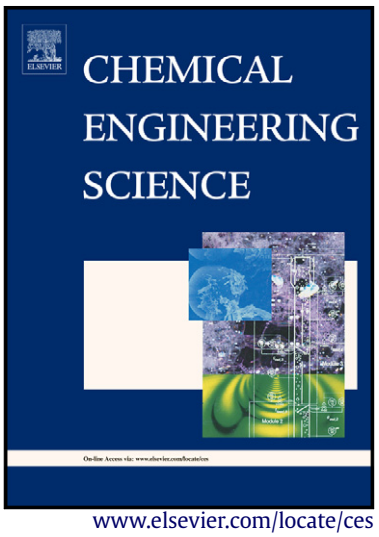

Dynamics of biconcave vesicles in a confined shear flow

Zheng Yuan Luo, BoFeng Bai

PII: S0009-2509(15)00465-0
DOI: http://dx.doi.org/10.1016/j.ces.2015.06.057
Reference: CES12460

To appear in: *Chemical Engineering Science*

Received date: 12 February 2015
Revised date: 27 May 2015
Accepted date: 23 June 2015

Cite this article as: Zheng Yuan Luo, BoFeng Bai, Dynamics of biconcave vesicles in a confined shear flow, *Chemical Engineering Science,* http://dx.doi.org/10.1016/j.ces.2015.06.057

Dynamics of biconcave vesicles in a confined shear flow

ZhengYuan Luo, BoFeng Bai *

State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, P.R. China

** Corresponding Author:*

Dr. BoFeng Bai, E-mail: bfbai@mail.xjtu.edu.cn

Abstract

To study the dynamics of red blood cells (RBCs) in confined shear flows is essential to understand the flow behavior of RBCs in capillaries and in microfluidics, especially when the length scale of the flow is comparable to the RBC size. However, previous studies are focused on RBC dynamics in unbounded shear flows, and only a limited number of cases concern RBC dynamics in confined shear flows by using two-dimensional (2D) vesicle model. Here, we develop a more native-mimicking three-dimensional (3D) model to investigate RBC dynamics in confined shear flows. The present model can reproduce experimental data of the deformation of healthy RBCs under the stretching of optical tweezers. Using the validated model, we find that RBCs in a 3D confined shear flow can exhibit breathing, swinging and tumbling motion. Particularly, breathing and swinging motion were observed in previous 3D simulations of unbounded shear flows, but in previous 2D simulations of confined shear flows only tumbling and tank-treading motion were observed. In confined shear flows, the deformation of RBCs is significantly promoted by increasing the confinement (i.e., the ratio of the RBC size to the channel size), thus breathing motion is preferable over tumbling motion. By increasing confinement alone, the dynamical state of RBCs can transit from the tumbling to the breathing via an intermittent state (i.e., breathing with a weak tumbling). These results provide new insights into the dynamics of RBCs suspended in confined shear flows, and can be helpful for further studies on the dynamics of RBC suspensions in capillaries and in microfluidics.

highlights

- We developed a 3D model for red blood cells (RBCs) in confined shear flow.
- RBC deformation is significantly enlarged with the confinement increasing.
- Increasing confinement can induce Tumbling-Breathing transition of RBC dynamics.
- Phase diagram for RBC dynamics is given based on viscosity ratio and confinement.