

# **OPERATION WITH CERAMIC MEMBRANE FILTRATION SYSTEM FOR DWTP IN JAPAN**

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## **KEYWORDS**

**Ceramic membrane, micro filtration, coagulation, membrane filtration, virus removal, drinking water**

## **INTRODUCTION**

Membrane filtration technology has been widely applied to many kinds of fields, not only industrial applications, but also municipal applications. For these applications, both polymeric membranes, that dominate the major parts, and ceramic membranes have been used. Ceramic membrane has been mostly limited to a certain special application because of its higher cost, although the membrane performance and durability are better than those of polymeric membranes. But METAWATER, a Japanese company that supplies from ceramic membrane to filtration system, filtration facility as an EPC or PFI project, broke through the cost problem and has been expanding the market share of drinking water treatment plant (DWTP) in Japan. In Czech republic and its surrounding countries, Envi-Pur, s.r.o., who took over all the system know-how from METAWATER, is a responsible company. In this paper, METAWATER ceramic membrane filtration system for municipal drinking water application is introduced.

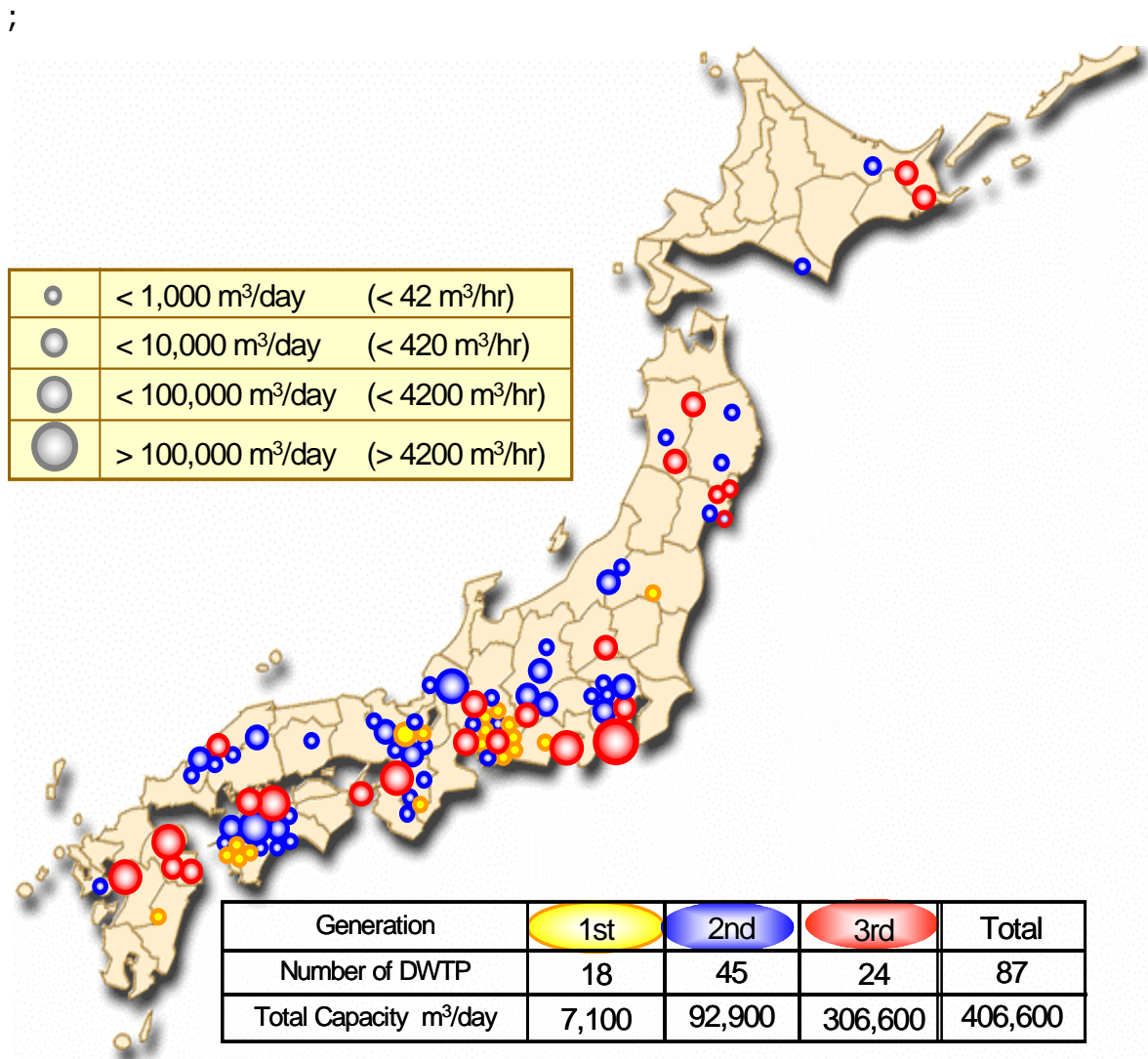
## **HISTORY OF CERAMIC MEMBRANE FILTRATION TECHNOLOGY**

