# Pilot scale evaluation of the suitability of peat as sorbent filter material for metal removal from mining drainage water

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**Abstract** Peat is an inexpensive and biodegradable sorbent material with good capacity to sorb cationic ions such as metals and metalloids. The aim of this study was to evaluate metal removal efficiency of natural and chemically treated (HCl) peat when applied as sorbent media in small scale pilot filter systems. Based on the results obtained, purification efficiency e.g., removal of nickel and arsenic, was good but decreased with time. Leaching of aluminium and iron occurred in both pilots, but residual concentrations of leaching elements were mainly lower than the Finnish drinking water quality recommendations.

**Key words** peat, pilot, metal removal, sorption, filter

## Introduction

Peat is an inexpensive, biodegradable and widely available biomaterial that is mostly composed of lingocellulosic constituents which are associated with good capacity to sorb cationic ions such as metals and metalloids (Brown et al. 2000). Peat can also be modified (e.g., chemically treated) to increase its sorption capacity (Bulgariu et al. 2011). A number of studies have reported substantial potential of natural or modified peat for mining water purification (Brown et al. 2000, Bulgariu et al. 2011). However, there is a lack of pilot and real scale demonstrations which can attest to the suitability of peat as sorbent material for mining water purification in real purification systems.

The research work conducted under the Min-North project (Development, Evaluation and Optimization of Measures to Reduce the Impact on the Environment from Mining Activities in Northern Regions–Interreg Nord, EU) aimed to bridge the gap on the available knowledge by assessing in pilot scale the suitability of natural and modified peat as sorbent media for horizontal flow filter systems. The objective was to evaluate the purification efficiency (removal of selected metals) achieved by natural and chemically treated peat and the feasibility of using it as sorbent media in filter systems.

## Material and methods

Natural peat, normally used in energy production, was used and based on literature review as well as previous studies an acid treatment (HCl) was selected as the modification method. The peat modification process applied is fully described in Gogoi (2016). Natural and modified peat (particle size 90-250 μm) were placed into two identical compartmentalized horizontal flow filter systems (fig. 1). Characterization of natural and modified peat mate-

rials used can be found in Gogoi et al. (2017). Drainage water (900L) was collected from a mining site in Northern Finland. The filters were composed of 3 sequential compartments with the first and last compartments filled with inert quartz sand (particle size 3-5 mm and 0.7-1.2 mm respectively). The middle compartment (10x7.7x7.2cm) was filled with peat. Mining drainage water was introduced with a discharge rate between 7.5 and 8.5 mL/min.

