

SUMMARY

During the past 20 years, considerable interest has been expressed in the potential use of a variety of natural biological systems to help purify water in a controlled manner. These natural biological treatment systems include various forms of ponds, land treatment and wetlands systems. As a result of both extensive research efforts and practical application of these technologies, considerable insight has been gained into their design, performance, operation and maintenance. Constructed wetlands treatment systems are engineered systems that have been designed and constructed to utilize the natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist in treating wastewater.

Constructed wetland systems using filter medias with high P removal capacity are showing promising results with regard to pollutant removal from domestic wastewater. Light Weight Aggregates (LWA) and shellsand are the most studied and used materials in CW systems in Norway.

The overall objective of this thesis was to investigate these two possible filter materials for CW systems treating domestic wastewater for their P sorption capacity and factors influencing P removal. The two materials used in this thesis were shellsand from Hordaland tørkei, Norway and Filtralite P® the last generation of LWA's in Norway specially developed for P sorption. The study involved short- and long-term laboratory tests (batch, small-scale long-term box experiments, meso-scale long-term column and trench studies), field- and literature studies. Synthetic P solution was used in most of the laboratory experiments as well as secondary wastewater in one column in the column test. Filtralite P® was investigated in batch-, box-, trench-, column- and field tests while shellsand was used in batch- and column experiments.

The batch experiments showed high removal rates with a maximum P sorption capacity of 3.3 and 9.6 g P/ kg material for Filtralite P® and shellsand respectively. However in the long-term laboratory and field scale tests these maximum sorption capacities measure in batch studies were not reached until the effluent concentrations reached the Norwegian P effluent limit (1 ppm). Or when these maximum sorption capacities were reached the material was fully saturated with P (inlet = outlet). This concludes that batch experiments could only be used to compare filter materials regarding their maximum P sorption capacity and not for projecting expected lifetime of CW systems. Today batch experiments being conducted in various ways all over the world, with an internationally accepted standard method all materials could be equally compared and ranked by their P sorption capacity.

In the long-term laboratory tests the Filtralite P® showed that its P sorption capacity did not depend on the hydraulic loading rate (only increased the speed of saturation) while it was dependent on the initial P concentration as higher inlet P concentration sorbed more P. The introduction of wetting and drying periods increased the P sorption capacity of Filtralite P® with 22-53% depending on the hydraulic loading rate. There was no significant difference in P sorption capacity of the different grain sizes of Filtralite P®. Sequential extraction of Filtralite P® showed that loosely bound, Ca-P and Al-P were the primary P sorption pools both in small and large scale systems; however the proportion of these fractions varied with time and change in pH. Column studies showed that there was no difference in performance of Filtralite P® material running with P solution versus secondary wastewater.

Shellsand showed a high and long lasting P removal capacity in column studies as well. However there was a significant difference in TP content between extraction method and mass balance calculation.

Our final conclusion was that long-term laboratory studies could provide better information about the processes taking place in an onsite system and about better design and better utilization of the filter media. For better utilization of the material for P removal, inlet-outlet positioning and size reduction was suggested.