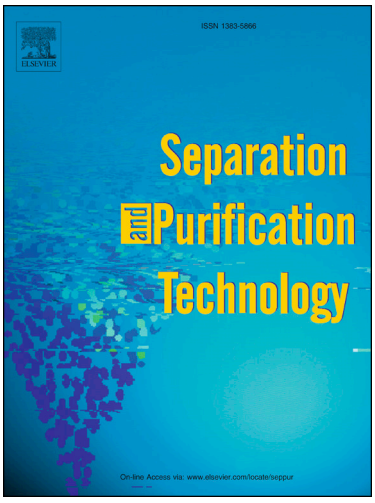

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Speeding up the magnetic sedimentation of surface-modified iron - based nanoparticles

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ABSTRACT

Nanoparticles with surface-modified shells are used for selective sorption of different impurities from water. Subsequent removal of nanoparticles from water can be strongly enhanced by using particles with magnetic core, providing their separation by sedimentation or filtration in magnetic field. The velocity of the magnetic sedimentation is strongly controlled by the particles aggregation which can be efficiently changed by interparticles interaction, in particular, by mixing the positively charged particles with negatively charged particles. The aggregation and sedimentation dynamics of the mixtures of the complex nanoparticles having the magnetite or the iron core, e.g., Fe_3O_4 / SiO_2, Fe_3O_4 / SiO_2-NH_2 and Fe / C-NH_2 in water were studied in a vertical gradient magnetic field $B \leq 0.3T$, $dB/dz \leq 0.13$ T/cm. The sedimentation time t_s was measured using two independent methods: by optically registered turbidity and from residual particle concentration in water by Nuclear Magnetic Resonance Relaxometry (NMRR) method. The t_s reaches a minimum (7-10 minutes) for the (1:1) mixtures of the target Fe_3O_4 / SiO_2 and the seed Fe_3O_4 /SiO_2-NH_2 nanoparticles. Adding of the seed Fe / C-NH_2 nanoparticles to the target Fe_3O_4 / SiO_2 water suspension is more effective due to smaller sizes and to larger magnetic moments of the Fe-based particles. The sedimentation time of about (6-10) minutes is observed for rather small fraction (6, 15 mass %) of the added Fe / C-NH_2 particles, which is important for application to reduce the residual sediment volume significantly. Preliminary exposure of the mixtures in the absence of magnetic field favors to more complete nanoparticles aggregation and, as a result, more rapid sedimentation of the nanoparticles in a vertical gradient magnetic field.

The data obtained are useful for development of the methods aimed at magnetic separation of magnetic and nonmagnetic nanoparticles in water purification technologies.

KEYWORDS: magnetic nanoparticles; water suspensions; sedimentation dynamics; gradient magnetic field; aggregation; sedimentation acceleration