Microbial water quality in clean water tanks following inspection and cleaning

Christensen, Sarah Christine Boesgaard; Esbjørn, Anne; Mollerup, Finn; Albrechtsen, Hans-Jørgen

Publication date: 2014

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

Link back to DTU Orbit

Microbial water quality in clean water tanks following inspection and cleaning

Sarah C.B. Christensen*, Anne Esbjørn**, Finn Mollerup** & Hans-Jørgen Albrechtsen*
*DTU Environment, Technical University of Denmark
** VCS Denmark

Introduction

Clean water tanks should be cleaned and inspected regularly to remove e.g. sediments and to ensure that the structural integrity of the tanks is not compromised.

It is the desire of drinking water utilities to be able to distribute the drinking water to consumers, immediately after the tanks have been cleaned, without preceding discard of large volumes of drinking water and without the use of disinfectant.

The drinking water is ground water based, and there is no physical or biological barrier, such as UV-filter or supplying of chlorine, at the outlet of the clean water tanks.

Results

Sampling campaigns were carried out in two clean water tanks to investigate microbial water quality before, during and after cleaning of the tanks. Growth potential, bacterial concentrations and dominating bacterial groups were quantified.

Bacterial counts [yeast extract agar, 22°C] increased slightly after cleaning of the tanks, but did not exceed guideline values at any point during the investigations. Immediately after start-up, a maximum of 10 CFU/ml (Colony Forming Units) were measured in both tanks, and after less than 24 hours the concentrations were below 1 CFU/ml in both tanks. The low concentrations were maintained the following days. Bacterial counts [yeast extract agar, 37°C] were below 2 CFU/ml at all times.

To include bacteria not normally quantified by traditional methods, such as plating, we included ATP (Adenosin-Tri-Phosphate) measurements of the water. ATP is present in all living bacteria. ATP concentrations in the water immediately after start-up were high compared to the concentration of cultivable bacteria which may indicate that bacteria from the sand filter, which do not grow on agar plates, were present in the water.

Ribosomal 16S rRNA sequences showed that the dominating bacterial groups were the same before and after the tanks were emptied, inspected and flushed. Functional filter bacteria, such as the nitrite oxidizing bacteria Nitrospira sp., were transported from filter to clean water tanks and further into the distribution network.

Conclusions

• Bacterial counts [yeast extract agar, 22 and 37°C] did not exceed guideline values at any point during the investigations.
• No pathogens or indicator bacteria were detected in water, sediment or biofilm.
• ATP concentrations increased more than concentrations of culturable bacteria in water leaving the tanks after cleaning. This indicates that bacteria from the sand filter, which do not grow on agar plates, were present in the water.
• Ribosomal 16S rRNA sequences showed that the dominating bacterial groups were the same before and after the tanks were emptied, inspected and flushed. Functional filter bacteria, such as the nitrite oxidizing bacteria Nitrospira sp., were transported from filter to clean water tanks and further into the distribution network.

• Investigate why increased bacterial counts are often registered after start-up of clean water tanks after inspection and cleaning.
• Examine whether increased bacterial counts are due to intruding bacteria from the external environment, or due to naturally present drinking water bacteria, not constituting a health risk.
• Develop best practice procedure for inspection, cleaning and following start-up.

Perspectives

The use of DDS (Documented Drinking water Safety) has increased the focus on risk management when working with drinking water.

VCS Denmark has developed a DDS plan in which the risk assessment is based on HACCP (Hazard Analysis and Critical Control Point) and follows the principles of ISO 22000.

When inspecting and cleaning a drinking water tank, there is now focus on all aspects of the process through risk assessment.

Introduction

Clean water tanks should be cleaned and inspected regularly to remove e.g. sediments and to ensure that the structural integrity of the tanks is not compromised.

It is the desire of drinking water utilities to be able to distribute the drinking water to consumers, immediately after the tanks have been cleaned, without preceding discard of large volumes of drinking water and without the use of disinfectant.

The drinking water is ground water based, and there is no physical or biological barrier, such as UV-filter or supplying of chlorine, at the outlet of the clean water tanks.

Results

Sampling campaigns were carried out in two clean water tanks to investigate microbial water quality before, during and after cleaning of the tanks. Growth potential, bacterial concentrations and dominating bacterial groups were quantified.

Bacterial counts [yeast extract agar, 22°C] increased slightly after cleaning of the tanks, but did not exceed guideline values at any point during the investigations. Immediately after start-up, a maximum of 10 CFU/ml (Colony Forming Units) were measured in both tanks, and after less than 24 hours the concentrations were below 1 CFU/ml in both tanks. The low concentrations were maintained the following days. Bacterial counts [yeast extract agar, 37°C] were below 2 CFU/ml at all times.

To include bacteria not normally quantified by traditional methods, such as plating, we included ATP (Adenosin-Tri-Phosphate) measurements of the water. ATP is present in all living bacteria. ATP concentrations in the water immediately after start-up were high compared to the concentration of cultivable bacteria which may indicate that bacteria from the sand filter, which do not grow on agar plates, were present in the water.

Ribosomal 16S rRNA sequences showed that the dominating bacterial groups were the same before and after the tanks were emptied, inspected and flushed. Functional filter bacteria, such as the nitrite oxidizing bacteria Nitrospira sp., were transported from filter to clean water tanks and further into the distribution network.