Jordan University of Science and Technology

Scalability analysis of magnetic bead separation in a microchannel with an array of soft magnetic elements in a uniform magnetic field

Authors: Saud A. Khashan and Edward Furlani

Abstract: The scalability of magnetic bead separation and capture efficiency are studied for a flow through microfluidic system with integrated magnetic functionality. The system consists of a microchannel on a substrate that contains a planner array of embedded soft-magnetic elements. The elements become magnetized in the presence of an applied field and produce a local magnetic force that separates the beads from the flow. The Particle and fluid transport for this system are predicted using a discrete particle model (DPM) that employs a combined Lagrangian?Eulerian computational fluid dynamic (CFD) approach. The model is used to predict the bead separation dynamics and capture efficiency for different configurations of the magnetic elements. Both the total (system level) and local (per-element) capture efficiency are analyzed as a function of the number of magnetic elements, their volume, aspect ratio and spacing. The analysis shows that both the total and local capture efficiency increase as the volume of the elements increases for a fixed element aspect ratio and spacing. The total capture efficiency increases as the element aspect ratio increases or alternatively, as the inter-element spacing decreases. A key finding is that the total capture efficiency increases with the addition of the first few elements to the array, but then remains essentially constant as more elements are added. This implies that scale up for high throughput separation can best be realized by parallelizing the process, i.e. by replacing a single channel with a large number of magnetic elements with a parallel arrangement of shorter channels having fewer elements. These findings provide insight into the capture dynamics and define metrics for optimizing system performance.