Start-up of a drinking water biofilter

Physical, chemical and bacteriological changes

Ramsay, Loren; Søborg, Ditte; Breda, Inês Lousinha Ribeiro

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Start-up of a drinking water biofilter
physical, chemical and bacteriological changes

Ramsay, L.ª Seborg, D.A.ª Breda, I.L.ª,b,c

Via University College, Research Group for Energy and Environment, Campus Horsens, Denmark
Skanderborg Forsyningsvirksomhed A/S, Denmark
Aalborg University, Department of Chemistry and Bioscience, Denmark

INTRODUCTION
When producing drinking water from groundwater, some waterworks use biofilters as the heart of the treatment process. In biofilters, microorganisms are allowed to populate granular filter media and to carry out the work of purifying the water (de Vol, 2009). This process is gaining attention because of a number of attractive features including 1) low price, 2) no addition of chemicals and 3) increase in the microbiological stability of the finished water.

One drawback of biofilters is the long start-up period when new filter medium is commissioned. During the start-up period, an inorganic coating and a biofilm are established on the filter medium, after which the treated water complies with drinking water criteria. This period typically lasts two or more months (Cai, 2015; Stenberg, 2004; Zeng, 2010). Disadvantages of a long start-up period include: 1) the need for drinking water standards, 2) the use of energy and the waste of a precious resource, and 3) the need for an alternative drinking water source for the consumers for the duration of the start-up period. If the start-up process is to be optimized, a thorough knowledge of the development of fully-functional biofilters is essential.

This poster elucidates the start-up process through a holistic monitoring approach at a newly-constructed full-scale waterworks in Denmark. This poster documents a natural start-up, using only inherent inoculation from microorganisms that are present in the raw water and the water used for backwash (no pro-active inoculation with old filter media or backwash water sludge was utilized).

METHODS

Filtration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Raw Water Average Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>0.38 mg/L ± 0.22</td>
</tr>
<tr>
<td>Iron</td>
<td>1.40 mg/L ± 0.19</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.45 mg/L ± 0.07</td>
</tr>
<tr>
<td>Ammonium</td>
<td>0.37 mg/L ± 0.04</td>
</tr>
<tr>
<td>Magnesium</td>
<td>7.6 mg/L ± 0.3</td>
</tr>
<tr>
<td>pH</td>
<td>7.3 ± 0.06</td>
</tr>
<tr>
<td>Conductivity</td>
<td>58 mS/m ± 0.8</td>
</tr>
<tr>
<td>Temperature</td>
<td>8 °C ± 0.1</td>
</tr>
</tbody>
</table>

One of the production lines at Truelsbjerg waterworks, Denmark (Seborg et al., 2010).

Sampling

- **Water samples** (unfiltered) were collected from stainless steel taps at 16 locations: 13 different depths on Filter 1 as well as raw water, water between filters and finished water.
- **Filter media samples** were collected from four different depths in Filter 1 using a hollow stainless steel probe.
- **Backwash water samples** were collected at one minute intervals during selected backwash events.

Analyses

- **Physical**
  - Continuous measurements
    - Temperature
    - Pressure
    - Turbidity
  - Grab samples
    - Grain size, surface area and particle shape using Camsizer®64, Retch Technology GmbH
- **Chemical**
  - Continuous measurements
    - Dissolved oxygen
    - In-line pH
    - Conductivity
    - Al-water ammonium
- **Microbial**
  - Continuous measurements
    - Bacterial counts (Sartorius BACMON)

RESULTS AND DISCUSSION

Physical

- **Retention time distribution**
  - Trajectories showed a median retention time in Filter 1 of 29 min.
  - This includes 0 min. contact with the filter media (green line).

- **Flow and pressure drop**
  - A filter run started on Day 15-16 showed that values returned to initial values following a backwash event. Note that the goal of backwashing during start-up is to avoid pressure build-up, not to ensure clean finished water.

- **Colour changes in filter media**
  - Time, the colour of the filter media changed in the four depths that were sampled:
    - day 22
    - day 35
    - day 39
    - day 43
    - day 63

- **Nitrospira, manganese a for media**
  - showed complete start as biofilters, using the media from Leptotrix)

- **MCM, from drinking water**
  - as used by Zeng,

- **2004**
  - Returned inoculation, from drinking water,
  - As oxygen deprivation in treatment processes in a full-scale drinking water biofilter, Water Supply 15.4, 629-633.

- **Breda, I.L.ª, Seborg, D.A.ª, Ramsay, L.ª, Seborg, D.A.ª, 2016**

- **Stenberg, T., Marko, M., Broik, F., Sipos, L., 2004. Rapid start-up of biofilters for removal of iron and manganese from groundwater**

CONCLUSIONS

- **Using inherent inoculation**, full-scale start-up was complete after a period of approximately 10 weeks.

- **The change from virgin filter media to fully functioning mature filter media is a complex mix of physical, chemical and microbiological processes**. Holistic monitoring of these processes using water, filter media and backwash water samples provided a more clear understanding of the start-up period.

- **Total bacteria (Eubacteria) were most abundant in the top 40 cm of Filter 1. Selected bacterial groups (AOB, Nitrospira, Leptotrichia) represented only a small percentage of the total bacteria**.

- **Results from this work have important implications for optimizing the start-up process such as when and where to inoculate and what to inoculate with.**

References:

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