Comparison of numerical simulation results for geometry G1 and G1-v1

Geometry G1 – old geometry G1, height of the channel before processing element: 2.575mm (Fig. 1a).
Geometry G1-v1 – new geometry G1, after correction, height of the channel before processing element: 1.5mm (Fig. 1b).

a)

b)

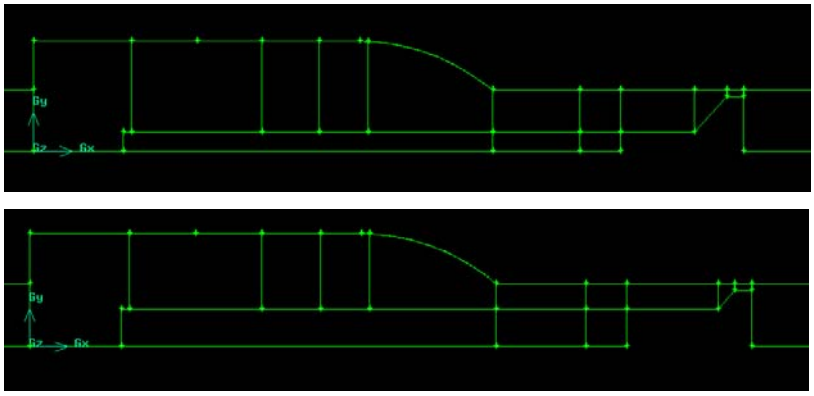


Figure 1. a) Geometry G1, b) geometry G1-v1.

Figure 2 shows longitudinal section along emulsifier model of the velocity vectors field in the vicinity of processing element for emulsifier with geometry G1 and G1-v1. For both cases flow fields are very similar in structure and in velocity value (vectors color).

a)

b)

