Polonite® & Sorbulite®

Calcium silicate/hydrate materials for P removal and recovery

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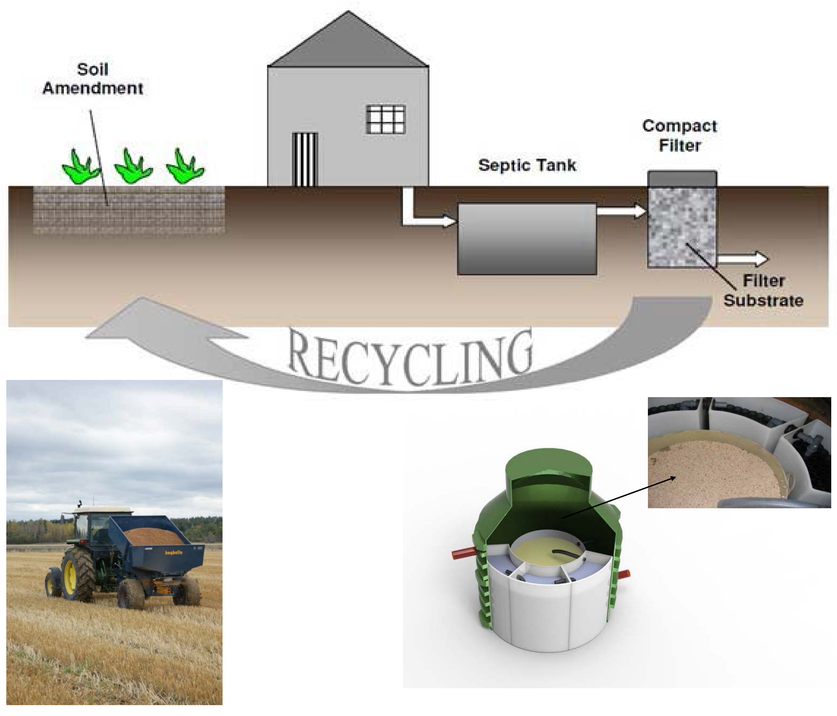
Success story of implementation and user uptake

The development of Polonite, Sorbulite and reactive bed filter (RBF) technologies has proven to be successful for phosphorus (P) removal and recovery from various low to high P enriched water streams. The KTH research is implemented through the spin-off company Bioptech. About 4000 small-scale wastewater treatment facilities in Sweden are currently operated with this technology for removal and recovery of P. On-going R & D will implement this P-recovery technology into solutions for medium-scale wastewater treatment, agricultural runoff losses and wastewater flow from animal production. The capacity as thin-layer capping materials for removal and recovery of P from anoxic Baltic Sea bottom sediments is scientifically established.

Highlights

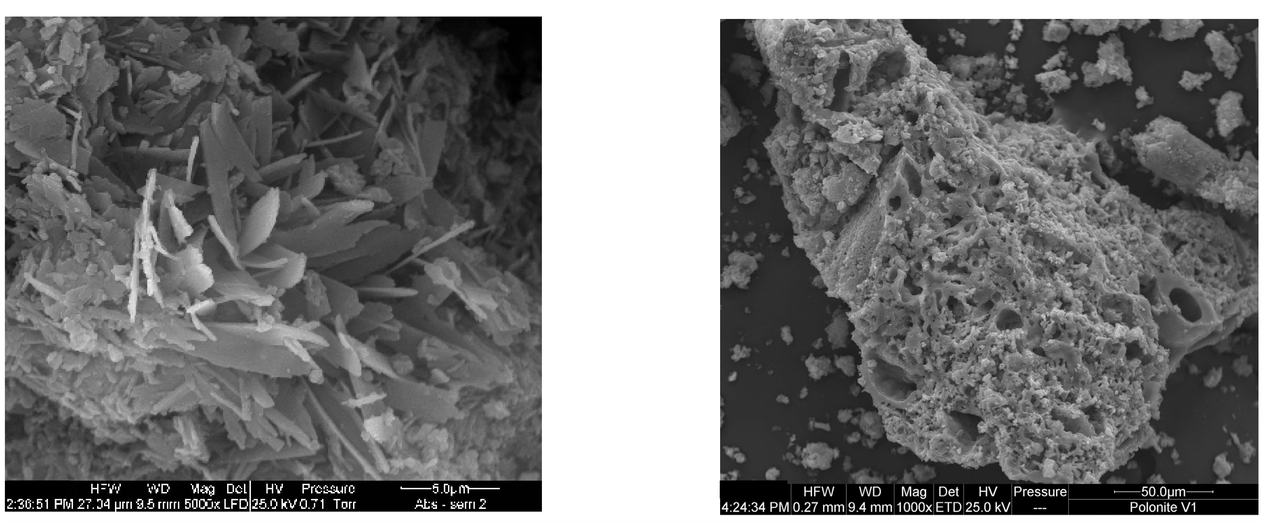
- Polonite® was registered as a trademark in 2000
- Fixed-bed reactor tests performed with real wastewater using reactive filter media such as Polonite and metallurgic slag, in laboratory experiments and in full-scale operation, 2000 – 2006
- Bioptech AB was founded 2006
- Tests performed of the forerunner to Sorbulite® 2005 to 2011, which was registered as a trademark in 2012
- Field and greenhouse tests of Polonite spent as filter media in wastewater treatment (2005-2010). Polonite proven effective as soil conditioner and slow-release P fertilizer
- Three PhD dissertations were produced at KTH within the field of reactive filter materials 1998-2009 (L. Johansson Westholm; A. Renman; V. Cucarella) and numerous MSc Thesis reports



