Université de Technologie de Compiègne

PhD Grants from the China Scholarship Council: PhD proposal for 2022

Thesis title: Mass transfer from core-shell cylinders subjected to flow

Keywords: Transport phenomena, computational fluid dynamics, lattice Boltzmann method, artificial lung, heat sink exchanger

Summary: The project aims to study systematically mass transfer from initially loaded cylinders covered with a semi-permeable shell and subjected to flow. Two-dimensional computer simulations based on two-component lattice Boltzmann method will be used to compute the flow around the cylinders and the mass transport of a released solute. Mass transfer efficiency will be characterized with the Sherwood number (the dimensionless transfer coefficient) as a function of different parameters, such as the shell permeability and the cylinders spatial arrangement. An in-house fully parallelized code developed with Fortran 2000 will be used together with the emerging techniques of machine learning to screen a wide range of control parameters. Access to modern advanced workstations and supercomputer platforms such as PILCAM2 of the UTC will be granted.

Planning of the PhD project:

1. First year: Extension of recent studies [1,2,3] to a large range of the blockage degree (ratio of the cylinder diameter to the width of the channel) to investigate numerically the effect of the confinement, which will be compared to the theory of Khan et al [4], while considering both cases: constant and varying boundary conditions at the surface of the cylinder,
2. Second year: Study the efficiency of mass transfer from a stationary array of core-shell cylinders, with the aim to complement the list of existing correlations in literature of heat efficiency in heat sink exchangers, while considering cylinders with semi-permeable shells (that adds an interfacial resistance). The model and the knowledge of this part of the project will be applied to model oxygen exchange in an array of cylinders for future design of artificial lungs,
3. Third year: Development of a numerical method to study mass transfer efficiency from a single core-shell cylinder, whose shell undergoes either growth or shrinkage (accumulation of an undesired matter or shell degradation due to aging), while coupling the lattice Boltzmann method (used for the transport phenomena) and the phase field model (used for the cylinder shape evolution).

References:

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[4] W. A. Khan, J. R. Culham, and M. M. Yovanovich, Fluid flow and heat transfer from a cylinder between parallel planes, J. Thermophys. Heat Transfer 18, 395 (2004)

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