

## Danish University Colleges

### Commissioning Of New Drinking Water Pipes - Role Of Biofilms In The Distribution Network

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# Commissioning of new drinking water pipes the role of biofilms in the distribution network



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## BACKGROUND

**Biofilm is considered beneficial** in the non-chlorinated Danish drinking water distribution systems, as it increases the microbiological stability of the water.

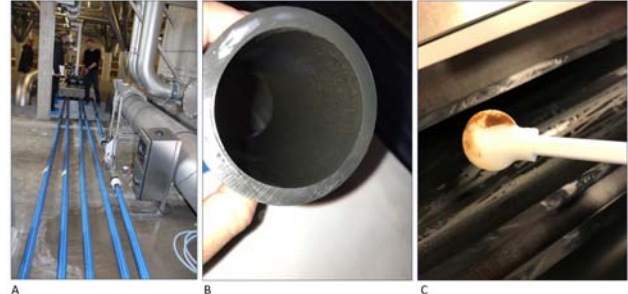
When introducing **new pipe sections** in the distribution network, the biofilm which develops on the new pipe wall is influenced by water quality, pipe material, the existing biofilm upstream the new pipe section, flow velocity, etc.

The **influence of biofilms** on the water quality in the long-term during the commissioning of new pipe sections remains **poorly understood**.

This project aims to analyze the long-term effect of the developed biofilm in newly installed drinking water PE pipes on the water quality to be able to optimize the commissioning procedure for installing new pipe sections in an **existing pipe network**.

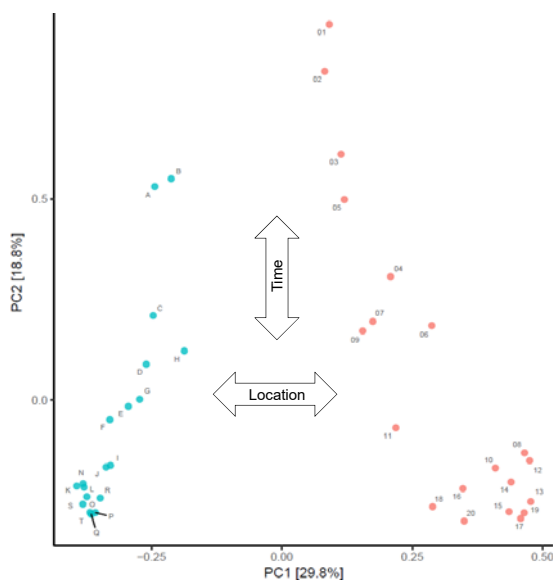
Two **different sampling locations (installed biofilm rigs)** were investigated for **biofilm development**. One biofilm rig was installed at the water works close to the ground water source (TBR) and the other biofilm rig in a water storage facility near the consumer (BUS).

## EXPERIMENTAL SETUP



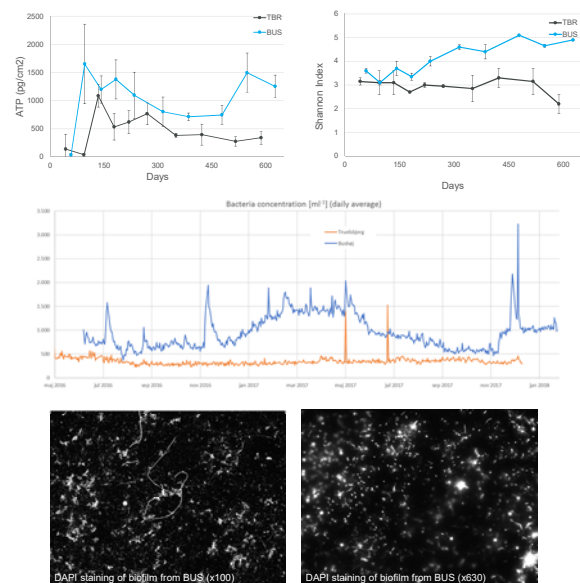
**Figure 1. Photos from the biofilm test rig and sampling of biofilm.** (A) The biofilm rig in a waterworks (TBR) with instrumentation (flowmeter, thermometer and GRUNDFOS BACMON). Length approx. 50 m. (B) PE pipe that was cut out for microbiological analysis. Biofilm colonies are visible inside the PE pipe. (C) The same PE pipe cut in half in the lab and swap for biofilm to be analyzed with molecular microbiological methods. A similar setup and procedure was followed for the biofilm rig placed in a water storage facility near the consumer (BUS).

## RESULTS



**Figure 2. Principal-component analysis** based on microbiological diversity analysis (16S rRNA) of biofilm swaps from biofilm test rigs TBR (1-20) and BUS (A-T). Each dot represents the full microbiological diversity in a sample at a given time from one of the two locations. Sample 1+2 (and A+B) are true replicates (and so on). Samples were taken approx. every 1.5 months during 1.5 years. After 1.5 years, samples from each location clustered separately along PC1, suggesting that the PC1 axis explains variations based on location (effect of upstream pipes, etc. on the biofilm). Distribution of samples along the PC2 axis is related to time of sampling (maturity of the biofilm).

## BIOFILM RESULTS



**Figure 3. Analysis of biofilm samples** with ATP, 16S rRNA Amplicon Sequencing (NGS) and GRUNDFOS BACMON. Two examples are shown of DAPI staining of biofilm from BUS showing several bacterial morphologies. Further biofilm was analyzed with qPCR and water samples leaving the biofilm rigs was analyzed with ATP (data not shown).

## SUMMARY OF RESULTS AND PERSPECTIVES

Biofilm development in new PE pipes placed at a waterworks (TBR) and in a water storage facility near the consumer (BUS) was followed over 18 months. These are the **preliminary and summarized results** from the study of the long-term effect of biofilm development:

- Development of the microbiological diversity of the biofilm over time was observed at two different locations. **BUS had higher diversity of microorganisms as compared to TBR.**
- At each location, the microbiological diversity of the biofilm reached a mature state within the **first 6 months** of development.
- From 6 to 18 months the developed biofilms at each location did not develop much further, however **the two locations had very different microbiological composition.**
- This difference in microbiological diversity between the two locations is most likely related to the difference in **influence from the water quality of the upstream water sources.**
- Besides having the highest diversity of microorganisms, **BUS also had the highest microbiological activity** measured with ATP as compared to TBR.

- GRUNDFOS BACMON measured the bacterial concentration over the 18 month test period.
- BUS had the highest cell concentration** over the entire test period as compared to TBR.
- At both test sites, we observed a **high biofilm establishment rate during the first two months** of flushing. The fouling rate was, quite different between the two sites with the lowest rate at TBR (approaching steady state) and a significant rate continuously observed at BUS (data not shown).

### PERSPECTIVES

- The flow cell fouling indicator from GRUNDFOS BACMON may be used as a measure for the **amount of biofilm and the rate of biofilm formation on the inner surfaces** of newly installed drinking water PE pipes.
- The new **commissioning strategy** of installing new pipe sections should **focus on rapid establishment of an intact and well-functioning biofilm** for increased microbiological stability of the water.

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