Evaluation of Pathogenic and Indicator Microorganisms Removal by Membrane Bioreactor

Yamashita, N., Sugita, D., Hata, A., Tanaka, H., Mori, N., Okuma, N.

1Research Center for Environmental Quality Control, Kyoto University
2Water Reuse Promotion Center
Background

Reuse of sewage treatment water

Microorganisms in sewage water become problem

Bacteria: *E. coli* O-157, Cholera, Shigella
Protozoa: Cryptosporidium, Diardia
Virus: Norovirus, Rotavirus, Adenovirus

Is **MBR** effective to remove microorganisms?
Knowledge of microorganisms removal by MBR is not enough. Especially, virus removal data is important.

Breaking of membrane module in MBR would be observed occasionally. What is appropriate indicator microorganism?
1. Removal of microorganisms by MBR

- Evaluation of microorganisms removal by MBR
  Comparison between MBR and CAS

2. Evaluation of indicator microorganisms

- Relationship between microorganisms removal and membrane condition
  Selection of appropriate indicator microorganism
Materials and methods
Membrane Bioreactor (MBR)

Sampling period: Aug 2014 - March 2015, twice a month
MLSS concentration: 6000-8000 mg/L

Membrane module replacement
Since breaking of a few hollow fiber membrane was observed, membrane modules were replaced in January 2015.

Comparison microorganisms data between before and after replacement of membrane modules
Conventional Activated Sludge (CAS) system

**Influent**

1. Sedimentation tank
2. Conventional treatment
3. Sedimentation tank
4. Chlorination
5. Effluent 1
6. Effluent 2
7. Excess sludge
8. Returned sludge
9. Deep shaft aeration treatment

**Sampling points:**
1. 2. 3.

**Sampling period:** September 2014 - March 2015

**MLSS concentration:** 1200-1500 mg/L
Target Microorganisms

Indicator bacteria

E. Coli
Coliforms

Pathogenic virus

Norovirus (GI,GII-NoV)

Rotavirus (RV)

Aichi virus (AiV)

F-phages (GI~GIV-FPH)
Pepper Mild Mottle Virus (PMMoV)
Detection

Water samples

Bacteria
- Culture method

F-phage
- Plaque assay

Virus
- Concentration with electro-negative filter
  - RT-qPCR
    - TaqMan® probe

Detection

Water samples

Bacteria
- Culture method

F-phage
- Plaque assay

Virus
- Concentration with electro-negative filter
  - RT-qPCR
    - TaqMan® probe
Results and discussion
Effluent concentration from MBR was $10^1$-$10^2$.

Bacteria removal by MBR was 5-6 logs.

*E. coli* was detected in effluent from MBR.
Bacteria concentration in CAS

**E. coli** concentration in influent and effluent in CAS

- Effluent concentration from CAS was about $10^4$.
- Bacteria removal by CAS was 2-3 logs.
- Concentration of **E. coli** in effluent from CAS was relatively high.
E. coli and total coliforms removal by MBR was 5-6 logs.

E. coli and total coliforms removal by CAS was 2-3 logs.

Bacteria removal by MBR was much higher than that by CAS.
Virus removal by MBR was 3-4.2 logs.

Virus removal fluctuated depending on samples and viruses.
Comparison between MBR and CAS removal

Virus removal by MBR was 3-4.2 logs as average.

Virus removal by CAS was 1-3 logs as average.

MBR will be effective to remove viruses in water.
Membrane replacement

Since breaking of a few hollow fiber membrane was observed, membrane modules were replaced in January 2015.

Compare microorganisms removal between before and after
Bacteria removal by MBR – Membrane replacement

Bacteria removal by MBR was 6-7 logs.
Bacteria removal was improved after replacement.
Rejection by membrane will be the important role.
Bacteria removal by MBR was improved after replacement.

*E. coli* was not detected in effluent from MBR.

*E. coli* would be used as a indicator to evaluate membrane condition.
Virus removal by MBR – Membrane replacement

Virus removal fluctuated depending on samples and viruses.

Virus removal by MBR was not improved after replacement.

Rejection by membrane will not be important for virus removal.
Conclusions

Removal of microorganisms by MBR

- Bacteria removal by MBR was 5-6 logs and virus removal was 3-4.2 logs.
- Microorganisms removal by MBR was higher than that by CAS.

MBR will be effective to remove microorganisms in water.

Evaluation of indicator microorganisms

- Bacteria removal was improved after membrane replacement.
- *E. coli* was not detected in effluent from MBR.
- Virus removal was not improved after replacement.

*E. coli* would be used as an indicator to evaluate membrane condition.
Thank you for your kind attention