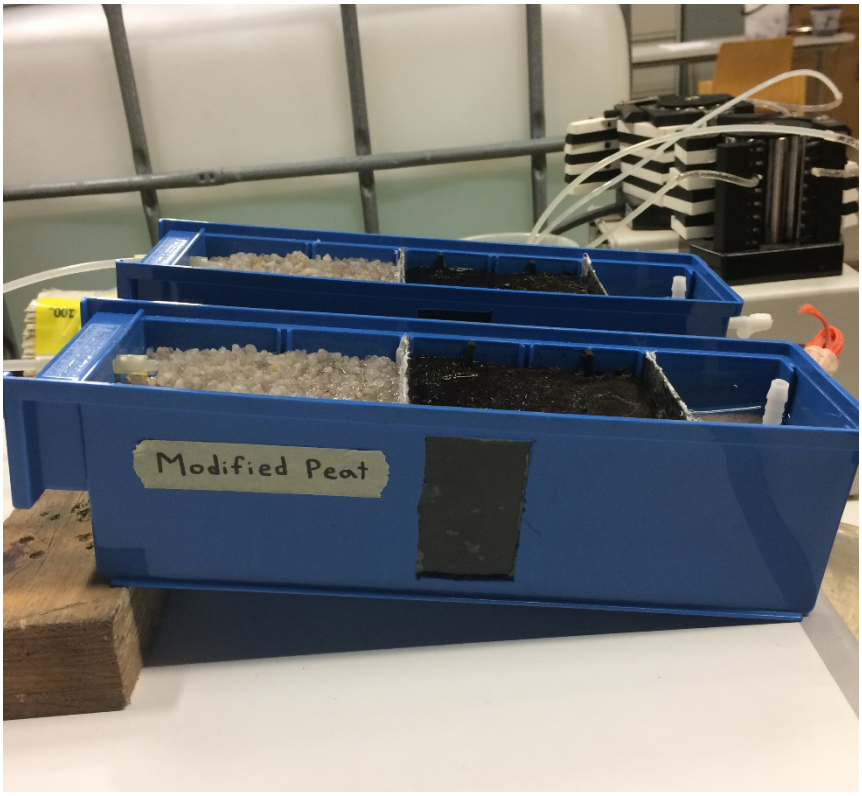


***Figure 1*** *Pilot filter systems.*

Evaluation of purification efficiency was conducted based on in- and out-flow water sampling (24 hr, 48 hr and twice a week for the duration of the trial) and analysis of the following elements: nickel (Ni), arsenic (As), antimony (Sb), iron (Fe), aluminium (Al) and manganese (Mn). Furthermore, samples were collected weekly and analysed for suspended solids and dissolved organic carbon. Hydraulic conditions within the pilots was evaluated via tracer (NaCl) tests experiments and via determination of effective bed volume. The pilots were operational for about 4 weeks.

## Preliminary results

During the 4 weeks long testing period a total of 296 L of mining water was treated in pilot 1, in which natural peat was tested, and 264 L was treated in pilot 2 where modified peat was tested. According to tracer experiments and calculations based on effective volume the

retention time within the peat compartment was at the end of testing period about 1.5 hours and about half of that at the beginning of tests. Thus, clogging of the system occurred.

Generally, removal efficiency of e.g., Ni and As was good but decreased with time. Leaching of Al and Fe occurred in both pilots (tab. 1). It is important to note that residual concentrations of leaching elements were lower than the Finnish drinking water quality recommendations (e.g., < 200 µg Al/L and < 200 µg Fe/L) (D 1352/2015) except leaching of Al from modified peat pilot observed during week 1 which was above drinking water limits. Significant differences in metal retention and leaching were observed between the two pilots, highlighting the effect of chemical treatment on the sorbent characteristics. However, the overall performance of natural peat was similar and in some occasions better than that of the modified product leading to the conclusion that the acid treatment applied here is not cost effective. Both peat material used presented low hydraulic conductivity, this along with the required retention times for effective purification restrict the use of tested system in real application where large water volumes are treated. Sieving of peat is an energy intensive process, the small particle size used (due to requirements of chemical treatment) actually led to decreased hydraulic conductivity when compared with natural un-sieved peat according to preliminary tests conducted using column experiments prior to the design and set-up of the filter systems. Although full evaluation of the system has not been completed, it is possible to suggest that for peat to be used as sorption material in a filter system, a different system design (e.g., pressurized flow) and product treatment have to be applied (e.g., pelletization, etc.).

***Table 1*** *Mining drainage water quality and removal efficiency of selected elements at the beginning and at the end of the pilot tests.*

| **Pilot 1 – Natural Peat** | | | | |
|---|---|---|---|---|
| **Sample** | **Ni** | **As** | **Fe** | **Al** |
| Mining drainage water quality | 101 (µg/L) | 31.9 (µg/L) | 13.8 (µg/L) | 7.2 (µg/L) |
| Removal week 1 | 96 % | 87 % | -99 % | -1256 % |
| Removal week 4 | 72 % | 25 % | -105 % | -18 % |
| Pilot 2 – Modified Peat | | | | |
| Sample | Ni | As | Fe | Al |
| Mining drainage water quality | 101 (µg/L) | 31.9 (µg/L) | 13.8 (µg/L) | 7.2 (µg/L) |
| Removal week 1 | 98 % | 31 % | -215 % | -3025 % |
| Removal week 4 | 87 % | 0 % | -8 % | 40 % |

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