A short note on validation of computational fluid dynamics for industrial processes

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Summary APEX Research B.V. established an experimental set-up to validate Computational Fluid Dynamics (CFD) results and to calibrate the CFD software for the application of plate type flow configurations. This allows the reliable prediction of flow field characteristics like pressure drop or flow uniformity in our plate type heat exchangers with our calibrated CFD Software.

The CFD model is shown in figure 1 and the corresponding physical model is shown in figure 2. The model is a 1:1 scaled channel as installed in our plate type heat exchanger. The physical model is completely made of plexi-glass allowing optical access at all positions in the channel. The validation is based on pressure drop analysis and velocity distribution in the channel. Differential pressure sensors measure the pressure drop and the velocity is measured with the latest Laser Doppler Anemometry system, one of the most accurate velocity measurement technique. Volume flow rates are measured with a vane anemometer and validated by cross sectional LDA measurements.

Figure 3 shows the comparison between results from CFD and from the experimental investigation with respect to total bulk pressure drop for different Reynolds numbers. The red curve shows the relative difference between measurement results and not-calibrated simulation and the blue curve shows the relative difference between measurement results and calibrated simulation. The differences are in the range of 1% for the whole Reynolds number range, whereas the not-calibrated curve shows a strong Reynolds number dependency as well as a maximum deviation of 15%.

Main influences on the result of the simulation are boundary conditions like velocity profile and turbulence intensity profile at inlet into the channel, volume flow rate and mesh generation.

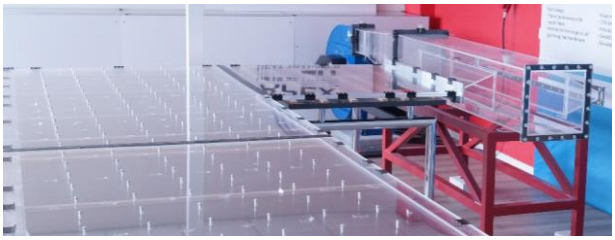

Figure 2 Photograph of physical model used for laser optical measurement techniques

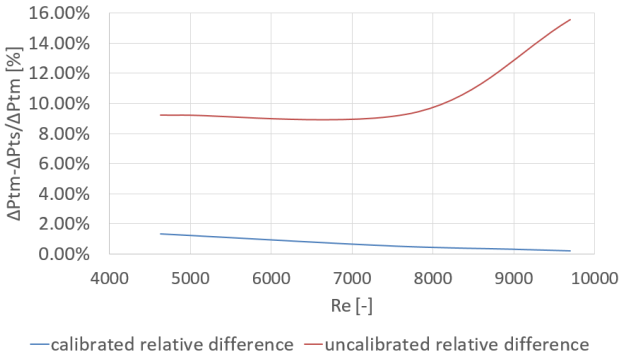

Figure 3 Comparison of relative pressure drop difference between experimental and computational results

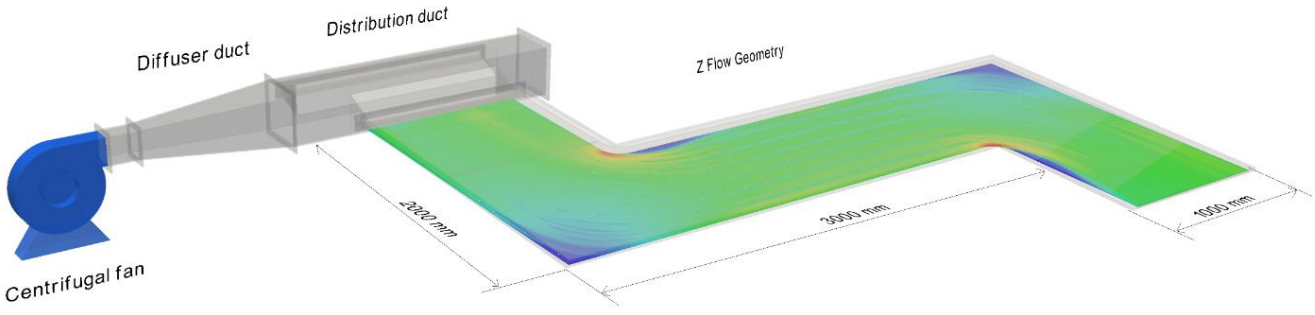

Figure 1 CFD model of Z-type flow configuration, color coding shows velocity magnitude, red indicates large velocities, blue indicates low velocities