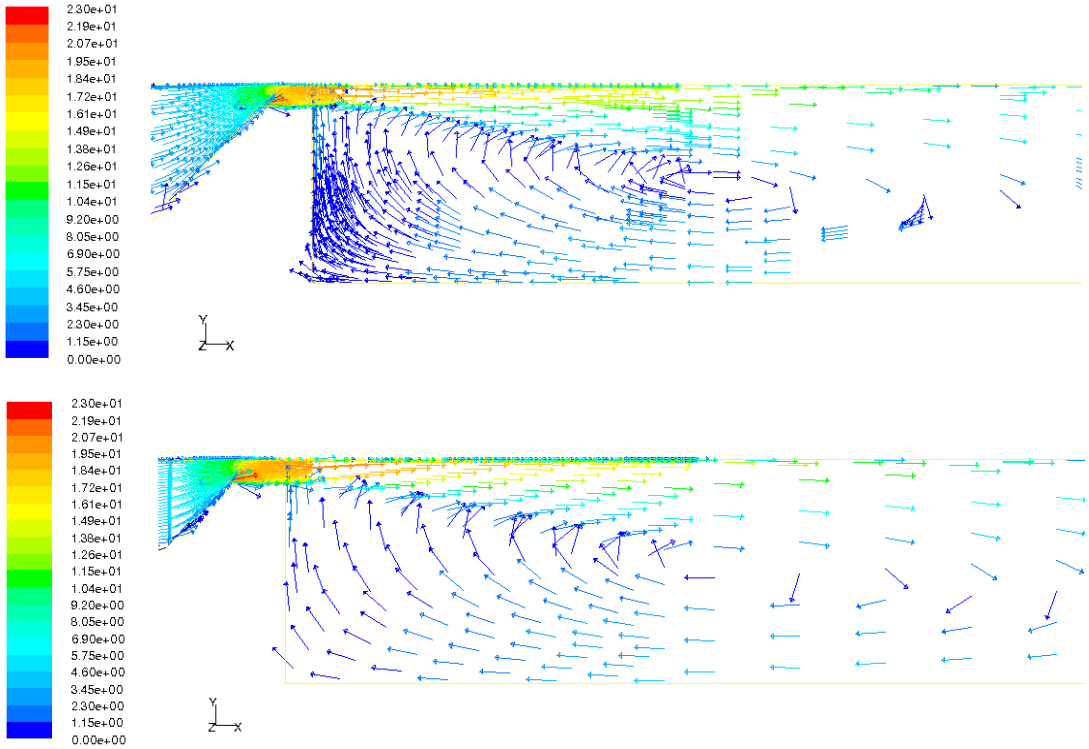


Figure 2. Velocity vectors in the vicinity of the processing element [m/s]: a) geometry G1, b) geometry G1-v1.

Velocity magnitude contours showed on figure 3 are very similar in the region behind processing element. In the channel before the gap velocity value for geometry G1-v1 is approximately two times higher than for geometry G1. For both cases (Fig. 2a and 2b) maximum velocity is in the gap between processing element and walls and takes value about $20 m/s$.

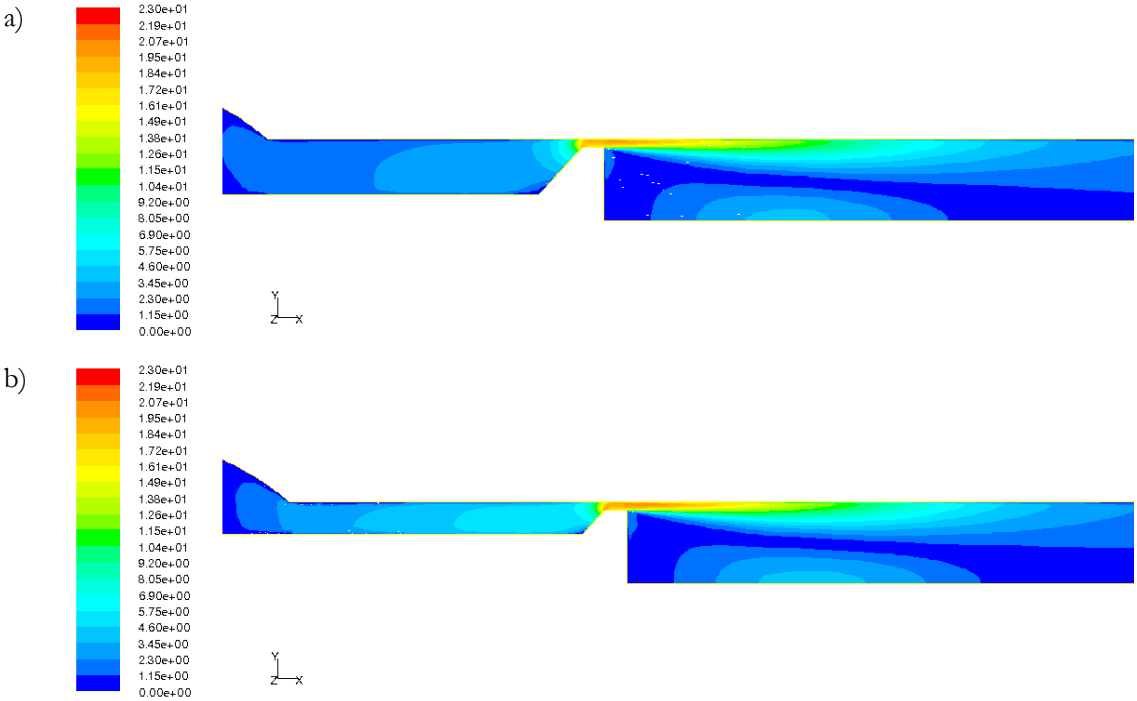


Figure 3. Contours of velocity magnitude $[m/s]$: a) geometry G1, b) geometry G1-v1.

Contours of velocity x-component (fig. 4ab) for geometry G1 and G1-v1 are similar, also.

