Investigation of the three-dimensional flow in a T-shaped micromixer by means of CFD and stereoscopic Micro Particle Image Velocimetry (stereo µPIV)

Project leaders
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Research theme
Complex dynamics of fluids

Participants
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Cooperations
LaVision GmbH, Göttingen, Germany

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Information
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Project aim

Develop a three-dimensional microscale velocity measurement technique for the investigation of complex microfluidic flows. Use this measurement technique together with supporting CFD analysis to reveal the symmetry breaking of the laminar stationary flow in a symmetric micro-scale T-shaped mixer.

Progress

A stereo-µ-PIV system for the simultaneous measurement of all three components of the velocity vector in a measurement plane (2D-3C) in a closed microchannel has been developed to support a fundamental description of the three-dimensional laminar flow in a T-shaped micromixer. Due to the very small confinement, standard calibration procedure by means of a calibration target is not possible, and therefore stereo-µ-PIV measurements in closed microchannels require a calibration based on the self-calibration of the tracer particle images. With the novel method the flow in a T-shaped micromixer at Re = 185 is investigated and the complex three-dimensional velocity distribution in determined. The experimentally observed flow patterns are verified by CFD calculations. A set of CFD experiments in performed to further understand the complex three-dimensional flow. The CFD results show that a flow instability occurs that leads to a bifurcation of the flow solution. This supercritical bifurcation is confirmed experimentally.

Dissertations

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Scientific publications

1. Hussong, J.; Lindken, R.; Pourquie, M.; Westerweel, J.: Numerical study on the flow physics of a T-shaped Micro-mixer. IUTAM Symposia Series "Advances in Micro- and Nanofluidics", Springer, in print.
2. Lindken, R.; Hussong, J.; Westerweel, J.: Micro-fluidic mixing by active control of the flow bifurcation in a T-mixer. µTAS2008 The 12th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Diego, USA, 12-16 October 2008.
3. Lindken, R.: Experimental and numerical investigation of the symmetry-breaking and flow bifurcation in a T-shaped micromixer. Keynote lecture, Heat Transfer and Fluid Flow in Microscale III, Whistler, BC, Canada, 21-26 Sept, 2008.
4. Lindken, R.; van Esch, J.; Westerweel, J.; Wieneke, B.: 3D particle imaging for the quantitative characterization of advective micro-scale mixing. 14th Int Symp on Applications of Laser Techniques to Fluid Mechanics, Lisbon, Portugal, 7-10 July, 2008.