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The effect of filter media on start-up of drinking water biofilters

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The effect of filter media on start-up of drinking water biofilters

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INTRODUCTION

Drinking water may be produced from an aerobic groundwater with the help of granular filters that remove iron, ammonium and manganese. In Denmark, this process has been used almost exclusively for more than 100 years. The filters often consist of washed, dried and sieved quartz sand, although various materials with different properties have been introduced. Examples of filter media in use include anthracite, calcium carbonate, manganese oxide, iron oxide, burnt flint, expanded clay and activated carbon. The start-up period of drinking water biofilters consists of a complex, interconnected set of processes in which new filter media matures into a fully functional biofilter coated with inorganic precipitates and biofilm. Different properties of the filter media (permeability, porosity, grain size, particle shape, surface area, catalytic capabilities and sorption capacity) determine the performance of the filters [1]. Improved knowledge and practical experience of these properties are required to better understand the chemical and bacteriological water treatment process during start-up of new biofilters [2]. This study examined the influence of different filter media on batch approach start-up of laboratory scale biofilters with specific focus on manganese removal and compared this effect with measured properties of the filter media.

METHODS

Laboratory scale setup of biofilters

- Start-up of biofilters was tested in laboratory scale at 10°C using a batch approach in which treated water amended with 0.4 mg L\(^{-1}\) of Mn was introduced to the filters each 48 hours.
- The effect of five different filter media on the start-up process for manganese removal was followed through 43 days by determination of the concentration of manganese in filtered water samples.
- Filter media properties were determined using gravimetric methods and dynamic image analyses (Camsizer®64, Retech Technology GmbH).
- ATP analysis (LuminUltra Technologies Ltd.) was used to determine presence of biofilm on the filter media.

RESULTS and DISCUSSION

There were significant variations between the different filter media properties

- Manganese was removed below drinking water criteria of 0.05 mg L\(^{-1}\) in all filters

Presence of biofilm in the filter containing quartz was confirmed by ATP analysis

<table>
<thead>
<tr>
<th>Filter medium</th>
<th>ATP (pg g(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz, day 0</td>
<td>103</td>
</tr>
<tr>
<td>Quartz, day 43</td>
<td>4846</td>
</tr>
</tbody>
</table>

- ATP results showed 47 times more ATP in quartz sand of the laboratory scale filter at day 43 compared to the quartz sand at day 0.

CONCLUSIONS

- Successful start-up of biofilters regarding manganese removal was shown for all filter media in laboratory scale using a batch approach.
- Manganese oxide and anthracite chemically removed manganese while quartz sand and calcium carbonate required development of biofilm containing manganese oxidizing bacteria.
- The sorption properties of the filter media was the most significant for the start-up process.
- Less than 1 month was required for start-up indicating potential for full-scale use of the batch approach.
- Further analyses are required to conclude which filter medium is the best for development of biofilm, and to what extent a particular medium can enhance growth of specific groups of bacteria.


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