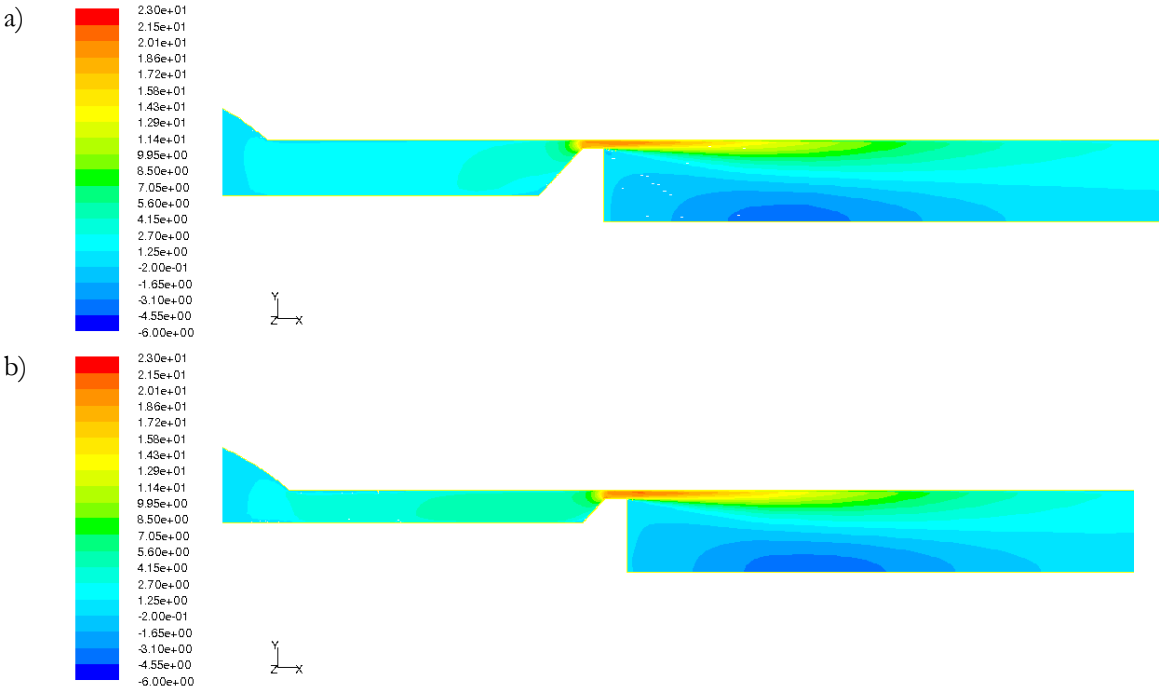


Figure 4. Contours of velocity x-component $[m/s]$: a) geometry G1, b) geometry G1-v1.

