QNET-CFD

A Thematic Network for Quality and Trust in the Industrial Application of Computational Fluid Dynamics

D29-V1_TA6_P18_DRAFT TUBE

QUALITY REVIEW OF AC DRAFT TUBE

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1. BACKGROUND

The present application challenge is a draft tube, the geometrical part downstream of a Kaplan turbine. The purpose of this curved diffusor is the recover of the kinetic energy of the runner flow. The flow in the draft tube is analyzed in design and off-design conditions. The inflow coming from the runner is complicated with swirling mean flow and periodic velocity components.
This test case was subject for two international ERCOFTAC workshops on Draft Tube flow, which are documented at http://www.luth.se/depts/mt/strl/turbine99.

2. REVIEW

The draft tube is identified as a test case, which can be accepted as an Application Challenge. The important comments of the review are summarized here:

- Detailed information about the test case set-up is given outside this document on the draft tube workshop homepage.
- The boundary conditions are described shortly in the document. The main uncertainty for the comparison of experimental data and CFD results is caused by the fact, that the radial velocity component is missing in the experimental data. There are some assumptions made for the CFD calculations, but especially swirling flows are very sensitive to the inflow boundary conditions. It is therefore recommended to add a sensitivity study of the variation of the inflow conditions.
- The CFD computations are not documented in detail. It is not clear, which code is chosen for the comparison with experiments. A code description and information about of parameter studies is missing.

Application Challenge (AC) Title: Draft Tube
AC Author and Thematic Area: Rolf Karlsson (TA6)
Reviewer (Name/Organisation) : Florian Menter /AEA

1	**TOP LEVEL CHECK**	**YES**	**NO**	**CO**
1. 1	Is this AC an Industrial test case for judging CFD competency?	☑	❑	❑
1. 2	Are the design/assessment parameters (DOAPs) defined?	☑	❑	❑
1. 3	Have these assessment parameters been measured?	☑	❑	❑
1. 4	Are CFD calculations available ?	☑	❑	❑
		H	**M**	**L**
1. 5	Importance of AC to Industrial Sector (IS)?	☑	❑	❑

Comments:

Please identify Underlying Flow Regimes for this AC:

Boundary layer in positive pressure gradient
Flow curvature
Flow rotation
Flow separation

DETAILED CHECK

2	GEOMETRY	YES	NO	CO
2. 1	Is the geometry fully specified?	☑	❑	☑
2. 2	Are the locations of boundaries specified?	☑	❑	❑
2. 3	Are the boundary types specified?	☑	❑	❑
2. 4	Is the geometry clearly illustrated?	☑	❑	❑
2. 5	Is the geometry available in digital form?	☑	❑	☑

Comments:
2.1/2.5: Geometry available in different CAD formats (download from workshop homepage)

3	FLOW PHYSICS AND FLUID DYNAMICS DATA	YES	NO	CO
3. 1	Are the physics of key processes identified?	☑	❑	❑
3. 2	Are the properties of the fluid specified?	☑	❑	❑
3. 3	Are the governing non-dimensional parameters (GNDPs) identified?	☑	❑	❑

Comments:

TEST DATA

4	OVERVIEW OF TEST DATA	YES	NO	CO
4. 1	Have all the experiments been adequately defined?	☑	❑	❑
4. 2	Are the measurement techniques used described?	☑	❑	❑
4. 3	Has a summary of test runs been provided (matrix)?	☑	❑	❑
4. 4	Are there any important scaling issues/simplifications/uncertainties associated with the test geometry?	❑	☑	❑
		H	**M**	**L**
4. 5	Impact of uncertainties on DOAPs ?	☑	❑	❑

Comments:

5	EXP1a, EXP1b, EXP2a, EXP2b	YES	NO	CO
5. 1	Is the experimental setup defined unambiguously?	☑	❑	❑
5. 2	Are the geometrical parameters defined?	☑	❑	❑
5. 3	Are the values of GNDPs specified**?**	☑	❑	❑
5. 4	Are the measured parameters (MPs) fully described?	☑	❑	❑
5. 5	Are measured data available in digital format?	☑	❑	❑
5. 6	Have conditions at all boundaries been specified?	☑	❑	❑
5. 7	Are any of the boundary data uncertain?	☑	❑	☑
5. 8	Is a realistic estimate of data accuracy given?	☑	❑	❑
		H	**M**	**L**
5. 9	Impact of uncertainties on DOAPs ?	☑	❑	❑

Comments:
5.7: Radial velocity components are missing at the inlet profile

CFD SIMULATIONS

6	OVERVIEW OF CFD SIMULATIONS	YES	NO	CO
6. 1	Have all the CFD runs been adequately defined?	☑	❑	❑
6. 2	Are the solution techniques used described?	☑	❑	❑
6. 3	Has a summary of runs been provided (matrix)?	☑	❑	❑
6. 4	Are there any important uncertainties associated with the computational domain geometry?	❑	☑	❑
		H	**M**	**L**
6. 5	Impact of uncertainties on DOAPs ?	❑	❑	☑

Comments:

7	CFD 1a, CFD 2a	YES	NO	CO
7. 1	Is the modelling strategy defined?	☑	❑	❑
7. 2	Is the modelling strategy appropriate for the physical problem?	☑	❑	❑
	Solution strategy			
7. 3	Is the code (and version) specified?	☑	❑	❑
7. 4	Are the equations solved described adequately?	☑	❑	❑
7. 5	Is the numerical discretisation scheme used specified?	☑	❑	❑
7. 6	Is the solution algorithm described?	☑	❑	❑
	Computational Domain			
7. 7	Is the domain fully described?	☑	❑	❑
7. 8	Boundary conditions fully detailed?	☑	❑	❑
7. 9	Is the domain used an idealisation/simplification?	❑	☑	❑
7. 10	Is the mesh used fully described?	☑	❑	❑
7. 11	Is the mesh quality appropriate?	☑	❑	❑
	Boundary Conditions			
7. 12	Are the boundary conditions fully defined?	☑	❑	❑
7. 13	Are they appropriate?	☑	❑	☑
7. 14	Do these replicate conditions in test rig?	☑	❑	❑
7. 15	Were sensitivity runs carried out to explore	❑	☑	❑

	effects of uncertainties in boundary data?			
	Application of physical models			
7. 16	Were turbulence models and other physical models applied in an appropriate and consistent way?	☑	❑	❑
	Numerical Accuracy			
7. 17	Is there any demonstration/estimation of numerical (discretisation) accuracy?	☑	❑	❑
7. 18	Was a mesh sensitivity study carried out?	❑	☑	❑
7. 19	Was sufficient iteration convergence achieved?	☑	❑	❑
		H	**M**	**L**
7. 20	Impact of uncertainties on DOAPs ?	☑	❑	❑

Comments:

7.13: Assumptions of radial velocity components, experimental data missing

8	**EVALUATION - Comparison of Test data and CFD**	**YES**	**NO**	**CO**
8. 1	Is the comparison of CFD and test data clearly presented?	☑	❑	❑
8. 2	Are the discussion, conclusions and recommendations adequately supported by the available experimental and CFD results?	☑	❑	❑

Comments: