CFD Modeling of a Mixture Device for Medical Applications

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Introduction: The present work is dedicated to the flow characteristics and their influence on the mixing process in pipe branches. The influence of swirl flow on the mixture is a matter of particular interest. The geometry of the simulation model is build up as shown in Fig. 1. There are several studies, which examine the relationship between swirl flow in pipes and heat transfer, such as the recent study by K. M. Saqr [1]. The present simulation is built up to study a machine mixing fluids.

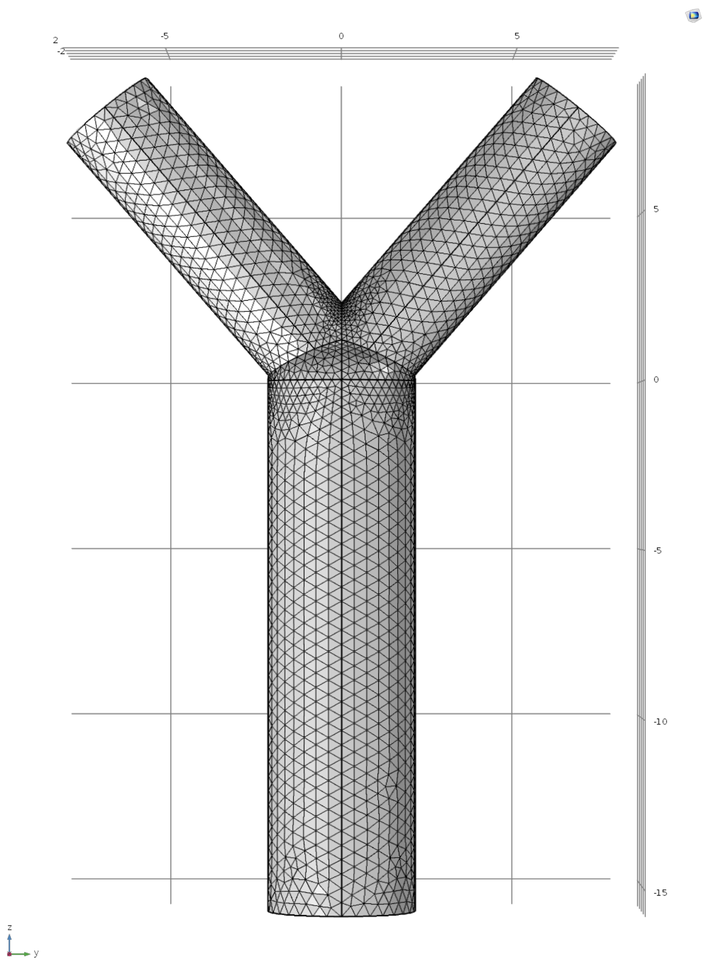

Figure 1. 3D meshed geometry

Computational Methods: Besides different fluid flow characteristics, the influence of geometric modifications has been investigated within the study. Using the CFD Module of COMSOL Multiphysics®, the simulation is built up as a 3D, stationary study. Regarding to the physical state, the fluid properties of water are used in the model. It is solved based on the Navier-Stokes Equations and the continuity equation.

$$0 = -\nabla p + \nabla \cdot (\mu(\nabla u + (\nabla u)^T)) + F$$
$$\nabla \cdot (u) = 0$$

Results: First of all the simulation has shown that streams with a concordant angular momentum on both inlets yield to a stream with an angular momentum at the outlet (cp. Fig. 2).

