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Design of Laminar Flow Machine Rotor By Using Topology Optimization Method

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Abstract

Flow machines are very important to industry, being widely used on various processes. Thus, performance improvements are relevant factors and can be achieved by using optimization methods, such as topology optimization. This work aims to develop a method to design a radial flow machine's rotor that works on laminar flow, based on Topology Optimization Method (TOM). The design of a rotor involves firstly modelling the fluid flow by using Navier-Stokes equations on a rotary referential and using the Finite Element Method for solving these differential equations. This modelling is performed by using FEniCS, an OpenSource platform for finite element problem solving. To determine the material distribution on domain, a porous flow model based on Darcy equation is employed, by using a local permeability that permits a transition between fluid and solid. In the optimization problem formulation, a multi-objective function is defined, aiming to minimize the pressure loss, vorticity and power. The optimization problem is implemented by using DOLFIN-adjoint platform and the PyIpopt optimizer. Optimized topologies of flow machine rotors are obtained by using this method. Their performance is analyzed by evaluating velocity and pressure distributions inside rotor. Prototypes of these rotors are built by using a 3D printer and an experimental characterization is performed by measuring fluid flow and pressure head.