shaft output. The figures show an optimized propeller in an axial pump and an optimized layout for a horizontal axis wind turbine. The paper discusses the method, its application and limitation for real life problems, while presenting a novel set of flow machinery designs obtained under the limitation of steady-state low Reynolds number flows.





References

[1] N. Aage, B.S. Lazarov, Parallel framework for topology optimization using the method of moving asymptotes, *Structural and Multidisciplinary Optimization,* **47**(4)**,** 493-505, 2013

[2] T. Kondoh, T. Matsumori, A. Kawamoto, Drag minimization and lift maximization in laminar flows via topology optimization employing simple objective function expressions based on body force integration, *Structural and Multidisciplinary Optimization,* **45**(5)**,** 693-701, 2012