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Experimental Correlation for Erythrocyte Aggregation Rate in Population Balance Modeling

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Abstract : Red Blood Cells (RBCs) or erythrocytes tend to form chain-like aggregates under low shear rate called rouleaux. This is a reversible process and rouleaux disaggregate in high shear rates. Therefore, RBCs aggregation occurs in the microcirculation where low shear rates are present but does not occur under normal physiological conditions in large arteries. Numerical modeling of RBCs interactions is fundamental in analytical models of a blood flow in microcirculation. Population Balance Modeling (PBM) is particularly useful for studying problems where particles agglomerate and break in a two phase flow systems to find flow characteristics. In this method, the elementary particles lose their individual identity due to continuous destructions and recreations by break-up and agglomeration. The aim of this study is to find RBCs aggregation in a dynamic situation. Simplified PBM was used previously to find the aggregation rate on a static observation of the RBCs aggregation in a drop of blood under the microscope. To find aggregation rate in a dynamic situation we propose an experimental set up testing RBCs sedimentation. In this test, RBCs interact and aggregate to form rouleaux. In this configuration, disaggregation can be neglected due to low shear stress. A high-speed camera is used to acquire video-microscopic pictures of the process. The sizes of the aggregates and velocity of sedimentation are extracted using an image processing techniques. Based on the data collection from 5 healthy human blood samples, the aggregation rate was estimated as 2.7x10³(±0.3 x10³) 1/s.

Keywords : red blood cell, rouleaux, microfluidics, image processing, population balance modeling
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