Studies of the ERCOFTAC Centrifugal Pump

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Abstract

Numerical solution of the rotor-stator interaction using OpenFOAM-1.5-dev was investigated in the ERCOFTAC Centrifugal Pump, which is the ERCOFTAC *Test Case U3: Centrifugal Pump with a Vaned Diffuser*, a testcase from the ERCOFTAC Turbomachinery Special Interest Group. The case studied was presented by Combès at the *ERCOFTAC Seminar and Workshop on Turbomachinery Flow Prediction VII*, in Aussois, 1999, which has 7 impeller blades, 12 diffuser vanes and 6% vaneless radial gap, and operates at the nominal operating condition with Reynolds number of $6.5*10^5$ at a constant rotational speed of 2000 rpm.

2D and 3D models were generated to investigate the interaction between the flow in the impeller and that in the vaned diffuser using the finite volume method and a standard k-ε turbulence model closure with wall-functions. The incompressible Reynolds-Averaged Navier-Stokes equations are solved with an implemented Generalized Grid Interface (GGI) method that provides the means to sliding grid approach, a transient method where the rotor mesh actually rotates with respect to the stator mesh[1].

Several computational methods were considered on the choices of Euler, Backward and CrankNicholson time discretization, upwind and linear upwind differencing scheme, varied CrankNicholson off-centering coefficient. The choice of different maximum Courant Number has been studied, as well as required computational time. All the cases were analyzed with respect to the accuracy in the distribution of the ensemble-averaged velocity components and the ensemble-averaged static pressure coefficient compared against the available experimental performance provided by Ubaldi[2].

Results from all the computational cases showed some similarity with the experimental results, but the one with upwind differencing scheme failed in capturing the wake effect of the unsteadiness induced by the stator on the relative flow leaving the centrifugal impeller. In consideration of taking the shortest computing time, the case with maximum Courant Number of 4 was regarded as having the most efficient set-up to succeeded in depicting the characteristic flow behavior of the ERCOFTAC Centrifugal Pump.

Key words: CFD, OpenFOAM, Turbomachinery, GGI, ERCOFTAC centrifugal pump

References

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