Deterministic ratchet technology for high throughput and efficient separation of suspensions

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Introduction

Deterministic ratchets consist of periodic arrays of obstacles, spaced such that particles having a minimum size are displaced (Fig. 1). The major advantage compared to membrane filtration is the inherent absence of particle accumulation in the flow direction as the characteristic gap size exceeds particle size. Potential applications are removal of particles from laundry washing water, harvesting of algae, and fractionation of spent grains or starch granules.

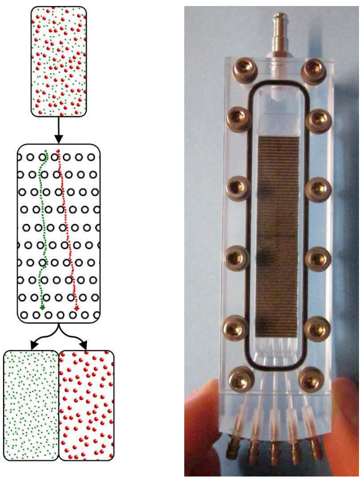

Fig. 1. Left: Separation by particle displacement in deterministic ratchets. Right: Ratchet device with a throughput of e.g. 9 L/h displacing particles in the range between 90 and 106 μm.

Aim

Investigate deterministic ratchets as a separation technology for concentration and fractionation of particles suspensions.

Results

Up-scaled deterministic ratchets provide efficient separation for model particle suspensions up to 12 v/v%[1]. High flow rates up to 9 L/h could be achieved in the ratchet device in Fig. 1. Maximum concentrations did not lead to blockage of the device and were much higher compared to concentrations normally achieved for membrane separation.
Surprisingly, separation efficiency increased with increasing flow rate or Reynolds number. Numerical simulations and high speed camera experiments showed that the superior separation at higher flow rates could be explained by changed particle displacement behavior[2]. This change was attributed to the inertial flow regime where the flow pattern strongly depends on Re (Fig. 2).

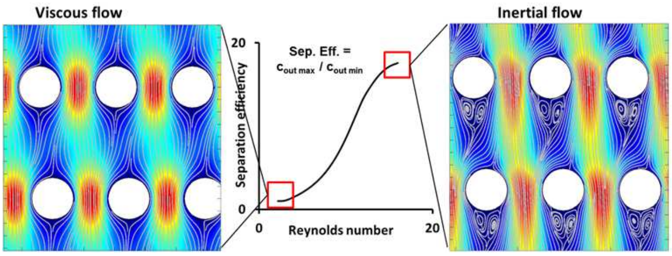

Fig. 2. Different flow regimes in deterministic ratchets lead to different separation behaviour[2].

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References

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2. Y.S. Lubbersen, J.P. Dijkshoorn, M.A.I. Schutyser and R.M. Boom. 2013. *Sep. Pur. Tech.* **109**:33-39.