

CFD VALIDATION EXAMPLES

by

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A. INTRODUCTION

CFD analysis became very powerful and has the advantage that it can be used for very complex flow situations which are not possible to solve by „hand calculation“ methods, using standard correlations. However, this power comes with a disadvantage : the designer has limited possibilities of verifying the results. In order to gain confidence in the results predicted by simulation of a certain software package the user must compare these results with known, verified results. Such verified results can be obtained from laboratory experiments on physical models or against trusted literature sources.

This article is comparing the simulation using FloEFD software with results published by И.Е. Идельчик in „Справочник по гидравлическим сопротивлениям“ 1-е изд. in 1960 (I. E. Idelchik Handbook of Hydraulic Resistance 1st Edition). These experimental results have been obtained on water table models and other such laboratory models.

B. FIRST EXAMPLE

This example, Fig.1 shows the flow pattern in a simple 90°-bend. The interesting aspect is the pair of opposing vortices. We have modeled in CFD the rectangular duct only (b) as a wide duct as shown in Fig.2. The results reported in Fig. 2,3 and 4 demonstrate that CFD results reproduce the flow behavior observed experimentally.

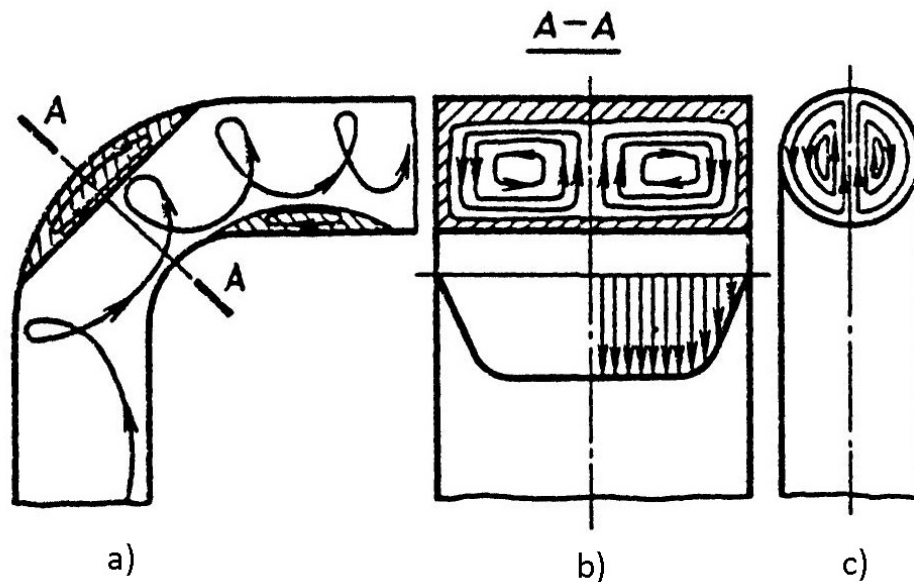


Figure 1. Double vortex at outlet:
a - longitudinal section ; b – transversal section (rectangular channel); c – transversal section(duct with circular section).

