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Separation of rigid and compliant cells of biological suspensions in the tube flow by standing acoustic wave

Authors

Artem Baranov

Natalya Kizilova

lja Lucenko

Organisation(s):

Kharkov National University, Kharkov, Ukraine

ICM Warsaw University, Warsaw, Poland

Veterinary Academy, Kharkov, Ukraine

Email(s):

n.kizilova@gmail.com

Abstract:

Concentration and separation of particles by means of the standing acoustic wave and laminar tube flow is well known. Recently the method has been proposed for separation of the red blood cells (RBC) and platelets, RBS and lipids or polymer molecules/fibers in the microchannel flows and in droplets. Here the ability of the method for separation the more rigid and compliant particles is experimentally shown. The experimental flow chamber consisted of the straight and glass tube with the inner uniaxial tube of a smaller diameter branched then in three curved tubes. The chamber was equipped by the micro pump engine and acoustic wave generator (2.64 MHz). The native blood of chicken and human was studied. The portion of blood was mixed with 0.9% NaCl and heparin for preventing blood coagulation. The RBC was washed in the 0.9% NaCl solution in centrifuge (12000 min^{-1}) and collected in the 0.9% NaCl at concentration 35%. The laminar low of suspension driven by the pressure drop in the straight tube was affected by the acoustic wave. Due to the wave reflection the wave node appeared at the axis of the tube. Concentration of the particles along the axis has been observed. The contents of three curved tubes have been collected and studied by the microcapillary (d=0.1 mm) flow and standard microscopy dry smear test. It was shown the collected portions are different in size and RBC wall rigidity. The differences in rigidity might be connected with high and low cholesterol diet and of different age of RBC. T is known the young RBC possess compliant membrane while the old cells are more rigid. The two types of cells were separated in the curved tubes by the influence of centrifugal forces.

The model of two-phase suspension of compressible compliant particles in compressible Newtonian fluid is used for theoretical study of the particle concentration and optimization of the separation process.