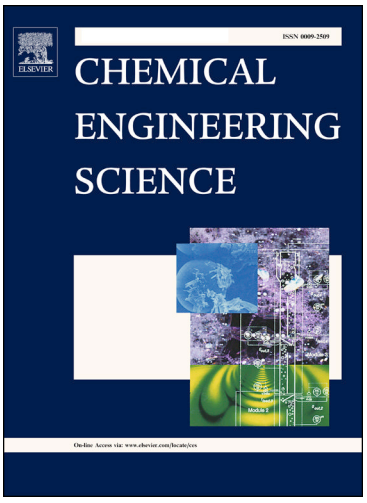

Effects of obstacle lengths on the asymmetric breakup of a droplet in a straight microchannel

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Effects of obstacle lengths on the asymmetric breakup of a droplet in a straight microchannel

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Abstract Rheological behaviors of a droplet moving in the micro-channel with a linear obstacle off the channel axis are investigated numerically by employing Volume of Fluid methods. Five different hydrodynamic patterns of the rheological behaviors of the droplet have been observed. The effects of the length ratio L of the mother droplet to the linear obstacle on the critical capillary number of the droplet breakup have been particularly studied. When L is less than a critical value L_{min}, the larger the droplet is, the smaller the critical capillary number Ca_{cr} is; when L is greater than L_{min}, the larger the droplet is, the greater Ca_{cr} is. The curve of Ca_{cr} as a function of L has a minimum point at L_{min}, which means that the droplet with $L=L_{min}$ could be broken up most easily. This is caused by the competition of the enhancing (positive) factors and the hindering (negative) factors on the droplet breakup, which has been analyzed carefully in this paper. When other parameters are fixed, it is very interesting to find out that the change of the obstacle length does not change the value of L_{min}, which is fixed to 0.66 for the conditions discussed in this paper. The results obtained here might enlighten potential applications for the design of the micro-channel with