The 1<sup>st</sup> generation ceramic membrane (specification: 1m-length x 30mm- $\varphi$  x 0.4m<sup>2</sup>) was started industrial application in 1985, and installed a membrane plant for the first DWTP in 1996. In order to reduce the membrane cost and increase the membrane performance further, the 2<sup>nd</sup> generation membrane (specification: 1m-length x 180mm- $\varphi$  x 15m<sup>2</sup>) and the 3<sup>rd</sup> generation membrane (specification: 1.5m-length x 180mm- $\varphi$  x 25m<sup>2</sup>) were developed and installed to DWTP in 2001 and 2006 in Japan respectively. In 2008, this technology was selected for 25 years BTO (Build-Transfer-Operation) project of DWTP with 171,050m<sup>3</sup>/day (17,000m<sup>3</sup>/hr) in capacity.

In 2008, as of august/2009, METAWATER ceramic membrane filtration system was used or will be used for 87 DWTPs, and the total water production capacity reached about 400,000m<sup>3</sup>/day (17,000m<sup>3</sup>/hr) in Japan. In 2009, the first installation out side of Japan with the capacity of 37,850m<sup>3</sup>/day (1,600m<sup>3</sup>/hr) was decided in CO/USA.



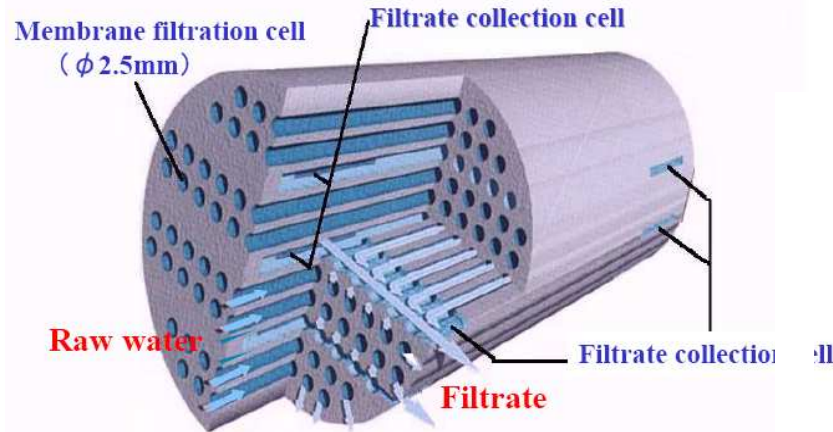
Picture 1. Specification of ceramic membrane



