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THE EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THE COANDA EFFECT AT THE FLAT PLATE

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The Coanda effect is the tendency of a fluid jet coming from the slot to be attracted to a nearby surface. In ventilation issues, the aforementioned effect is mainly considered as an undesirable phenomenon, which may cause an unsuitable air distribution and the lack of thermal comfort. Our interest in the use of the hysteresis of the Coanda effect in improving the effectiveness of mixing ventilation systems required also the initial investigations of the effect itself [1]. The study, with the help of the FloVent software, was carried out on the experimental rig at the University of Warmia and Mazury in Olsztyn. In [2] a very good review of Coanda effect can be found.

The laboratory examinations took place in a special test chamber whose dimensions were 3850x2255x2009 mm. The 2D air stream was generated by the Witoszynksi's nozzle of dimensions: height h = 0.6 m and width b = 0.02, 0.02 and 0.05 m, flowing freely, or along the plate of the turntable. The plate of the turntable could be manually turned with the angle range of $\alpha = 0° - 90°$. The air velocity range used during the investigation was 5 m/s to 30 m/s, so the Reynolds numbers based on the nozzle's width was about Re= 8000 up to almost 40000. [3]

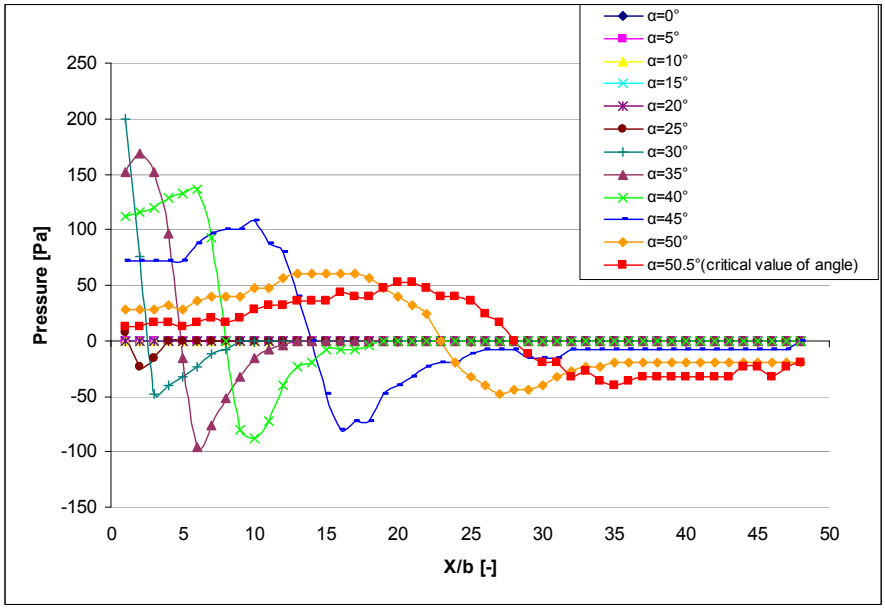

Fig. 1: pressure on the turntable for different angle α .

By using a thermoanemometr a measurement of velocity profiles and turbulence level was made. Also, the analysis of critical value of the separation and reattaching angle was performed. What is more, the length of separation bubble and the value of pressure and force

at the board of the turntable were examined. The results of pressure distributions on the plate surface are presented in Fig. 1.
The biggest values of pressure are directly before the nozzle for angle value 35°. After that, with the angle being increased the pressure is decreasing until the critical value of 50,5°. Finally, when the air stream has torn off, the force value is 0 N/m. The hysteresis of the Coanda effect was also analyzed.

Next, the numerical simulation of the free stream flow with a plate for varying angle α between the stream axis and plate. The FloVent from Mentor Graphics was used for our simulations. In a numerical model we recreated our experimental ring and repeated the investigations which took place in a laboratory. Total number of grid cells was about 3000000 and the simulations were done with turbulence K-ε model. Fig. 2 is showing the exemplary results of the CFD simulations.

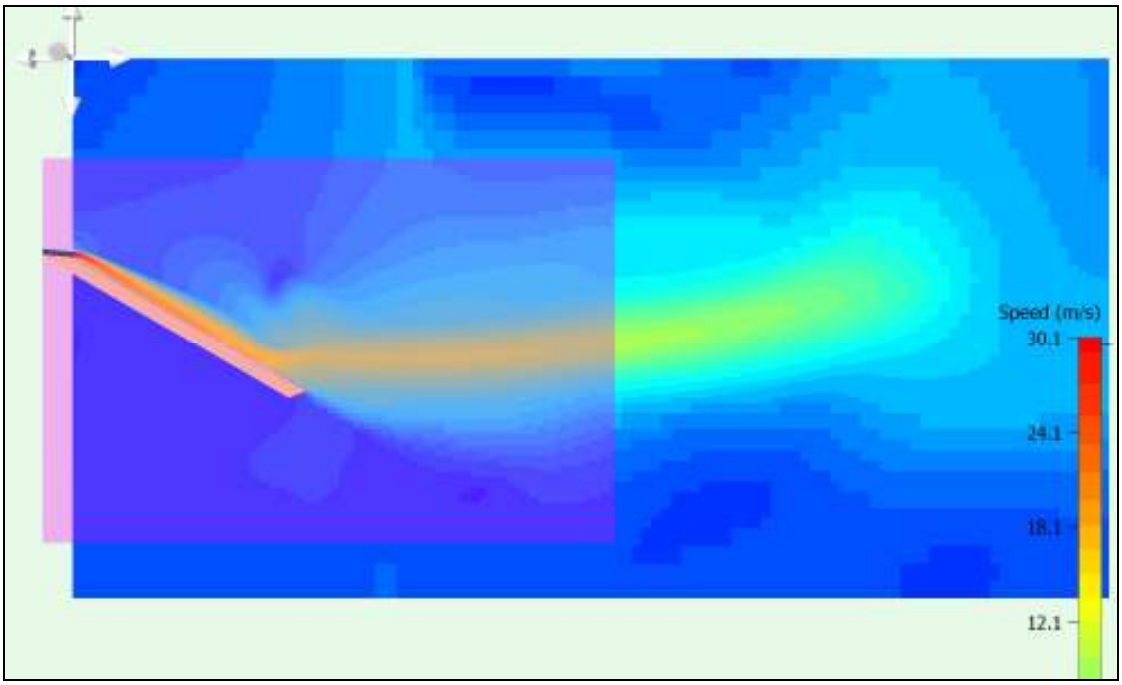

Fig. 2: Simulation of the Coanda effect with FloVent calculations, angle α=30°.

The results obtained with the use of FloVent confirmed experimental investigations relating the Coanda effect. Particularly, the value of the critical angle when the separation of jet from the flat plate took place was confirmed. Hence, gained was not only the opportunity to examine the properties of jet (velocity and turbulence level) with the use of CFD tools, but also the range of occurrence of the Coanda effect.

References

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