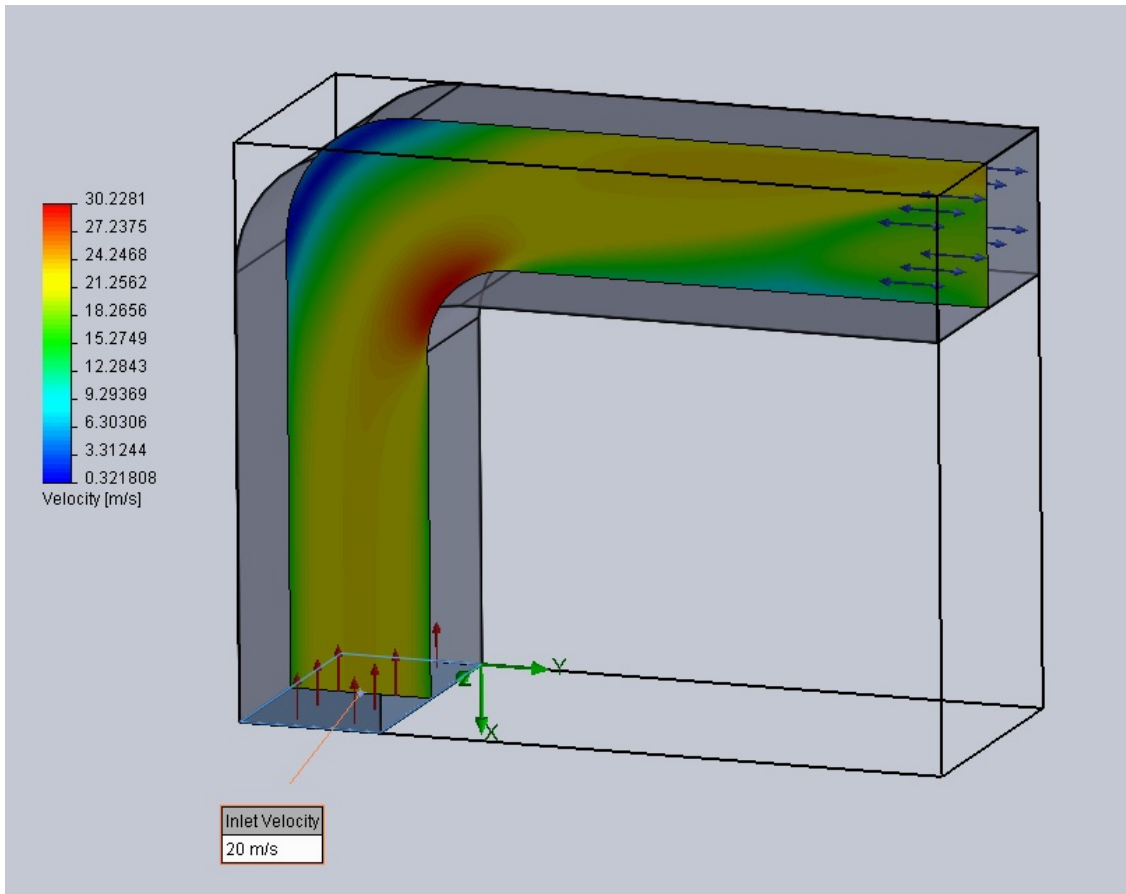


Figure 2. Velocity cut plot in longitudinal section.

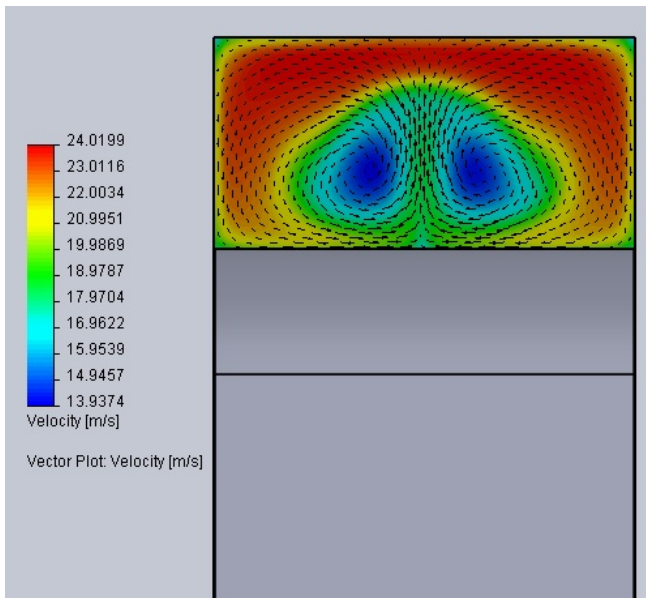


Figure 3. Double vortex and velocity profile at outlet section.