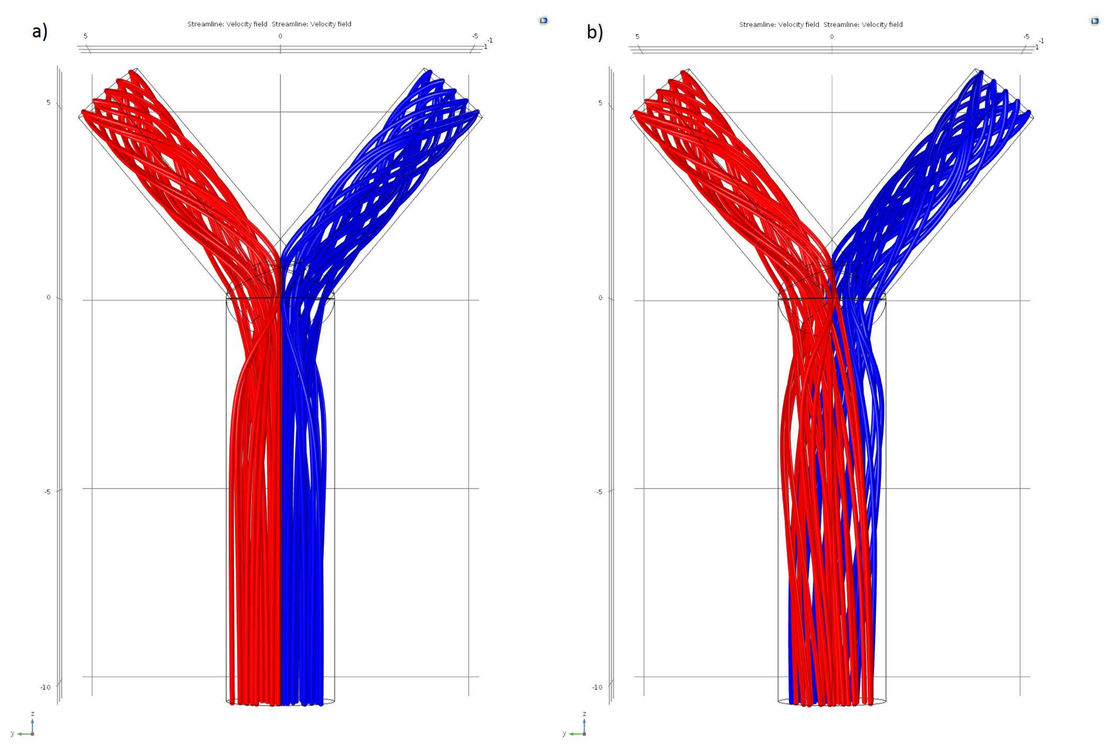

Figure 2. Streams with a) opposing angular momentum, b) concordant angular momentum

Secondly, the study has shown that swirl flow at the inlets leads to a higher mixture ratio. This result is shown in Fig. 3.

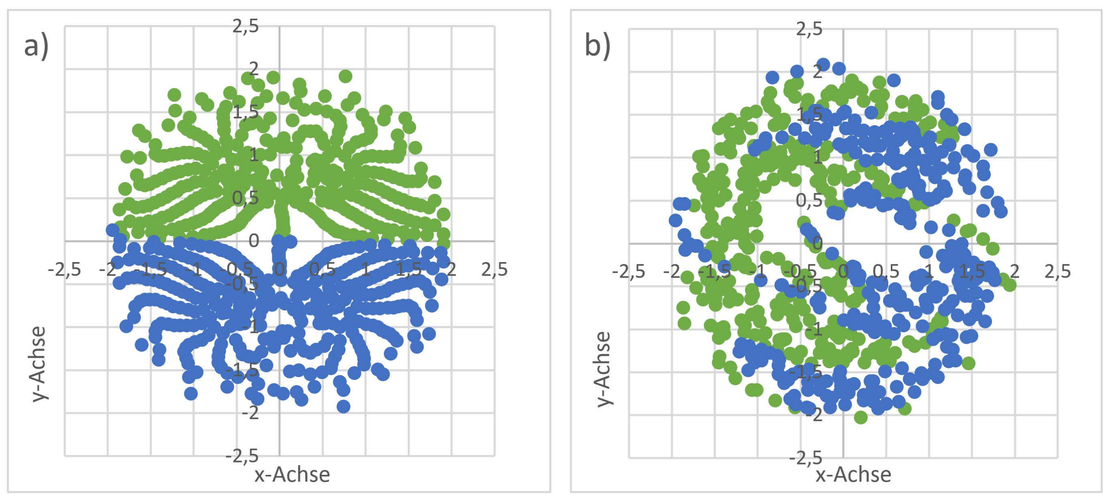

Figure 3. Streams at the outlet a) axial stream, b) concordant angular momentum

Conclusions: The results have a significant influence on the development of the mixing process. For further improvement it is possible to build up a transient model.

References:

1. K. M. Saqr, A. “CFD modelling of entropy generation in turbulent pipe flow: Effects of temperature difference and swirl intensity,” Applied Thermal Engineering, vol. 100, pp. 999–1006, 2016.