Mathematical Modelling in Shape Optimization of Water Turbines

Bohumír Bastl[1], Stanislav Štěch[2]

[1]) University of West Bohemia, Pilsen
bastl@kma.zcu.cz
[2]) Mavel, Benešov
stech@mavel.cz

Water turbines are machines which convert kinetic and potential energy of water to mechanical work. There are different types of water turbines, from Kaplan turbines, which are used especially for lower heads and high flow rates, through Francis turbines, which are used in a wide range of heads and flow rates, to Pelton turbines, which are used for high heads and low flow rates. Water turbines are frequently used in the whole world also because of their high efficiency they belong among the most effective machines.

Thus, manual optimization based on experience of a designer is still more and more difficult. On the other hand, formulation of an automatic shape optimization procedure is a very challenging task because of the complexity of the problem. In the presentation, we will describe our approach to automatic shape optimization for Kaplan turbines which was developed in our last projects. The overall approach is based on a hybrid optimization method which combines a gradient-free and a gradient-based method. The geometry of all necessary parts is described with the help of B-spline objects which also serve as a basis in the developed incompressible turbulent flow solver.

Acknowledgement. This work was supported by the European Commission through the project no. 678727 Multi-ObjecTive design Optimization of fluid eneRgy machines.