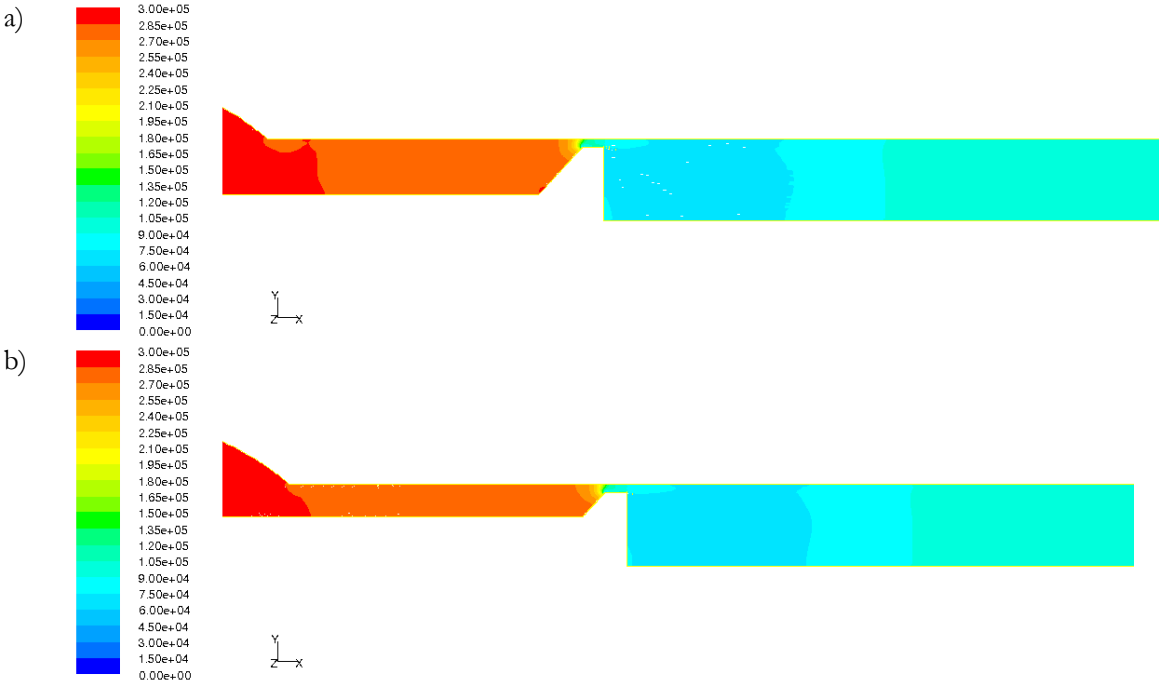


Figure 5. Contours of absolute pressure [*Pa*]: a) geometry G1, b) geometry G1-v1.

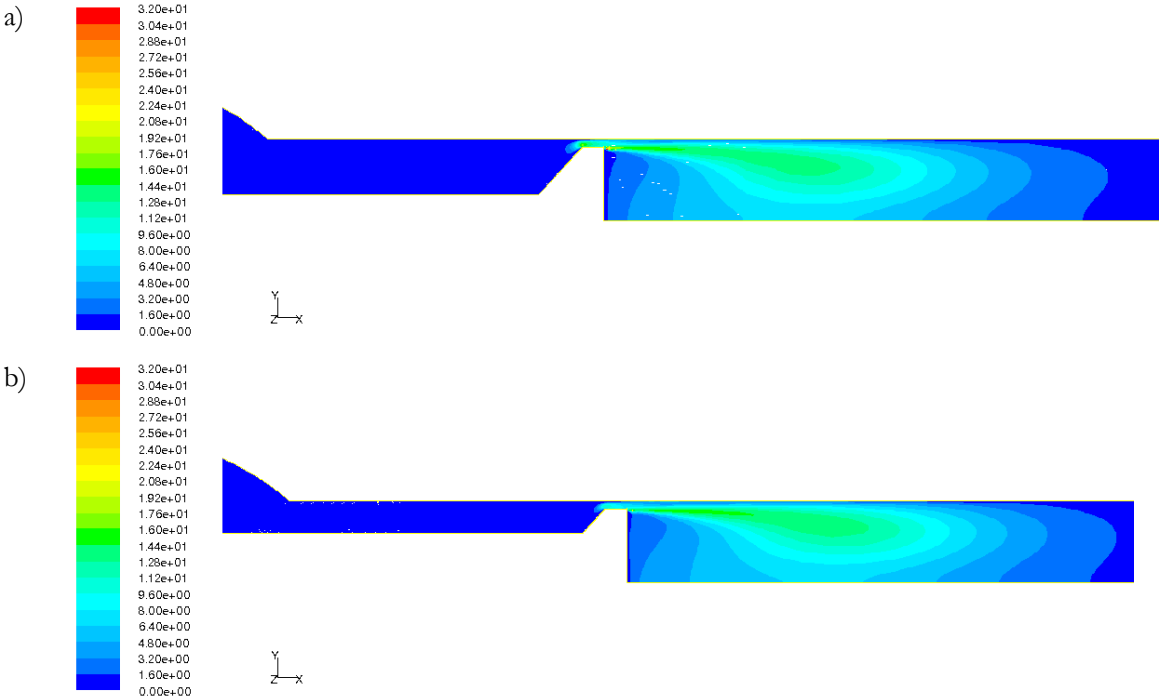


Figure 6. Contours of Turbulent Kinetic Energy [m^2/s^2]: a) geometry G1, b) geometry G1-v1.

