Labor Windkanal/Strömungsmesstechnik

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Advanced Flow Quality for a Calibration Wind Tunnel

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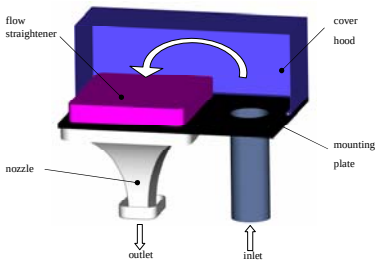
Introduction

One of the most important criteria of the flow quality of a wind tunnel is its turbulence intensity, which prevails in the measurement section.

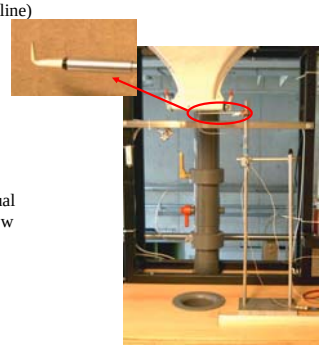
With the help of numerical numerical flow-simulation different geometries to improve the streamguiding between in- and outlet should be examined at an installed windtunnel at the University of Applied Sciences, Regensburg.
The calculated geometry causing the minimum turbulence intensity in the measurement section by calculation, was realized.
An apprpriate measurement performed by hot wire anemometry, should verify the results of the numerical simulation.



Measuring turbulence intensity

For the measururement of turbulence intensity at the outlet the DANTEC Streamline CTA system was adopted.

The system consists of following components:
- •hot-wire anemometre 1-D Filmprobe
- •CTA-Modul (Constant Temperature Anemometre Modul)
- •A/D converter
- •PC with appropriate software (Streamline)



For measuring the distribution of turbulence intensity across the nozzles outlet a crosswise raster was defined.

The tripod with the probe can be moved manual to the predefined coordinates by which the flow field is scanned.

Numerical simulation by CFD

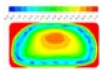
For calculation the following steps are necessary:

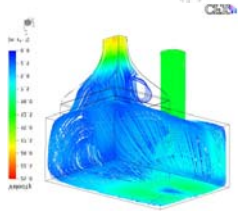
1 Modelling the fluidvolume
- •measuring the geometry of fluid
- •modelling the 3-dimensional fluidvolume via CAD-programm or the meshing tool

2 Meshing the fluidvolume
- •import the CAD-model into the meshingtool ***ICEM CFD***
- •definition of element-sizes
- •generating and optimizing qality of mesh

3 Setting of boundary conditions (Preprocessing)
- •import the mesh into the simulationprogramm CFX
- •allocating boundary coditons (in- and/or outlet-velocity, roughness, etc.)
- •choosing a turbulencemodel

4 Calculation and conditioning the results (Solution and Postprocessing
- •calculation ends at reaching a defined convergence criterium
- •revisioning the calculation about plausibility
- •graphical expositioning of results
- •pointing out special details

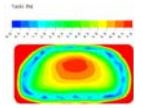




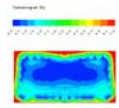
Results

After numerical variations of several geometries the best one was chosen and realized.

A comparison from the distribution of turbulence intensity between the origin version and the calculated geometry showed a significant improvement, which has to be verified by measurement.



turbulence intensity origin version (calculated)



turbulence intensity calculated geometry (calculated)

stream guiding

diffusor

After the manufacturing of the improved hardware, the components had to be integrated into the windtunnel.

The essential parts, a circle-rectangle-diffusor and the streamguiding, were sponsored by Fa. Stahl-Lasertechnik, Wackersdorf.

A final measurement of turbulence intensity couldn´t verify the numerical solution in the full calculated amount.

Possible reasons are:
- •use of an unapted turbulence model
- •discrepancies in the used turbulence intensity definition
- •unadapted boundary conditions (roughness, exact flow conditions at inlet)

Literatur:
- Oertel, H. ; Böhle, M.: *Strömungsmechanik,* Braunschweig/Wiesbaden: Vieweg-Verlag 2002
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- Jørgensen, F.: *How to measure turbulence with hot-wire anemometers;* practical guide: Dantec Dynamics 2002