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内置周期挡板的T–型微混合器

何秀华, 颜杰, 王岩

江苏大学 能源与动力工程学院, 江苏 镇江 212013

T-shaped micromixer with periodic baffles

HE Xiu-hua, YAN Jie, WANG Yan

School of Energy and Power Engineering, Jiangsu University, Zhenjiang 212013, China

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摘要 设计了一种流道内布置周期挡板结构的高效T-型微混合器来提高微流控系统的混合效率。该微混合器结构简单,周期布置的挡板可以有效地缩短流体混合所需的流道长度和时间,混合效率高。安排了正交实验组,利用计算流体力学软件ANSYS CFX研究了流道结构参数对混合效果的影响。采用静态田口分析法对数值模拟结果进行分析。结果表明:流道结构参数对混合效果的相对影响程度排列如下:挡板攻角(θ) >流道高度(H) >挡板宽度(L) >相邻混合单元之间距离(D)。根据结构参数对混合效果的影响程度,得出研究参数范围内的最优组合为:θ=75°,H=0.4W_m,L=0.7W_m, D=0.6W_m(这里W_m为流道宽度,等于200 μm)。实验显示,结构参数符合最优参数组合的微混合器的混合效果提升显著,雷诺数Re=54时即可实现完全混合(混合指标M>95%)。文中研究了流道结构对进出口压降的影响,结果显示,攻角θ对进出口压降的影响趋势在不同雷诺数下相同,参数H,D亦如此。

关键词 : 微流控, 微混合器, 田口方法, 微混合, 混合效率, 正交试验设计

Abstract : An effective passive micromixer based on the T-shaped channel with periodic baffles mounted on the bottom of main channel was designed to enhance the mixing performance of the microfluidic system. Instead of complex spacial geometries, simple periodic geometric features were used to decrease the required mixing distances and time and to obtain remarkable mixing efficiency. With an orthogonal array, the effects of geometrical parameters on the mixing performance were studied by numerical simulations using commercial computational fluid dynamics code ANSYS CFX. A static Taguchi analysis was taken to evaluate the relative effectiveness of the geometrical parameters. The analysis results indicate that the relative effectiveness can be ranked as: the angle of attack(θ) >microchannel height(H) >baffle width(L) >baffle spacing(D). Based on the relative effectiveness of the geometrical parameters, an optimal parameter group selected are θ=75°, H=0.4W_m, L=0.7W_m, D=0.6W_m(here W_m is the channel width with a value of 200 μm). It demonstrates that the mixing performance of the micromixer with optimal parameter group is improved obviously, and a complete mixing(mixing index M is better than 95%) can be obtained when the Reynolds number Re is 54. The characteristics of the pressure drop depending on the geometrical parameters are also investigated, and the result shows that the selected θ affects the pressure drop in a similar way under different Reynolds numbers, so does the selected H and D.

Key words : microfluidics micromixer Taguchi method micromixing mixing efficiency orthogonal experiment design

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作者简介: 何秀华(1961-),女,四川成都人,教授,硕士生导师,2010年于江苏大学获得博士学位,主要从事流体机械内部流动及其性能研究。E-mail:xiuhua.he@ujs.edu.cn颜杰(1990-),男,江苏泗洪人,硕士研究生,2013年于江苏大学获得学士学位,主要从事微混合器内部流动及其应用研究。E-mail:yanjieujs@163.com

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