Emmanuelle Prest of PWNT: "Drinking water must remain of the same quality on its way to the consumers' taps"

A researcher at PWNT, Emmanuelle Prest shares her insight in the importance of maintain drinking water standardduring transportation from plant to consumers' taps.

Emmanuelle Prest, a researcher at PWNT

Emmanuelle Prest is a scientist at the water technology company, PWNT, in the Netherlands. Her research focuses on drinking water quality during the transport of water from treatment plant to consumers' tap and its biological stability. In other words, how to prevent the growth of micro-organisms and formation of sediments in the transport and distribution pipelines?

Disadvantages of chemical disinfection

"It is important for every drinking water producer that the drinking water quality remains the same on its way to the consumers' tap, especially from a microbiological point of view," explained Prest. "That is a global requirement and that is the idea behind biological stability. For instance, in the U.S. disinfectant chemicals, such as chlorine or monochloramine, are dosed into the distributed water. They keep the concentration high across the distribution system to prevent bacterial growth and activity. Most countries all over the world use chlorine in their distribution. That is their way to maintain microbiological safety in the water. However, the big disadvantage is that chlorine can react with molecules in the water and form reaction byproducts that affect human health.

Seasonal biological sediment formation in a full-scale drinking water distribution system

E. Prest, B. Martijn, P. Schaap

INTRODUCTION

Sediments in drinking water distribution systems can provide optimal environment for microbial growth and cause aesthetic deterioration of drinking water.

In a full-scale distribution system in the Netherlands, occasional problems are reported in summer:

- turbid / coloured water complaints
- *Aeromonas* counts above regulatory guidelines

Objective: provide insights in sediment formation mechanisms and in relations between sediments and microbial activity in biofilms and water in drinking water distribution systems.

Figure 1: Sediments from a consumers tap

METHODS

5-year monitoring of (i) sediment formation and composition, and (ii) microbial activity in drinking water in a specific distribution area.

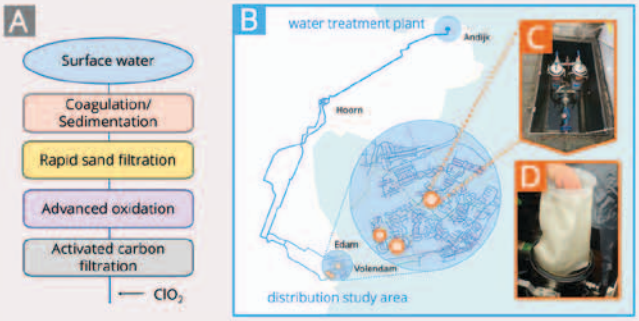

Figure 2: (A) overview of water treatment steps; (B) overview map of the supplied distribution system and detailed map of the studied distribution area; locations of filter installations (brown circles); (C) filter installation; (D) filter.

Semi-quantitative microscopic sediment analysis

Filters (25 µm) collected at 3 locations every one to two weeks and analyzed for:

- sediment volume
- sediment composition (detritus, *Asellus* feces, sand, rust, ...)
- invertebrates type and number

Quantitative water analysis

Routine measurements at variable and fixed household taps:

- ATP
- *Aeromonas* counts
- TOC
- Turbidity
- Water temperature

RESULTS

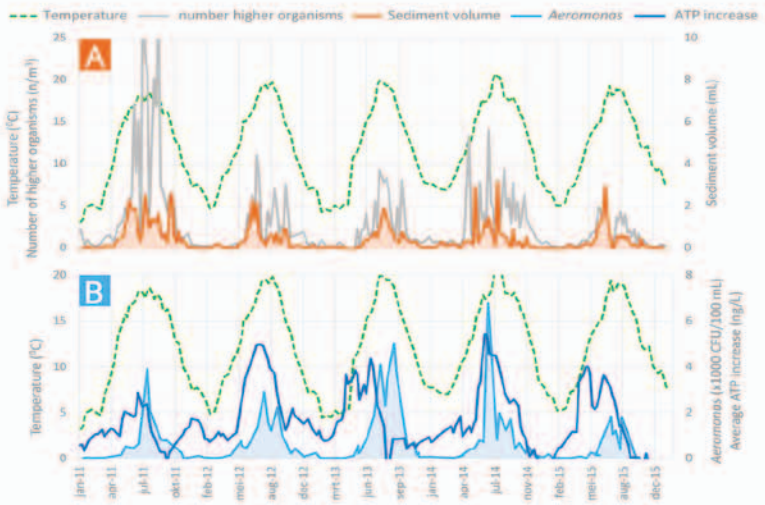

Figure 3: variations in time of water temperature and (A) sediment volume and invertebrate numbers retained in filters, and (B) Aeromonas *counts in water, and ATP increase between the water treatment work and studied distribution area.*

- No effect of water consumption on sediment volume
- Seasonal variations in sediment volume congruent with variations in
  - temperature
  - invertebrates number (Figure 3A)
  - *Aeromonas* counts in water phase (Figure 3B)
- Increased bacterial activity (ATP) in water in spring/summer (Figure 3A)
- Sediments composed at 85-90% of organic material (Figure 4):
  - fecal pellets excreted by invertebrates;
  - detritus (dead organic matter and microorganisms)

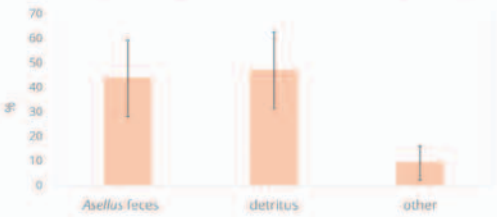

Figure 4: Qualitative estimation of sediment composition

CONCLUSIONS

- Seasonal sediment formation in the drinking water distribution system results from microbial activity at treatment and/or distribution stages (Figure 5).
- Detritus composing sediments in the distribution system are likely not released from the water treatment but rather formed during water distribution (preliminary results of follow-up research).

