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RESEARCH PAPER

Clogging of microporous channels networks: role of connectivity and tortuosity

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Abstract The aim of this work is to study the pore blocking by the use of microfluidic devices (microseparators) and numerical simulation approaches. The microseparators are made in PDMS and are constituted of an array of microchannels 20 μm wide with three types of structure: straight microchannels, connected microchannels (or aligned square pillars) and staggered square pillars in order to mimic merely the complexity of the flow encountered in filters or membranes (tortuosity, connectivity between pores). Direct observation with video microscopy of filtrations of 5 μm latex particles has been performed to examine the capture of particles. The results show a piling up of particles within the porous media leading to a clogging. The capture efficiency remains low (<0.1 %). In the case of filtration in the forest of pillars, the capture is faster and arises mainly between the pillars. The increase in tortuosity in the microseparator leads then to a rise of the clogging. It must be caused by the increase in critical trajectories leading to the capture of particles on the PDMS walls. At the same time, numerical simulations of filtration in parallel with microchannels have been performed in the same flow conditions with GeoDict software. The different kind of experimental deposit structure can be simulated, but there is still inaccuracy in the description of the accumulation kinetics. These discrepancies are probably due to the lack of accuracy to depict particle/particle colloidal interactions in simulations and the fact that re-suspension of particles after capture is not well described.

Keywords Microchannels · Plugging · Filtration · Numerical simulation · Fouling

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1 Introduction

The understanding of pore clogging is an important scientific challenge to maintain flow in microfluidic systems transporting particles as well as to optimize the efficiency of processes. For instance, the prediction of internal clogging in membrane processes is still impossible in the water treatment. The understanding of the conditions under which particles clog a porous media and the reversibility of the capture process (by a flow reversal, a

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