About 600 ton P is lost (i.e. not recycled) per year in onsite wastewater treatment systems in Sweden. The RBF-technology with 500 kg of Polonite as filter material is able to save 90% of P released in one household during two years. Spent material is recycled to agriculture. The grains of Polonite is slowly broken down in the soil and improve soil status with respect to pH, phosphorus, silicon and several micronutrients.

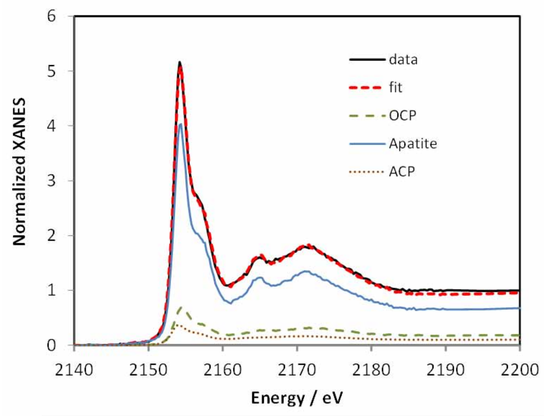
R & D background and future prospects

Polonite® ($CaO{\cdot}SiO_2$, $CaSiO_3$) was developed from a natural calcium silicate bedrock and is mined and manufactured in a sustainable way. The unique properties of this material include high porosity and specific surface area. The predominant mineral phase of Sorbulite is tobermorite ($Ca_5Si_6O_{16}(OH)_2{\cdot}4H_2O$). Sorbulite is produced in a similar manner as autoclaved aerated concrete. Both filter materials are granulated to a particle size suitable for the particular application.



ESEM images of Sorbulite (left) with flakes of calcium phosphate precipitated on the particle. The microporous structure of the Polonite raw material (right) is formed by diatomes and other fossil marine organisms.

Evidence for calcium phosphate precipitation was revealed by the use of XANES (X-ray absorption near edge structure). For Polonite the following components were found: Octa Calcium Phosphate (OCP, 61%), Hydroxyapatite (HA, 30%) and aluminum oxide (Alox-P, 9%. Sorbulite used in contact with wastewater consisted of Amorphous Calcium Phosphate (ACP, 63%) and OCP (37%).



Linear combinations and normalized sample data from Sorbulite used in agriculture ditch P trap. Stable apatite (HA) is mainly formed.

Calcium silicate (hydrate) has a release capability of Ca^{2+} and OH^- and can react with the phosphate ions to form calcium phosphates. The precipitated P is bound in fixed-bed filters. Decreasing pH during filtration creates conditions for different P removal mechanisms. Pre-treatment of the wastewater, i.e. organic matter removal is crucial for successful P recovery. Future work is focused on the next generation of Ca-Si based filter media, having a recovery capacity of up to 100 mg P/g when used in commercialized wastewater treatment systems.

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