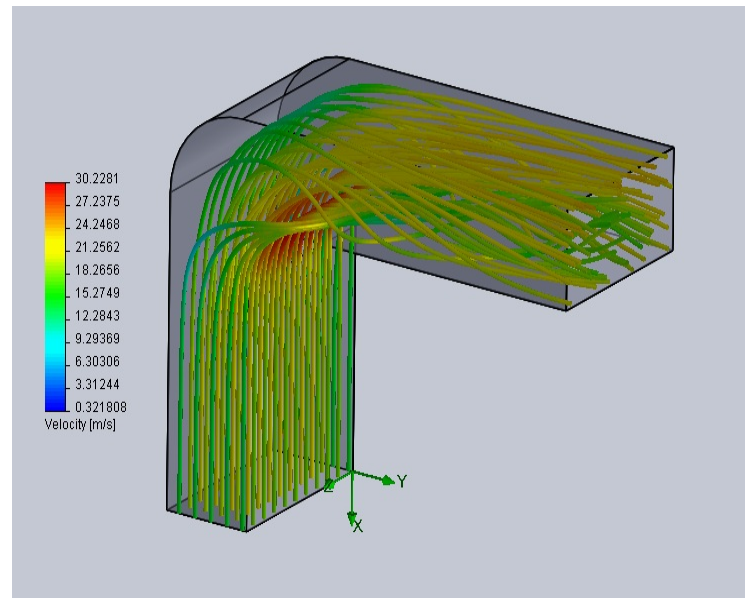


Figure 4. Flow trajectories .

C. SECOND EXAMPLE

In this example, Fig.5 is presented the velocity profile in different transversal sections, upstream and downstream of a 45°-bend, obtained from experimental measurements. Our CFD results of a 45°-bend, simulated for the same geometry are reported in figure 6 and 7. The simulated results reproduce quite accurately the experimentally results.