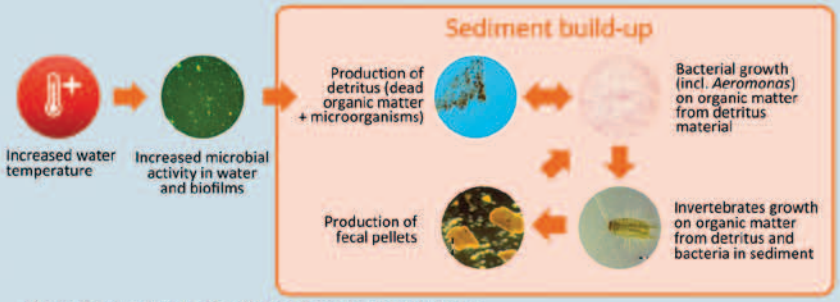

Figure 5: Hypothesis of sediment formation mechanism

The Dutch way of treatment

The Netherlands does not dose disinfectant chemicals into the water distribution. The counterpart is, if you do that, you need to treat your water so well to limit the microbial growth in the distribution system. The objective in the Netherlands is to remove as much compounds as possible from the water to minimise the availability of food for bacteria. The Netherlands are a specific case, as they treat, or 'over treat' the water so extensively, particularly for surface water treatment. This is needed because the surface water used in the Netherlands for drinking water production is extremely polluted. The main source is the IJssel Lake, which is the ending point of the river Rhine, hence, accumulating a lot of pollution (pharmaceuticals, pesticides, and more). By using extensive treatment steps like suspended ion exchange and ceramic membrane filtration, the country is able to obtain one of the best drinking water qualities in the world. Treatment trains usually contain pre-treatments such as coagulation, sedimentation, rapid sand filtration, followed by an oxidative treatment step such as ozonation or advanced oxidation (UV or peroxide) and a post treatment such as activated carbon filter or slow sand filtration. In many cases, dune infiltration is also an important part of the treatment. In comparison, other countries in Europe such as Switzerland or Germany have access to better quality surface water and do not need to treat water so extensively, even without adding disinfection residuals in the water. The growth of microorganisms in the water depend on several conditions, such as the type of source water, how this water is treated and how the environmental and climate circumstances are. If a country's average temperature is 10 degrees higher than the Netherlands, other kinds of bacteria can be found in the water. The famous saying here is 'everything is everywhere, but the environment selects'.

Sediment research by PWN/PWNT

"Together with Dutch water supply company and parent company PWN, I am doing research in the field of biological stability, because it is part of both water treatment (PWNT) and distribution where PWN is responsible for," said Prest. During distribution from the water treatment plant in Andijk to the house taps of consumers, the water goes through pipes of different sizes and materials. The water remains in these pipes for a certain amount of time and the water quality changes. This is because water is biological and not static, and any change in the conditions has an impact on the bacterial side.

"What you want as a water supply company is to be able to control this change in water condition. It is important how water is perceived by consumers, in terms of taste and colour. Our consumers must be pleased with the water they drink," said Prest.

The quality of the treated water is defined by being the same standard as when the water was supplied. Biological instability means there is activity in the water, hence, the change in quality. For instance, when there is not much movement in the pipes, small particles in the drinking water settle and form sediments.

Sediments have been a big issue for the past decade, especially in the areas of Volendam and Edam in north Holland where consumers complained about brown or turbid coloured tap water.

The water produced in the treatment plant of Andijk is transported through many pipes. It starts with big pipes that quickly transport the water, which flows at a high speed. At the end of the distribution system, the pipes are smaller. In fact, some distribution pipes in Volendam and Edam do not go any further and hits a dead end. And if there is a low consumption of water, there is no flow, which results in stagnant water that remains in the pipes for a long time. This causes biological instability, especially in summer time.

The high microbial activity in the water combined with the rising temperatures is trouble in the making. In the worst-case scenario, it results in the growth of pathogenic bacteria, but fortunately, that is rare and well-controlled. However, the growth of other bacteria can also cause the formation of sediments, a problem faced in Edam and Volendam. Based on intensive research, flushing the pipes regularly and placing filter screens before the distribution to the taps helped the issue considerably.

"We are still researching why we have that specific sediment growth in these areas as it does not happen in other areas of PWN. This could be because the areas use a different type of treatment," Prest analysed.

"We are researching the water from the Andijk treatment plant; from source to tap. I am also researching this biological instability on the treatment level and on the distribution level, and that has shown some progressive and promising results to fully control this problem in the future." WWA