Core Annular Flow in Micro-fluidic Contactor

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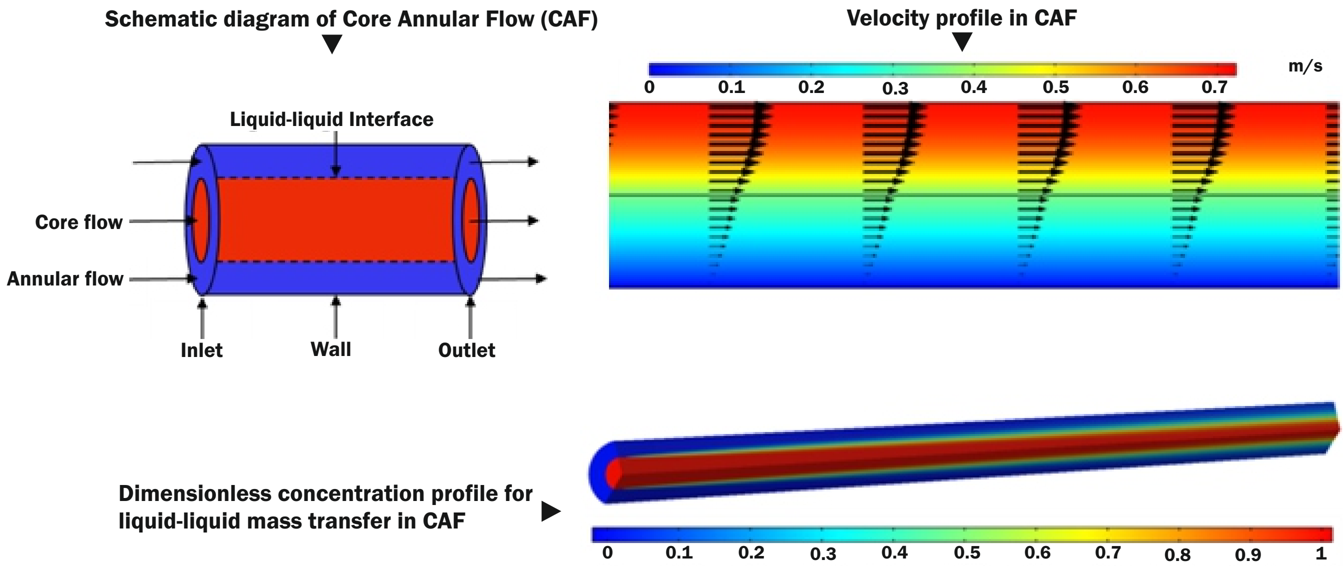
CFD Modeling of Liquid-Liquid Flow and Mass Transfer



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CFD modeling of Core Annular Flow in a micro-fluidic contactor provides fundamental understanding of liquid-liquid mass transfer, including dependence of dimensionless concentration boundary layer thickness and local Sherwood number on key dimensionless numbers. Correlations for estimating local Sherwood numbers are also obtained.

Micro-fluidic contactors are well known as process intensifying contactors owing to their features such as shorter diffusion length, high specific interfacial area, high overall volumetric mass transfer coefficients. Micro-fluidic contactors have been explored extensively for various liquid-liquid separations including the ones relevant for nuclear fuel cycle. Depending on the operating conditions and design of the micro-fluidic junction, different types of liquid-liquid flow patterns such as slug flow, droplet flow, core annular flow (CAF) may result in a micro-fluidic contactor. In this study (*Chaurasiya & Singh, CFD modelling of mass transfer in liquid–liquid core-annular flow in a microchannel, Chem. Eng. Sci. 2022, 249: 117295*), a CFD model to estimate mass transfer coefficient in CAF in a micro-fluidic contactor is reported.

CFD model involves numerical solution of Navier-Stokes and species transport equations with appropriate boundary conditions of velocity and shear stress applied on the liquid-liquid interface. The results of CFD simulations have been used to quantify the variations of dimensionless concentration boundary layer thickness on the core side and annulus side with dimensionless length, Reynolds number, Schmidt number, Graetz number, and distribution coefficient.

Film theory and penetration theory of mass transfer are evaluated for their applicability for liquid-liquid mass transfer in CAF and the latter is found to be suitable to predict the mass transfer coefficient with contact time defined as the ratio of the distance from the leading edge of the microchannel to interfacial velocity. CFD-based correlations to estimate core side and annulus side local Sherwood numbers have been reported. These correlations are useful to estimate overall mass transfer coefficient, which is prerequisite for design of micro-fluidic contactors.