Converting fiber sediment to hydrochar - new technology to eliminate landfilling and extract energy when remediating fiberbanks

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Introduction: Wood fiber-contaminated sediments, originating from discharges from pulp and paper industries from the early 20th centuary, have been found in many places in Sweden and Finland and many of them are priority objects for remediation due to their contamination status of chlorinated organic pollutants and metals [1]. At many places this fibrous waste has formed meter thick deposits (so-called *fiberbanks*) in the Baltic Sea, lakes and rivers [1]. Only 10% (40 sites) of potential sites in Sweden have yet been investigated, finding fiberbank sediments corresponding to a total volume of approx. 7 million cubic meters [1]. To prevent the spread of environmental toxic substances [2] and greenhouse gases [3] from the fiberbanks, innovative remediation methods are needed to handle potentially large volumes of contaminated fibrous sediment and at the same time eliminate landfilling.

The aim with this pilot study was to investigate the potential of producing hydrochar from fiberbank sediment, which can safely be incinerated in waste classified boilers, reused or disposed of, depending on the pollution content. Sediment from three different fiberbanks that represent different types of fiber material and pollution profiles were tested to evaluate whether the proposed technology (wet oxidation combined with hydrothermal carbonization, Oxy-power HTC™) is a way forward for treating different types of dredged fiberbank sediment.

Methods: Laboratory tests that simulates all unit operations of the Oxy-Power HTC™ treatment in a full-size facility (i.e. treatment under pressure at about 200 °C for one hour, wet oxidation of the separated water with oxygen for two hours and dewatering form a slurry of solid hydrochar) was performed with each of the three fiber sediments. In each test sediment corresponding to approximately 35 g of dry substrate was treated.

The concentration of chlorinated organic pollutants such as dioxins (PCDDs), furans (PCDFs), polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDTs) and heavy metals were measured in the sediment prior to treatment and afterwards in the obtained hydrochar and wet oxidized process water.

Results: All three fiberbank sediments were successfully converted into hydrochar using this method. The concentration (ng/g dry weight) of ΣPCBs in sediment and hydochar was found to be similar or slightly higher in the hydrochar. For ΣPCDD/Fs an increase in higher chlorinated congeners was observed in the hydrochar compared to the sediment. Whereas for ΣDDTs lower levels were found in the hydrochar compared to the corresponding sediment. Neither PCDD/Fs, PCBs and DDTs were found in measurable levels in the wet oxidized process water. For metals, similar or slightly higher levels were found in the hydrochar compared to sediment. Whereas, for methyl-Hg lower levels were found in the hydrochar. Metals (including methyl-Hg) were also found in the wet oxidized process water.

Discussion: This study shows that the hydrophobic organic contaminants are efficiently retained in the hydrochar and that the reduced contaminant levels of ΣDDTs are likely due to degradation occurring in the HTC treatment. However, this study also shows that the process water needs further clean-up to avoid release of metals when discharged. Overall the results are promising, showing the potential of using the Oxy-power HTC™ process to convert wet contaminated fiberbank sediment to hydrochar without the need for pre-dewatering and eliminating the need for landfilling as the hydrochar can be easily incinerated in a waste classified incinerator.

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References:[1] Norrlin and Josefsson (2017) *SGU-report* 2017:07; [2] Dahlberg et al (2021) *J Soils Sediments*, **21**, 1852–1865; [3] Lehoux et al. (2021) *Sci Total Environ*, **781.146772**:1-8