Biostability of nanofiltration permeate water in a pilot scale plant

Yujiro Yata

Keywords: Drinking water, Chlorine residual, Bacterial regrowth, Assimilable Organic Carbon, Nanofiltration

1. Introduction

In Japan, the standard for free chlorine at the end of distribution systems has been set to not less than 0.1 mg/L. However, complaints from consumers related to chlorinous odor have been on the rise over the last few years, and leading to the notion that the residual chlorine level needs to be kept at a minimum to mitigate the odor. Decreased residual chlorine condition will require an improvement of water quality in terms of biostability. Hence, this study was to evaluate nanofiltration (NF) pilot process for biostable water supply at lowest possible residual chlorine concentration.

2. Methods

The experiments were conducted at a water treatment plant with a pilot scale NF process. Feed water was drawn from effluent through ozone-activated carbon process. The biostability of NF permeate water was evaluated at no residual chlorine condition, using Assimilable Organic Carbon (AOC), and Heterotrophic Growth Response (HGR), which are indicators for bacterial regrowth potential. This study examined the impacts of water quality change (Aluminium, AOC/Heterotrophic Plate Count (HPC) ratio, pH drop) on bacterial regrowth. Further, the carbon-biomass conversion rate of bacterial species in NF permeate was determined, and then those dominant species were estimated using molecular technique. Additionally, the biofilm formation and bacterial regrowth in bulk water were investigated using batch culture and continuous-flow reactors with chlorine residual at 0.05 mg/L.

3. Results and discussion

3.1 AOC removal and biostability of permeate water

The results indicated that the average AOC was 68.7± 23.9 µgC/L and 31.6 ± 23.9 µgC/L for feedwater and permeate water, respectively (Figure 1) . This result suggests that the NF process was successful in reducing AOC partially. However, the average HGR of permeate water (3.91 logCFU/ml) was twice as much as that of feedwater (1.88 logCFU/ml), indicating that permeate water causes remarkable microbial regrowth, despite low nutrient contents.

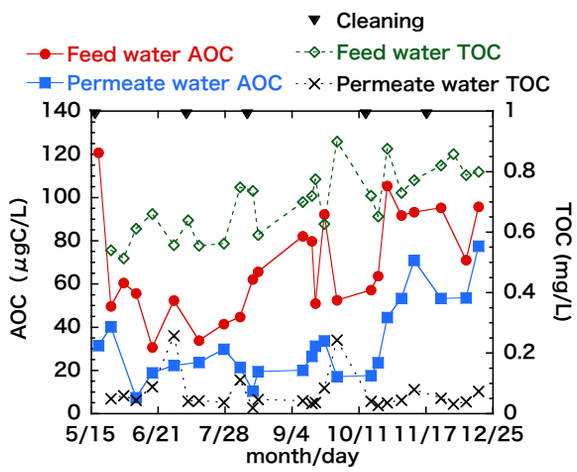

Figure 1 Change of TOC and AOC by NF

3.2 Biological characterization of permeate water

The bacterial species in NF permeate had high carbon-biomass conversion rate. The dominant species were estimated as *Herbaspirillum* sp by molecular characterization. *Herbaspirillum* sp. is able to grow in oligotrophic condition. This explains the more significant microbial regrowth in the permeate water.

3.3 Biostabillity improvement of NF permeate water with low chlorine residual condition

At 0.05 mgCl_2/L, no HPC increase was observed in bulk water in the range of AOC 17.1 -71 µgC/L. Contrarily, the biofilm HPC results showed that biofilm accumulation was suppressed with a net reduction of 3 log of biofilm, compared to chlorine-free condition. Based on comparisons with previous knowledges, this result highlights the biostability improvement by nanofiltration used in this study.

4. Conclusions

In this study, it is concluded that NF pilot process is useful to minimize chlorine residual concentration.