11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

A TOPOLOGY OPTIMIZATION APPROACH APPLIED TO FLOW MACHINE ROTOR DESIGN

J. S. Romero[1] and E. C. N. Silva[2]

[1] Department of Mechanical Engineering, Federal University of Espirito Santo, ES, Brazil, juan.saenz@ufes.br

[2] Department of Mechatronics and Mechanical Systems Engineering, Polytechnic School of University of Sao Paulo, SP, Brazil, ecnsilva@usp.br

Key words: *topology optimization, radial flow machine, rotor design, energy dissipation, vorticity.*

This work deals with topology optimization of radial flow machines (pumps and turbine), where a novel methodology for the propeller design is proposed based on the topology optimization method. The numerical analysis in this study consist of predicting the flow field between relative two blades of a rotor without considering the influence of the volute. The design objective is to optimize the shape of the channel between two blades of the rotor to minimize the energy dissipation and vorticity, and minimize or maximize the power in the case of a pump or turbine, respectively. These objective functions are combined in a multi-objective function. A two-dimensional Navier-Stokes problem in a rotating frame is derived for modelling the rotor behavior. The discretized state problem is a mixed finite element problem. We assume that the fluid is flowing in a idealized porous medium subjected to a friction force, which is proportional to the fluid velocity and the inverse local permeability. A design variable field is introduced through a material model [1], that defines the local permeability of the medium. The design optimization problem is solved by using the method of moving asymptotes (MMA) [2]. Numerical examples are presented to illustrate this methodology showing that topology optimization has a great potential to design these flow devices.

REFERENCES

[1] J. K. Guest and J. H. Prevost. Topology optimization of creeping fluid flows using a Darcy-Stokes Finite element. *Int. Journal for Numerical Methods in Engineering*, Vol. **66**, 461–484, 2006.

[2] K. Svanberg. The method of moving asymptotes: a new method for structural optimization. *Int. Journal for Numerical Methods in Engineering*, Vol. **24**, 359–373, 1987.