Upscaled application of Sachtofer PR as phosphate-binding filter

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Introduction

The phosphorus (P)-binding potential of Sachtofer was tested in laboratory flow-through tests and in a meso-scale set-up. In addition, the material was applied as a field barrier treating agricultural runoff from 17 ha of cropland.

Results

Sachtofer has a high content of gypsum (70%) and total concentration of Fe of about 10%. The laboratory tests included fresh and pre-leached (reduced amounts of Ca^{2+}, SO_4^{2-} and OH^-) materials. Depending on pre-leaching grade the materials exhibited P retentions between 6.8 and 20 mg/g (Figure 1). The material retains P through precipitation as Ca-phosphates (fresh state) and via sorption to Fe-hydroxide surfaces (pre-leached material).

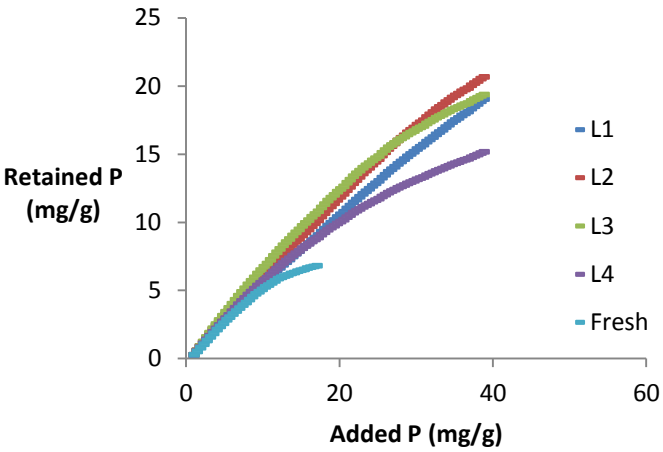

Figure 1. Phosphorus retention by fresh and pre-leached (L1-L4) Sachtofer in laboratory columns

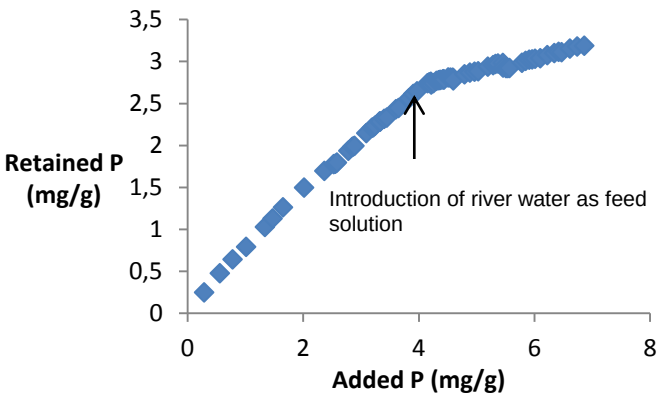

Figure 2. Phosphorus retention by Sachtofer on a meso-scale

The meso-scale test lasted for about 10 months and 47 m^3 of both tap and river water, with variable concentrations of P (0.1 – 6 mg/l) passed through the column (Ø=30 cm, H=40 cm). The P retention quotient of the filter, initially 0.68, decreased to 0.19 mg retained P/mg added P after the introduction of the organic-rich feed solution (5-16 mg DOC/l). The cumulative P retention by the filter was 3.2 mg/g, considering the initial mass of material (Figure 2). In addition, the system attenuated about 10% of the dissolved organic carbon.

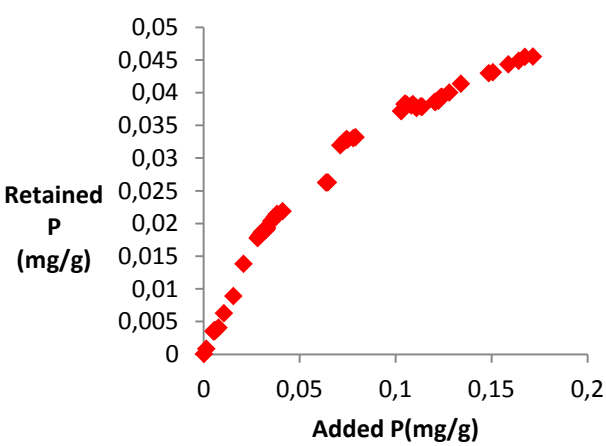

Figure 3. Phosphorus retention by Sachtofer during a 2.5-year field test

The field barrier, with a volume of 6 m^3, was monitored from August 2010 until January 2013. During this period, the concentration of P in the influent varied between 50 and 300 µg/l. The structure retained 0.44 kg of P (Figure 3), which is about 25% of the introduced mass. In the first year the P removal was 53% whereas in the last year it decreased to 15%.

Conclusions

Sachtofer can treat waters with variable concentrations of P. However, in the field set-up, onset of preferential flows gradually decreased the residence time and minimized the active bed volume of the filter. Retention of P may also decrease due to presence of humic substances and growth of algae and bacteria on the material's surface. Additional challenges involved collapse of the granule mass as a result of freezing during winter.