Picture 2. Installation map

## SPECIFICATION OF CERAMIC MEMBRANE

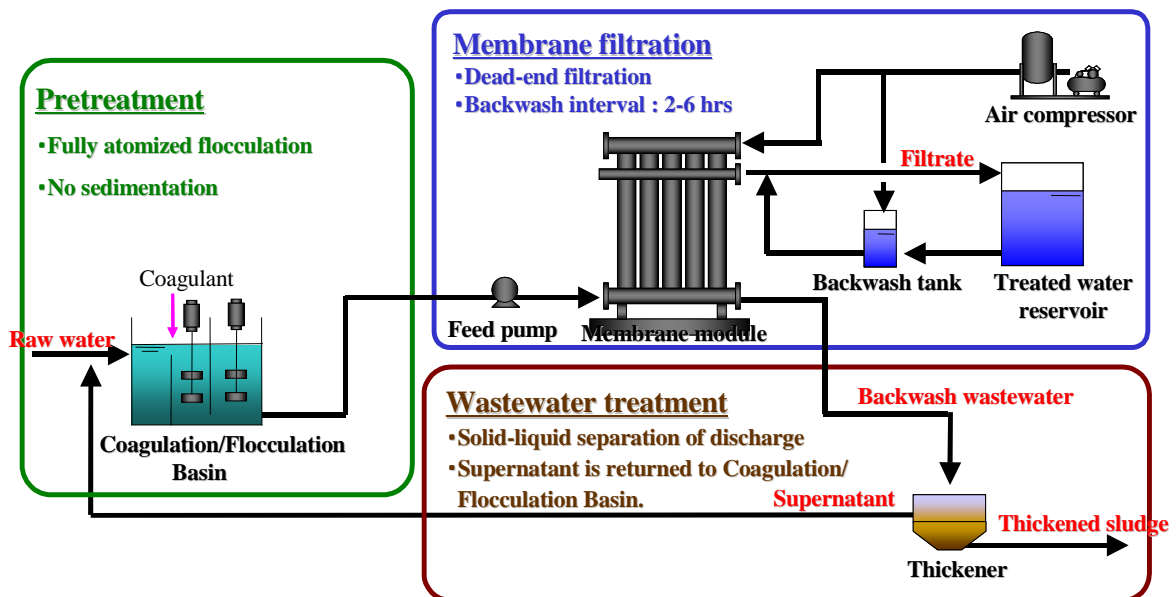
Ceramic membrane has 0.1 $\mu\text{m}$  as a nominal pore size, and is categorized to micro-filter (MF). Raw water is fed into 2,000 membrane filtration cells, which has 2.5mm- $\phi$  as a diameter, and totally collected as filtrate (dead-end filtration). Large volume of membrane filtration cell (in total 15 L) can store much turbid matter, and as a result, realize the long BW interval. And thanks to the filtration collection cell preparation, filtration is finished with very low pressure, although the outer diameter of the membrane is very large of 180mm- $\phi$ .



Picture 3. Ceramic membrane structure

## FILTRATION MECHANISM & INTEGRATION WITH COAGULATION

Variety kinds of water can be treated and purified by the integration with coagulation and ceramic membrane filtration. Even though the nominal pore size of the membrane is 0.1 $\mu\text{m}$ , this integration filtration system can remove not only the suspended solid, but also some dissolved material, bacteria, protozoa and virus.




Picture 4. Ceramic membrane filtration system  
CHARACTERISTICS OF CERAMIC MEMBRANE SYSTEM

Ceramic membrane has many unique characteristics, such as membrane durability, long serving life, stability against turbidity, low filtration pressure with high operation flux, high water recovery and so on. In case of the membrane replacement, which METAWATER has NEVER experienced for 12years, the used membrane will be used as ceramic products, and never be a waste. This means that ceramic membrane would meet "Zero emission" policy, and be an environmentally friendly technology.

