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Application of magnetic iron-based nanosorbents for water cleaning

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Iron-based magnetic nanopowders (Fe, γ-Fe2O$_3$, γ-Fe3O4) are effective sorbents for the cleaning of water from heavy metal ions, radionuclides, organic and biological materials. The sorption capacity of the powder is defined by the specific surface which for particle diameter in nanosized range comes up to hundreds of m2/g. However, the small particle size creates difficulties to separate the solid phase from the water suspension using conventional mechanical filtration and sedimentation methods without additional reagents. If the nanoparticles have magnetic moments, their separation from aqueous solution can be enhanced in gradient magnetic fields. This will help to avoid a secondary water pollution by coagulants and flocculants.

The sedimentation dynamics of the magnetite (Fe3O4) nanopowders with different particle sizes (10-100 nm) in water in gradient magnetic fields of different configurations (radial and strip), with the strengths H = 0.5-6 kOe, and gradients up to dH/dz= 2 kOe/cm was studied by optical and by Nuclear Magnetic Resonance (NMR) methods. . In the gravitation field the suspensions of the small particles ($\sim$ 10-20 nm) remain stable for over 20 hours. The sedimentation process can be greatly accelerated by the action of a vertical gradient magnetic field, and the sedimentation time is reduced down to several minutes. In a gradient magnetic field enhanced by a steel grid the sedimentation of the nanopowder (c0= 0.1 g/l) for 180 minutes resulted in the reduction of the iron concentration in water down to 0.4 mg/l. In the flowing water regime the residual iron concentration in water 0.3 mg/l is reached after 80 minutes. This corresponds to the hygienic and environmental standards for drinking water and fishery.