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Institute for Sanitary Engineering, Water Quality and Solid Wastemanagement | ISWA

BiOS AWT

Development of functionalized micro-particles for the recovery of valuable substances from wastewater streams (BioSuPaWert)

Current trends show that the resources for some industrially important raw materials are depleting rapidly. Hence, the recovery and recycling of these valuable materials is essential and will gain even greater importance in the future. Therefore, it is already critical to develop methods for the efficient recovery of valuable substances, which can later on be of significant use to compensate for the global depletion of resources and meet the future demand.

The goal of the project BioSuPaWert was to establish the fundamentals of an environmentally friendly method for the recovery of phosphate directly from wastewater streams, even at low concentrations. Phosphate was used as an exemplary compound for an irreplaceable nutrient and scarce, finite resource. Magnetically separable particles with functionalized surface were engineered for this purpose. These are composite microparticles, which consist of superparamagnetic Fe3O4 nanoparticles enclosed in a diamagnetic matrix of amorphous SiO2. The surface of the particles was modified with layered double hydroxides ion exchanger (MgFe-Zr LDH) for the selective and reversible exchange of phosphate with an absolute capacity of 30 mgP/gLDH. Phosphate adsorption should preferably take place in the pH range 4.5-5 with particles concentration of 1 g/L (corresponds to 400 mg/L LDH) and contact time 1 h. The phosphate loaded particles are regenerated in a washing solution where the phosphate is recovered through reverse ion exchange. The recovery solution contains reusable phosphate in a concentrated form.

The reusability of the particles in municipal wastewater (spiked with H3PO4) was demonstrated for up to 15 adsorption/desorption cycles on a lab-scale and the desorption solution was enriched in phosphate. An insignificant drop in performance was observed with high adsorption (75-97%) and desorption (95% relative to the total amount of P adsorbed) efficiencies achieved in every cycle. In absolute terms, 111 mg PO4-P were recovered corresponding to 83.5% of the total 133 mg PO4-P which were initially dosed into the system.

This idea has a potential to be applied for other valuable target substances which can be recovered in a similar fashion. For that purpose the functionalization of the particles has to be adapted accordingly. The final goal is to develop a method which will become a basis for the recovery of valuable substances with a relatively broad spectrum of application.

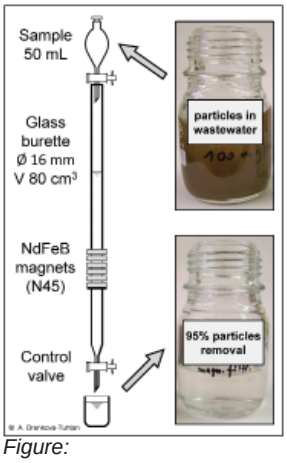

Figure:
Flow-through magnetic separator for separation of the functionalized particles on a lab-scale.

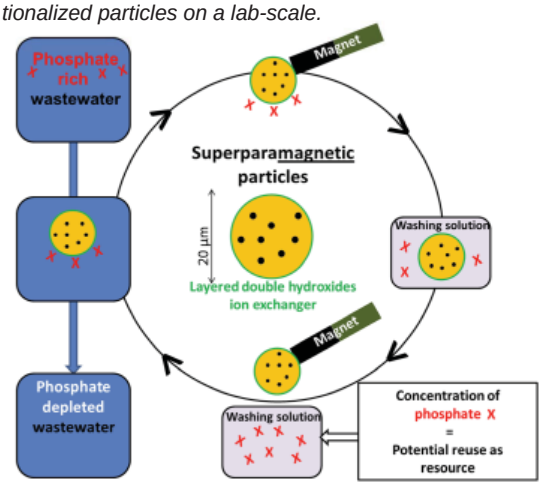

Figure: Schematic diagram of the phosphorus recovery method developed in the project BioSuPaWert (K.Mandel, Poster zum Forschungstag der BW-Stiftung 2013)

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