Treatment of worm infested biological rapid sand filters

Christensen, Sarah Christine Boesgaard; Albrechtsen, Hans-Jørgen

Publication date:
2014

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

DTU Environment
Department of Environmental Engineering

Technical University of Denmark

Treatment of worm infested biological rapid sand filters

Sarah C.B. Christensen & Hans-Jørgen Albrechtsen
Contact: scch@env.dtu.dk

Background

Water treatment in biological rapid sand filter is an extremely resource and energy efficient technology. The microbiological processes remove e.g. ammonia, manganese and iron in the raw water. It is therefore a prerequisite that the proper functional bacteria are present and under the right conditions. Danish drinking water production is based on simple treatment of groundwater consisting of aeration and filtration and no disinfectants are used in regular operation of the treatment plants.

However biological sand filters have proven also to host higher organisms such as round worms (nematodes) and segmented worms (oligochaete worms).

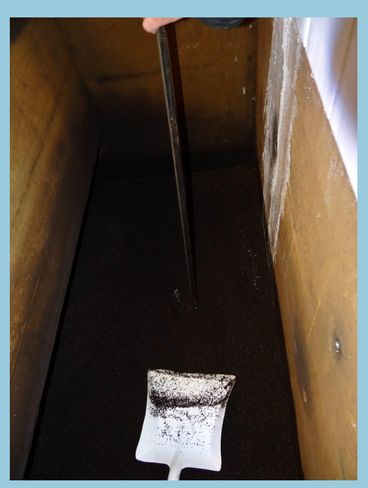
The largest worms found in Danish sand filters are 10 cm (approximately 4 inches) long. The large segmented worms are an aesthetical challenge to the water utilities whereas the microscopic roundworms have proven to host unwanted bacteria such coliform bacteria.

Worm from the top layer of a rapid sand filter

Ongoing studies

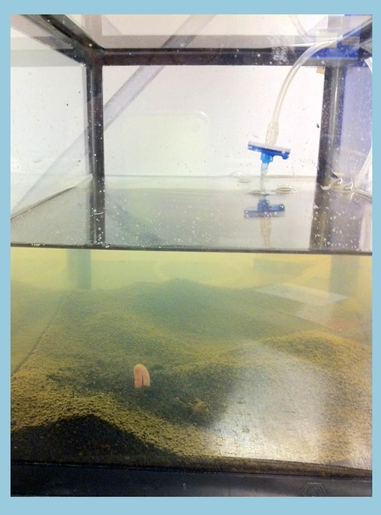
We expect oxidation with hydrogen peroxide to remove worms by impairing the function of the cuticula (skin) of the worms while being less damaging to the functional bacteria than chlorination.

Batch experiments and pilot scale filter column experiments are being set up in order to test the removal effiency while worms, protozoa and bacteria are quantified and filter functionality is monitored by measuring removal of ammonium and oxygen with an auto analyzer.



Sampling of segmented worms from the top layer of a drained biological rapid sand filter

Challenges



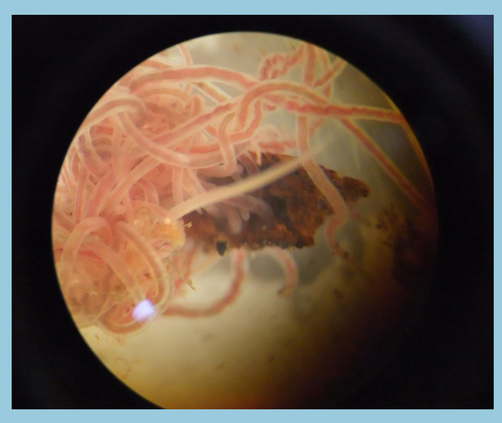
In order to ensure a reliable supply of worms for the experiments we are continuously working on establishing a breeding population in our laboratory.

The worms are kept in filter sand with aerated raw water at 10° C in order to mimic conditions at the water works.

Aquarium with a visible segment of a worm

Aims

- Develop a technology to remove the worms and their eggs from biological sand filters while minimizing the effects on the on the water treating abilities of the filter
- Investigate the impact of the worms on the biostability of the filters

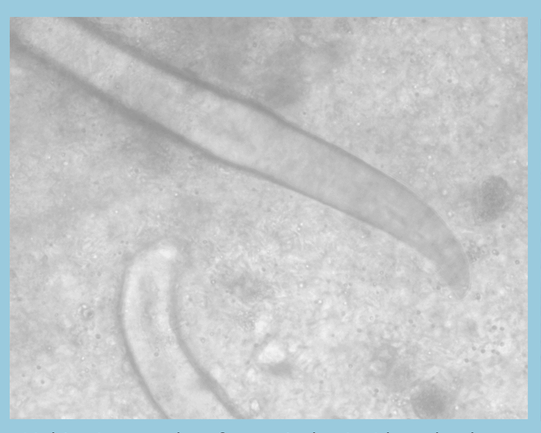


Intertwined worms sampled from top layer of a rapid sand filter

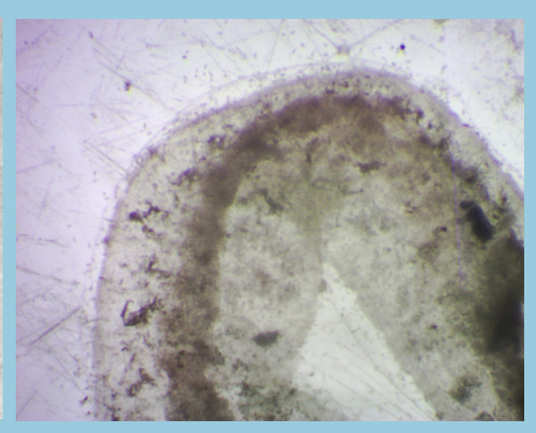
Results

Experiences have been gathered from participating water works. High chlorine concentrations (20 liters NaClO, 15% active chlorine, in 5 m^3 water) and retention times of 24 hours had been applied at the investigated treatment plant, followed by back washing, since moderate dosing had previously proven insufficient.

The high chlorine concentration treatment efficiently removed worms and eggs from the full scale filters. However the treatment killed the functional filter bacteria and for more than three months the filters were not meeting the required level of removal of ammonia and nitrite. Bacterial counts (HPC) at both 22 and 37° C were above guideline levels for more than four months after the treatment.



Light micrographs of nematodes inside a dead worm



Dead worm being colonised by nematodes and protozoa

Microscopy of dead segmented worms was performed repeatedly over time to identify the organisms colonizing the worms.

The results revealed that degradation of segmented worms supports growth of nematodes (round worms) and protozoa (single celled eukaryotes).

These organisms digest bacteria and their proliferation may lead to impaired functionality of the filters caused by removal of functional filter bacteria.