Differences in the shape of the contours of absolute pressure (Fig. 5) and contours of Turbulent Kinetic Energy (Fig. 6) are also very small.

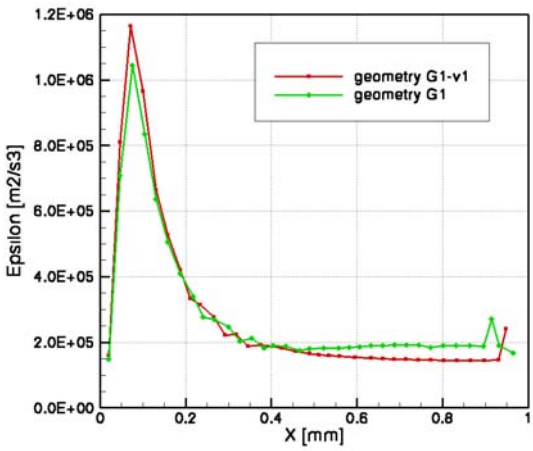
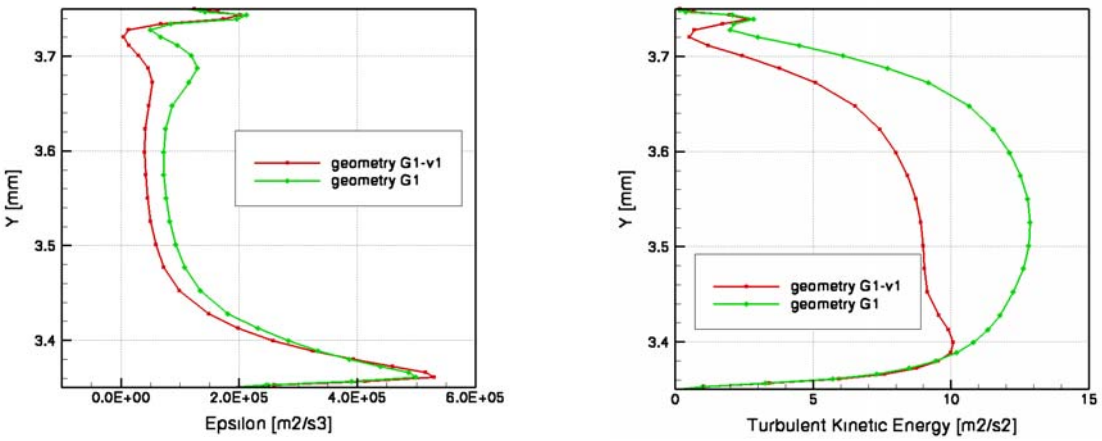


Figure 7. Horizontal profile of the averaged Turbulent Dissipation Rate *Epsilon* through the gap for geometry G1 and G1-v1.

Distributions of the averaged Turbulent Dissipation Rate (Epsilon) along the gap for geometry G1 and geometry G1-v1 (Fig. 7) are almost identical. Epsilon takes maximum value at the inlet to the gap. For geometry G1 this maximum value is $\varepsilon_{G1}^{\max} = 1.044 \cdot 10^6 m^2/s^3$ and for geometry G1-v1: $\varepsilon_{G1-v1}^{\max} = 1.160 \cdot 10^6 m^2/s^3$