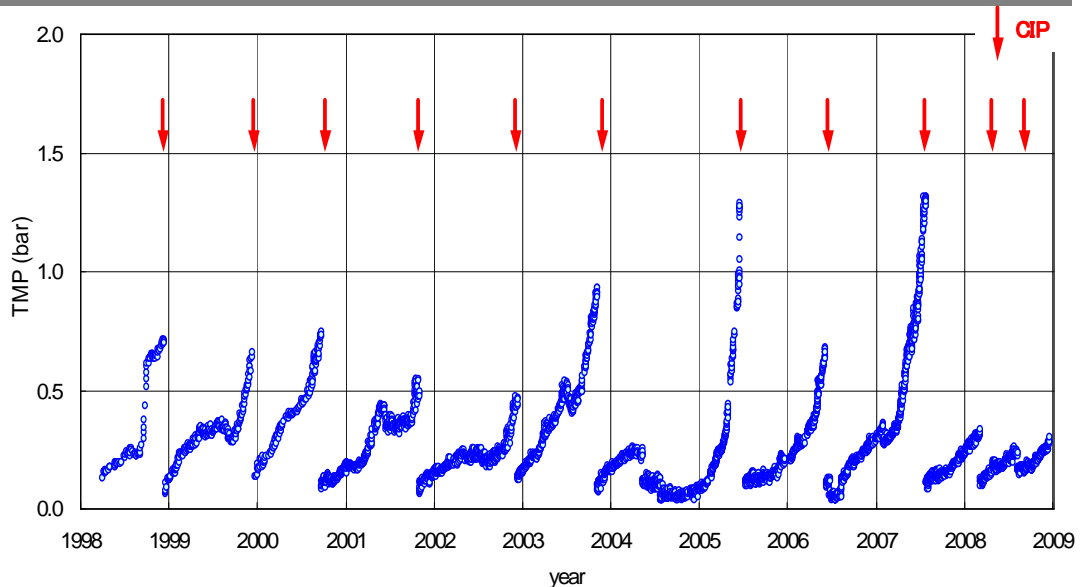
### Long service life

The oldest membrane plant was started operation in 1998. The raw water is river surface water that fluctuated seasonally, because of the weather and agricultural activity. Such surface water has been directly treated by only adding PACl as coagulant before filtration. For more than 12 years, the membrane permeability has been kept the original performance without any membrane breakage, any membrane replacement and operation shut down.



#### DWTP in Kyoto (Operation start in 1998)

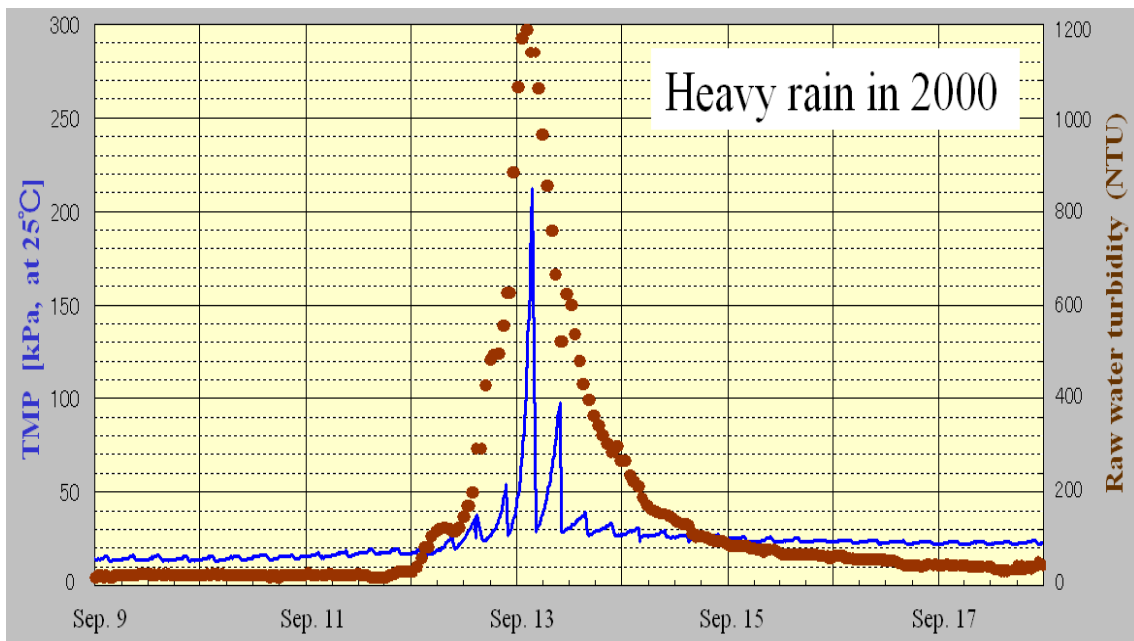
- Membrane: 30mmφ x 1,000mmL
- Capacity: 17.7 m<sup>3</sup>/hr (425 m<sup>3</sup>/day)
- Raw water: River surface water
- Flow: Coagulation(PACl) ⇒ Membrane filtration
- Flux: 64 LMH
- BW interval: 6 hrs
- CIP interval: once/year
- Recovery: >99%



