University of Stuttgart
Germany
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Recovery of phosphate from wastewater and process water with reusable magnetically separable ion-exchange particles in a large-scale test (SuPaPhos)

Phosphorus is an essential element for every living organism and a non-substitutable raw material for the production of fertilizers. At the same time, the natural mineral reserves are depleting steadily and their quality deteriorates progressively. Products with higher content of impurities, such as toxic heavy metals or radioactive pollutants, are becoming more common on the fertilizer market. In addition, the natural rock deposits are concentrated only in a few countries worldwide and this fact can be identified as a globally relevant bottleneck for the fertilizer and food industry. Europe alone imports more than 90% of its mineral phosphorus demand. As a consequence, rock phosphate was declared a critical raw material by the European Commission in 2014.

Germany, in particular, has a strong political motivation to reduce its import dependency and stimulate the development of technologies which are able to recover phosphate from variable sources. Therefore, the awareness to recover phosphate from secondary sources, such as wastewater, has arisen significantly in the last years. There is a lot of ongoing research providing a variety of technologies for P-recovery, especially from sewage sludge and its ashes. In contribution to the diversity of existing technologies, this research project proposes an alternative idea to use magnetic ion-exchange particles for the simultaneous removal and recovery of phosphorus directly from wastewater effluents, assuming that no earlier phosphate elimination takes place. The developed composite microparticles (20-25 µm) consist of superparamagnetic nanosized magnetite particles which are enclosed in a SiO_2 matrix, providing the magnetic properties of the adsorbers. The surface area of the magnetic carriers is modified with a phosphate selective ion-exchanger material. The magnetic sorbents are dispersed in wastewater, where selective phosphate removal takes place, and the P-loaded particles are then extracted from the water via magnetic separation. In a suitable washing solution the valuable phosphate can be desorbed from the particles, concentrated through multiple applications of the solution and finally recovered in the form of a solid fertilizer product. The regenerated particles can be reused repeatedly in multiple cycles. A major advantage of the method is that it can provide the dual benefit of phosphate elimination (down to µg/L trace concentrations) and its subsequent recovery, thus being an attractive option for substitution of the conventional P-elimination through chemical precipitation or EBPR processes. The goal of the project “SuPaPhos” is the upscaling of the already developed technology in a semi-technical scale. For this purpose, a larger-scale test should be performed by treating a total of 6.3 m^3 wastewater within 15 cycles of particles reuse.

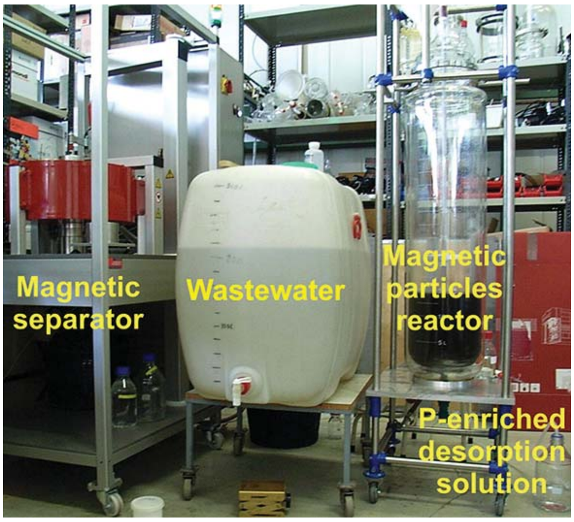

Figure: Experimental setup for phosphate recovery from wastewater effluent with reusable magnetically separable ion-exchange particles

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Baden-Württemberg Stiftung gGmbH
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Duration:
04/2014 – 07/2017