Parametric optimization of a laminar-flow micromixer by CFD

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Abstract

Mixing is still nowadays a crucial and challenging aim in laminar, low Reynolds number microfluidic devices.

In this article, a parametric study of the geometry of a micro-channel comprising a mixing unit is studied in order to optimize the mixing process in order to have the highest mixing efficiency as possible at the channel exit. Instead of complex spatial geometries and sample strategies, simple periodic geometric features are applied to decrease the required mixing distances.

For a given 2D geometry studied in a previous article [1] consisting of a "T" type inlet channel and a mixing unit in which there are two bars forming known and fixed angles alpha and beta with respect the channel walls, it will be shown how the values of alpha and beta affect the efficiency of the resulting mixing at the outlet section of the channel as well as the pressure requirements to run the channel.

After the optimization process, an optimal combination of the angles alpha and beta has been found for which the mixing efficiency is as high as possible and the pressure at the inlet section is as minimum as possible. Other angle values have been also found to have either the highest efficiency (regardless the pressure drop) or the lowest pressure drop (regardless the mixing efficiency). Following [2], the mixing cost (a ratio between the efficiency and the pressure drop) of each configuration has been also calculated and discussed. The configuration with the lowest cost is also presented.

Keywords: Mixing unit, CFD, microchannel, response surface, optimization.

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[2] Chung, C. K., & Shih, T. R. (2007). A rhombic micromixer with asymmetrical flow for enhancing mixing. *Journal of Micromechanics and Microengineering*,*17*(12), 2495.