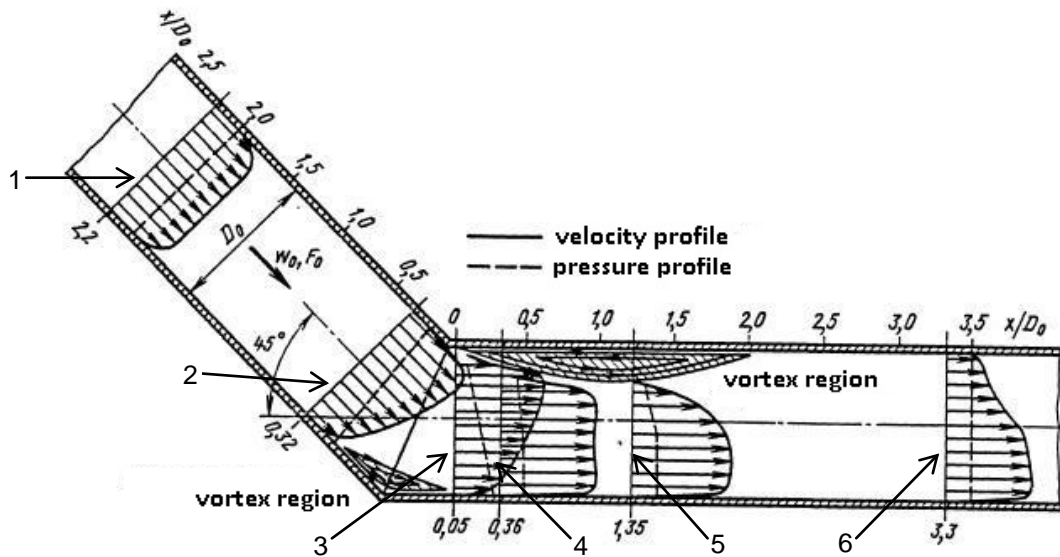


Figure 5. Variation of velocity and pressure profile in 45° bend

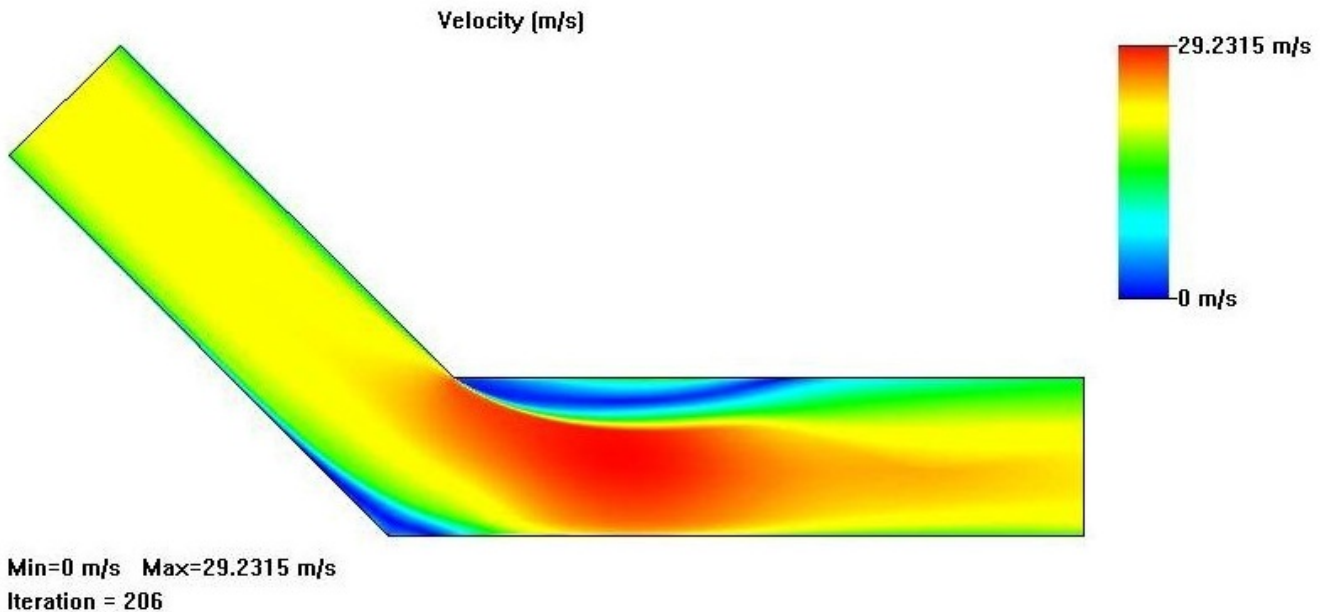
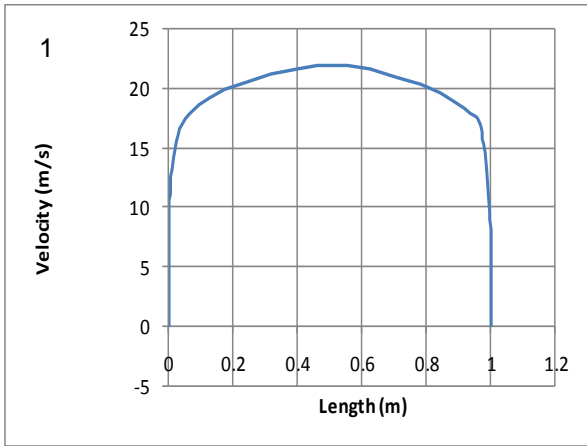
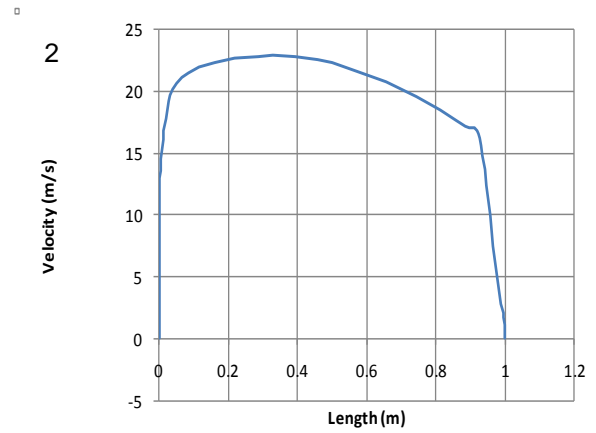


