HYDRAULIC OPTIMIZATION OF A T-JUNCTION - HYDRAULIC MODEL TESTS AND CFD-SIMULATION

BORIS HUBER [1], HERWIG KORGER [2] and KARL FUCHS [3]

[1] M.Sc., PhD, Project Manager, Institute of Hydraulic and Water Resources Engineering, Department of Hydraulic Engineering, Vienna University of Technology, Austria
(Tel: +43-1-58801-22231, Fax: +43-1-5045928, e-mail: boris.huber@kw.tuwien.ac.at)
[2] M.Sc., Assistant, Vienna University of Technology, Austria
[3] Eng., Vienna University of Technology, Austria

In this paper the hydraulic properties of a T-junction are investigated. The T-junction, planned in the Kops 2 high head power station by the Austrian Vorarlberger Illwerke AG, is located in the duct system between each turbine- and pump conduit of the three machine units.

To determine the flow characteristics and head losses the T-junction was investigated in a physical model test as well as in a CFD-simulation. The results of the hydraulic model tests were compared with the numeric calculation in order to assess the results. Then an alternative design of the junction was simulated to find out which junction has better flow properties or lower head-losses respectively.

Experiments were conducted with a length-scale of λl = 1:9.9. Numerous experiments with different flow and pressure conditions were carried out. In every case flow was gradually increased within a range where a constant loss coefficient was obtained.

Strong swirl flow was observed under certain operating conditions. To quantify swirl, a special measuring-equipment which was developed by our institute was used.

The numerical simulation (3-dimensional, steady) was conducted with the program package FLUENT 6.1.22. As turbulence models the Standard-k-ε-Model and the RNG-k-ε-Model (swirl dominated flow) were used. If the results of the CFD-simulation turned out to be satisfactory, a modified T-junction geometry should be simulated in order to find out which one had better hydraulic properties.

Under certain operation conditions there is a sudden change of flow direction. The flow pattern can be compared with an impinging jet - superposed with strong generation of swirl. It is not expected that the Standard-k-ε-Model performs well here. To account for the high swirl, the RNG-k-ε (swirl dominated) model was used and the boundary condition at the pump was modified. With this modification the loss coefficients agreed well with the experiments.

The hydraulic properties of the investigated T-junction proved to be very satisfactory. In particular the loss coefficients were comparatively small. The CFD-simulation agreed with the experiments very well. A variant of the T-junction was also investigated iIn the CFD-simulation. In case of turbine operation the head losses of the variant were slightly smaller, but in the other cases higher than the original T-junction. By the use of the numeric simulation instead of another physical model test with the alternative design it was possible to save costs.
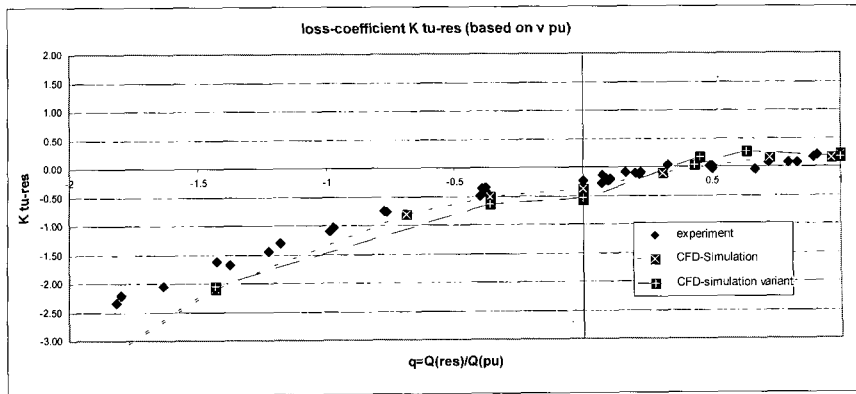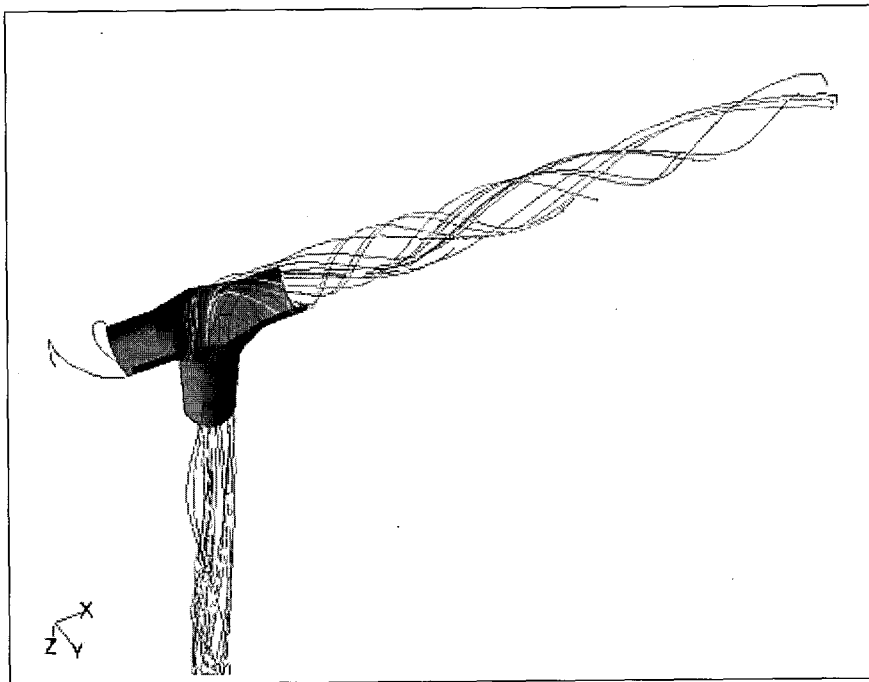
Fig. 1 Loss coefficient K tu-res

Fig. 2 Swirl flow in the T-junction, visualization with path lines

REFERENCES

Miller, D.S. (1978). *Internal Flow Systems,* BHRA Fluid Engineering, Vol. 5
Kopswerk II, leaflet, Vorarlberger Illwerke AG