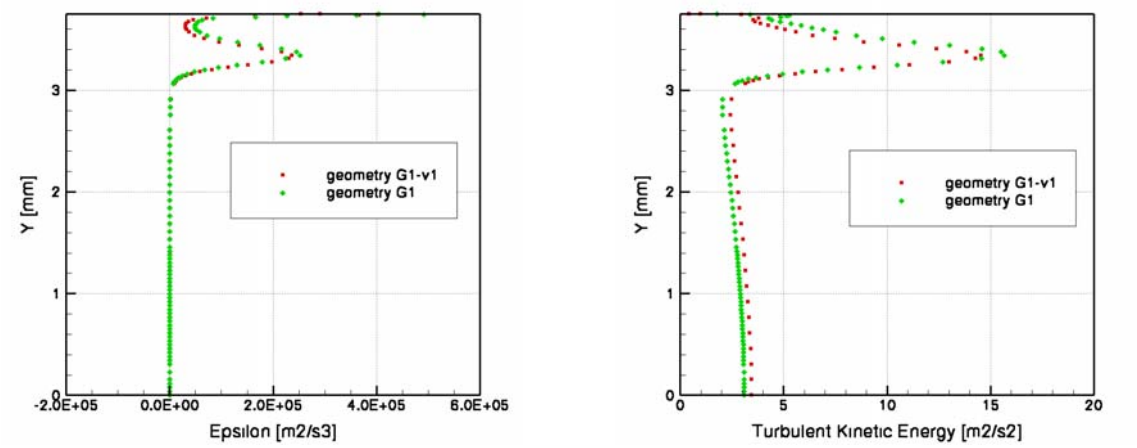
Figure 8 shows vertical profiles of Turbulent Dissipation Rate (Epsilon) and Turbulent Kinetic Energy in the middle of the gap for both geometries: G1 and G1-v1. Profiles of the Epsilon (Fig. 8a) are similar, but differences in profiles of Turbulent Kinetic Energy are significant (Fig. 8b).



(a) (b)

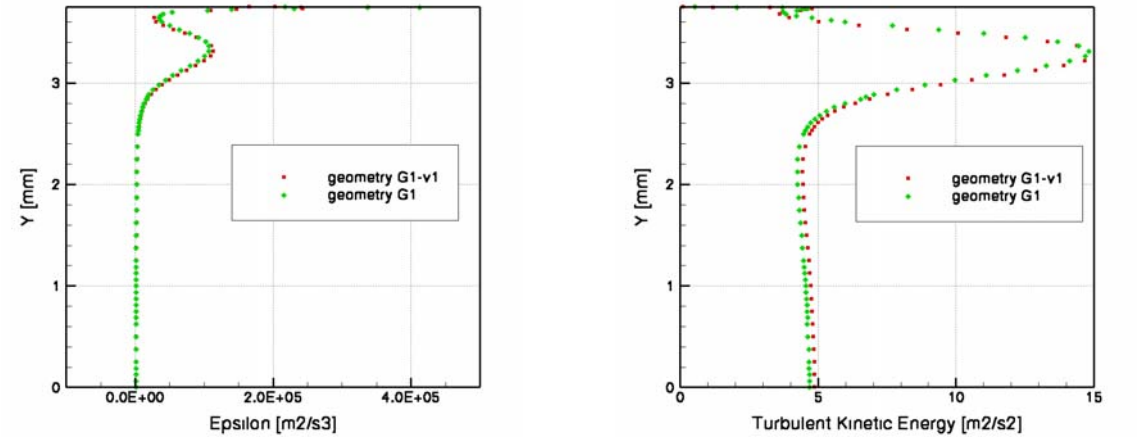
Figure 8. Vertical profiles of the Epsilon (a) and Turbulent Kinetic Energy (b) in the middle of the gap for geometry G1 and geometry G1-v1.

Profiles of Epsilon and Turbulent Kinetic Energy, located 1mm, 3mm and 8mm behind processing element showed in figures 9, 10 and 11 respectively are almost identical. Also, differences in profiles of x-component of the velocity (Fig. 12) are very small.



