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Computational Fluid Dynamic Modeling of Mixing Enhancement by Stimulation of Ferrofluid under Magnetic Field

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Abstract : Computational fluid dynamics (CFD) simulation was performed to investigate the effect of ferrofluid stimulation on hydrodynamic and mass transfer characteristics of two immiscible liquid phases in a Y-micromixer. The main purpose of this work was to develop a numerical model that is able to simulate hydrodynamic of the ferrofluid flow under magnetic field and determine its effect on mass transfer characteristics. A uniform external magnetic field was applied perpendicular to the flow direction. The volume of fluid (VOF) approach was used for simulating the multiphase flow of ferrofluid and two-immiscible liquid flows. The geometric reconstruction scheme (Geo-Reconstruct) based on piecewise linear interpolation (PLIC) was used for reconstruction of the interface in the VOF approach. The mass transfer rate was defined via an equation as a function of mass concentration gradient of the transported species and added into the phase interaction panel using the user-defined function (UDF). The magnetic field was solved numerically by Fluent MHD module based on solving the magnetic induction equation method. CFD results were validated by experimental data and good agreements have been achieved, which maximum relative error for extraction efficiency was about 7.52 %. It was showed that ferrofluid actuation by a magnetic field can be considered as an efficient mixing agent for liquid-liquid two-phase mass transfer in microdevices.

Keywords : CFD modeling, hydrodynamic, micromixer, ferrofluid, mixing
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