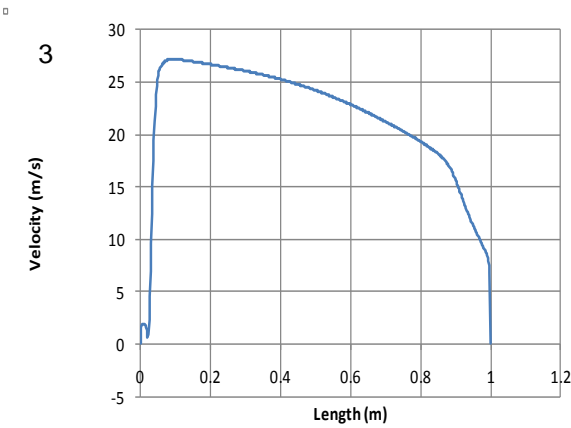
Figure 6. Velocity cut plot in longitudinal section.



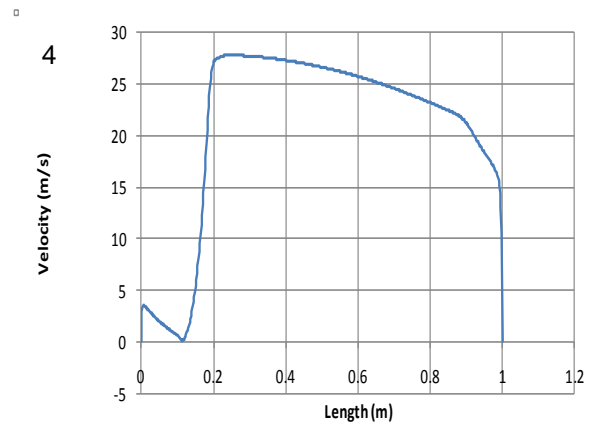
Velocity profile in section $x/D_0 = 2.2$ upstream the bend



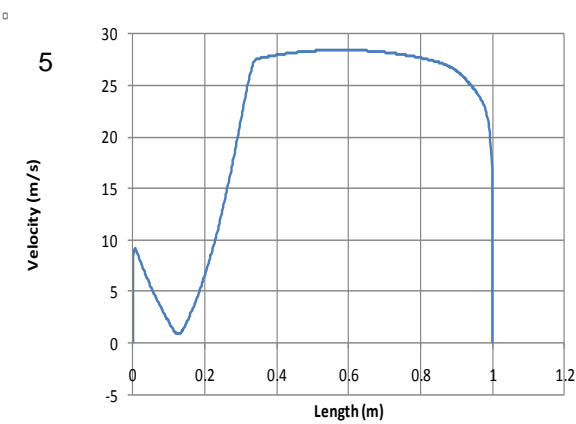
Velocity profile in section $x/D_0 = 0.32$ upstream the bend



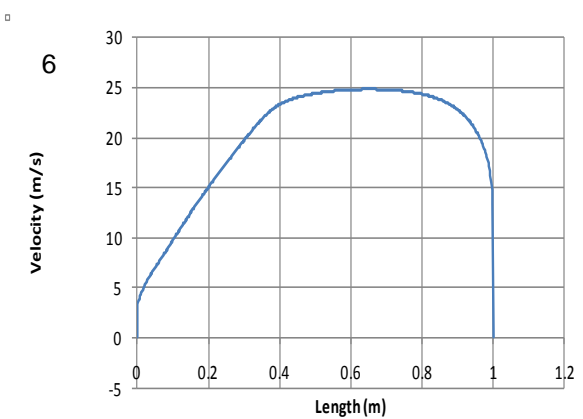
Velocity profile in section $x/D_0 = 0.05$ downstream the bend



Velocity profile in section $x/D_0 = 0.36$ downstream the bend



Velocity profile in section $x/D_0 = 1.35$ downstream the bend



Velocity profile in section $x/D_0 = 3.3$ downstream the bend

Figure 7. Velocity profiles in different transversal sections.

D. Conclusion

The examples presented above, demonstrate that CFD analysis is really a powerful and reliable tool. This comparisons give us also more confidence in CFD results for more complex flow pattern.

E. References

1. Handbook of Hydraulic Resistance 3rd Edition I. E. Idelchik