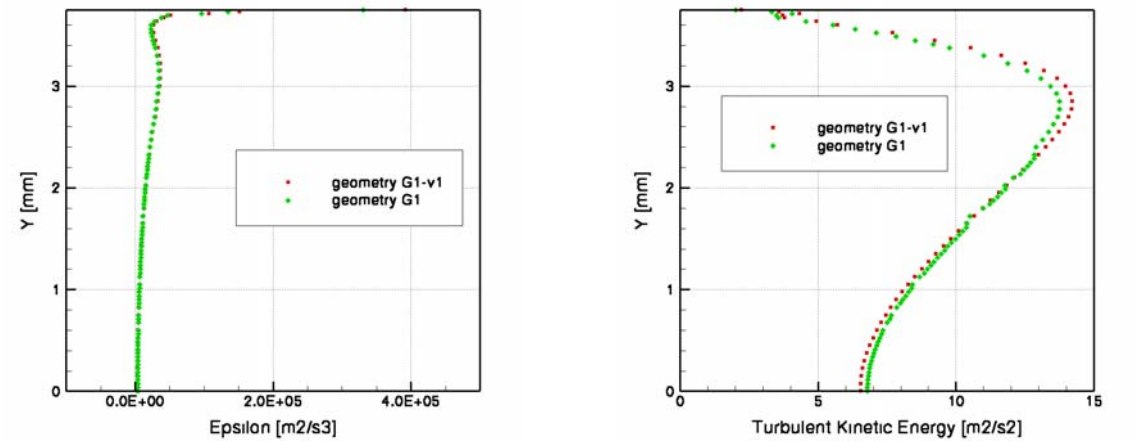
(a) (b)

Figure 9. Vertical profiles of the Epsilon (a) and Turbulent Kinetic Energy (b) 1mm after processing element for geometry G1 and geometry G1-v1.



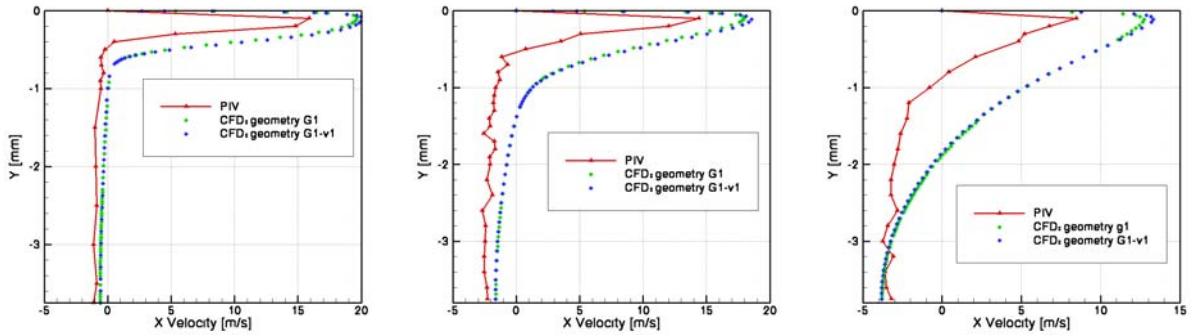
(a) (b)

Figure 10. Vertical profiles of the Epsilon (a) and Turbulent Kinetic Energy (b) 3mm after processing element for geometry G1 and geometry G1-v1.



(a) (b)

Figure 10. Vertical profiles of the Epsilon (a) and Turbulent Kinetic Energy (b) 8mm after processing element for geometry G1 and geometry G1-v1.



(a) (b) (c)

Figure 11. Comparison of numerical and experimental x-velocity vertical profiles for selected regions in emulsifier: 1mm after processing element (a), 3mm (b) and 8mm (c).

Conclusions

Channel height before the gap is insignificant for the flow structure in the vicinity of the processing element. Results obtained for geometry G1 (channel's height: 2.575mm) and for geometry G1-v1 (channel's height: 1.5mm) are very similar. Significant differences are noticed in the structure of Turbulent Kinetic Energy in the gap (Fig. 8b), only.