**Picture 5. Operation results (Long period operation)**

### Robustness for high turbidity

Ceramic membrane has a strong robustness against high turbidity over 1,000 NTU. Normally, most membrane filtration system had no chance but to stop operation, or install an additional pre-treatment to remove such turbid matters before membrane. The pilot test for river surface water was conducted by METAWATER in 2000, and then the raw water turbidity was suddenly increased up to 1,200 NTU by heavy rain. TMP had increased according to the increase of turbidity, but after conducting B.W., TMP was completely recovered without CIP. During this period, NO operation stop happened and stable operation was confirmed.



**Picture 6. Operation results (High turbidity)**

### **Virus removal**

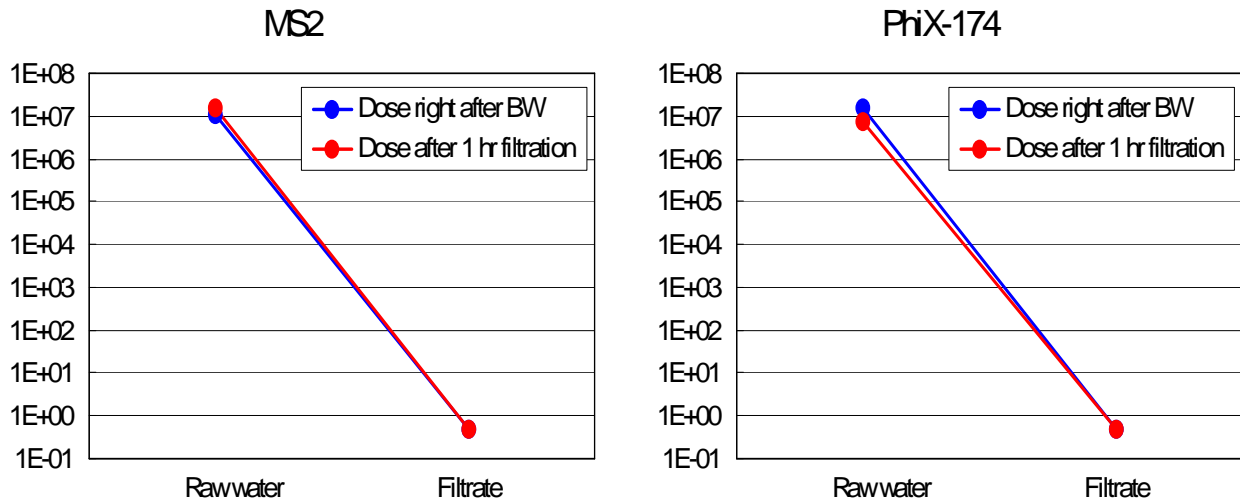
Regarding the virus removal, an investigation was carried out using two kinds of viruses that have a different isoelectric point, MS-2 and PhiX-174. Both viruses were dosed into the raw water taken from the water reservoir with the concentration of about  $10^7$  cfu/mL, and filtrate was sampled at the timing of 1) right after backwash (BW) and 2) 1 hour after starting filtration. The confirmed viruses in the filtrate showed under detection level for all samples, and the virus removal rate showed more than LRV 6. Together with coagulation, ceramic membrane can also remove such viruses perfectly.

### Used viruses

MS2 Size = 24-30 (nm), Isoelectric point = 6.6-6.8  
PhiX-174 Size = 24-30 (nm), Isoelectric point = 3.4-3.9

### Operation condition

Raw water Surface water  
(Dammed water)  
Coagulation PACl (3.0mg-Al/L)  
Flux 140 (LMH)



**Picture 7. Virus removal**

### References

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