Start-up of a drinking water biofilter
Ramsay, Loren; Søborg, Ditte; Breda, Inês Lousinha Ribeiro

Creative Commons License
Unspecified

Publication date:
2016

Document Version
Publisher’s PDF, also known as Version of record

Link to publication from Aalborg University

Citation for published version (APA):
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 (Cal, 2015; Stembal, 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 required.

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

**Sampling**
- Water samples (untreated) were collected from stainless steel taps at 16 locations: 13 different depths in Filter 1 as well as raw water, water between filters and finished water.
- Filter media samples were collected from 4 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 CernamorTM, Particle Technology GmbH
- **Chemical**
  - Continuous measurements
    - Dissolved oxygen
    - pH
    - Conductivity
    - Alkalinity
- **Microbial**
  - Continuous measurements
    - Bacterial counts (GenoTec BACMON)
  - Grab samples
    - Total bacteria using PowerBiofilm, Media Laboratories Inc.
    - (qPCR (Eubacteria)
  - Hydrogeological plate counts
    - DNA isolation (PowerSoil, MoBio Laboratories Inc.)
    - (qPCR (Eubacteria and relevant bacterial groups)

**Chemical**
- Iron concentrations achieved compliance almost immediately, complete ammonium removal required about 6 weeks while complete manganese removal required about 10 weeks.

### RESULTS AND DISCUSSION

**Physical**
- **Retention time distribution**
  - Tracer tests showed a median retention time in Filter 1 of 29 min. This compares to 12 min. contact with the filter media (green line).

**Chemical**
- **Iron**
  - Iron concentrations achieved compliance almost immediately, complete ammonium removal required about 6 weeks while complete manganese removal required about 10 weeks.

**Biological**
- **The bacterial community**
  - Numbers of specific bacterial groups increased over time, while EUB remained nearly constant. The highest number of EUB was found in the top layer of the filter. At the end of the start-up period, EUBs outnumbered the sum of the other bacterial groups by about 10:1.

### 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, Leptotrix) 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.


Acknowledgements: The authors appreciate the assistance of Aastra Water, Sifheds-Euweke and Xargi in connection with this work.

**VIA University College**


Acknowledgements: The authors appreciate the assistance of Aastra Water, Sifheds-Euweke and Xargi in connection with this work.

**VIA University College**

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

( a) Via University College, Research Group for Energy and Environment, Campus Horsens, Denmark

(b) Skanderborg Forsyningsvirksomhed A/S, Denmark

(c) Aalborg University, Department of Chemistry and Bioscience, Denmark