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TITLE: Closed-circuit magnetic separation of nanoparticles on a packed bed of spheres

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ABSTRACT BODY:

Abstract Body: In this work, we consider magnetic separation of iron oxide nanoparticles when a nanoparticle suspension (diluted ferrofluid) passes through a closed-circuit filter composed of a packed bed of microspheres magnetized by an externally applied magnetic field. Recent studies on isolated magnetic collectors have shown that the capture of nanoparticles of a size as small as 50 nm is still very efficient if the magnetic interactions between them is sufficiently strong to induce a phase separation in the nanoparticle suspension [Magnet et al. (2012, 2014)]. In the present case of the packed bed of magnetizable spheres, such phase separation (manifesting by appearance of drop-like aggregates of nanoparticles) is easily achieved at magnetic fields as low as 15 kA/m. We show that the key parameter governing the capture of magnetic nanoparticles in the present system is the Mason number - the ratio of hydrodynamic-to-magnetic forces exerted to nanoparticles. The capture efficiency, λ , defined through a ratio of the inlet-to-outlet concentration shows a power-law dependency on Mason number, $\lambda \propto Ma^{-0.8}$, in the range $Ma < 10^4$. We developed a theoretical model based on the trajectory analysis of particle motion in a concentric-sphere representative cell of the porous filter. This model allows a correct prediction of the Mason number dependency of the capture efficiency. The obtained results could be of potential interest for water purification systems based on chemical adsorption of micro-pollutants on magnetic nanoparticles, followed by a magnetic separation on the considered type of magnetic filter. Preliminary results on nickel ion adsorption on oleate-covered iron oxide nanoparticles have already been obtained and are also reported in this work.

References: Magnet C., P. Kuzhir, G. Bossis, A. Meunier, L. Suloeva, and A. Zubarev, "Haloing in bimodal magnetic colloids: the role of field induced phase separation," *Phys Rev. E* **86**, 011404 (2012).

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KEYWORDS: magnetic separation, magnetic nanoparticles, porous media.

(No Image Selected)

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