Comparison of Numerical and Experimental Results of the Flow in the Porjus U9 Kaplan Turbine Model

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Abstract

The present work compares simulations made using the OpenFOAM CFD code with experimental measurements of the flow in the U9 Kaplan turbine model. The focus is on the flow in the spiral casing and in the draft tube.

The U9 Kaplan unit in Porjus, Sweden, has an inlet pipe that is curved close to the inlet of the spiral casing. Nowadays, this curved pipe and its effect on the flow in the turbine is not taken into account when numerical simulations are performed at design stage. To study the impact of the inlet pipe curvature on the flow, measurements were made at the spiral casing inlet and in the spiral casing just before the guide vanes, using the Laser Doppler Anemometry (LDA) technique [1]. Time dependant pressure measurements were also taken in the spiral casing [2]. The present work compares the numerical and experimental results of the flow in the real geometry, including the inlet pipe curvature.

In the Porjus U9 model draft tube, pressure sensors were flush mounted at 20 positions around the draft tube cone and at 13 positions in the elbow [3]. In the same region, a number of velocity profiles were measured using the LDA technique [4]. The experimental results are used to specify the inlet boundary condition for the numerical simulations, and to validate the computational results.

Both computational grids used in this work are block-structured wall-function grids. Steady simulations are made in the inlet tube and spiral casing, and in the draft tube. The present work shows the importance of inlet boundary conditions for such simulations, both for the spiral casing and for the draft tube. The importance of having the runner coupled with the draft tube in the simulation of a draft tube is underlined, as well as the impact of a curved pipe on the flow at the inlet of the spiral casing.

Key words: Measurements, CFD, Water Turbine, Validation, Draft Tube, Spiral Casing, Distributor, OpenFOAM

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