

Using of membrane processed for water treatment in the world

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KEYWORDS

Ceramic membrane, micro filtration, coagulation, membrane filtration, virus removal, ozonation, PAC, drinking water, reclamation

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 this paper, METAWATER ceramic membrane filtration system for municipal drinking water and reclamation application is introduced.

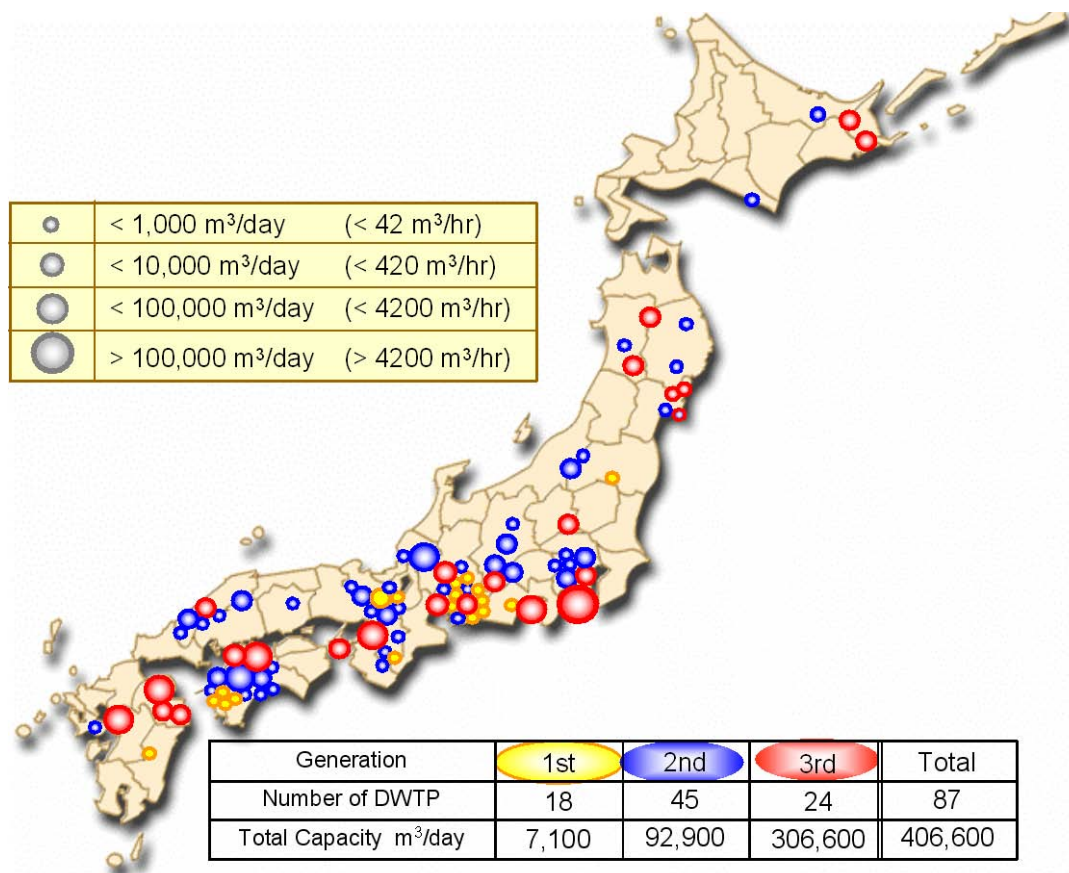
1. History of Ceramic membrane filtration technology

The 1st generation ceramic membrane (specification: 1m-length x 30mm- ϕ x 0.4m²) was started industrial application in 1985, and installed a membrane plant for the first DWTP in 1998. In order to reduce the membrane cost and increase the membrane performance further, the 2nd generation membrane (specification: 1m-length x 180mm- ϕ x 15m²) and the 3rd generation membrane (specification: 1.5m-length x 180mm- ϕ x 25m²) 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 171,050m³/day (7,130m³/hr) in capacity.



Picture 1. Specification of ceramic membrane

As of august/2009, METAWATER ceramic membrane filtration system was used or will be used for 87 DWTPs in Japan, and the total water production capacity reached about 400,000m³/day (16,700 m³/hr). In 2009, the first installation out side of Japan with the capacity of 37,850m³/day (1,600m³/hr) was decided in CO/USA.

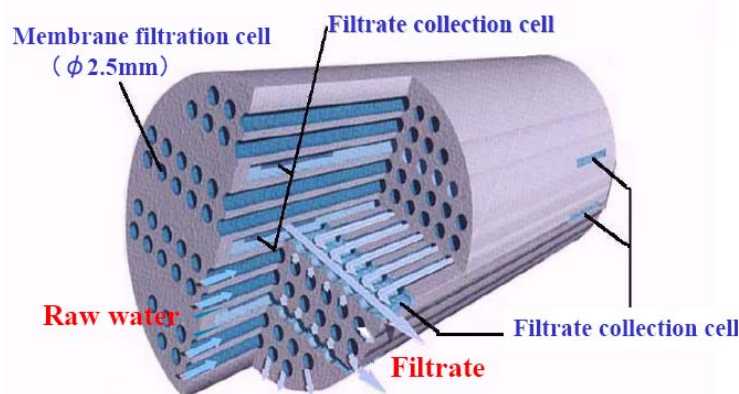


Picture 2. Installation map

2. Characteristic of ceramic membrane

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.

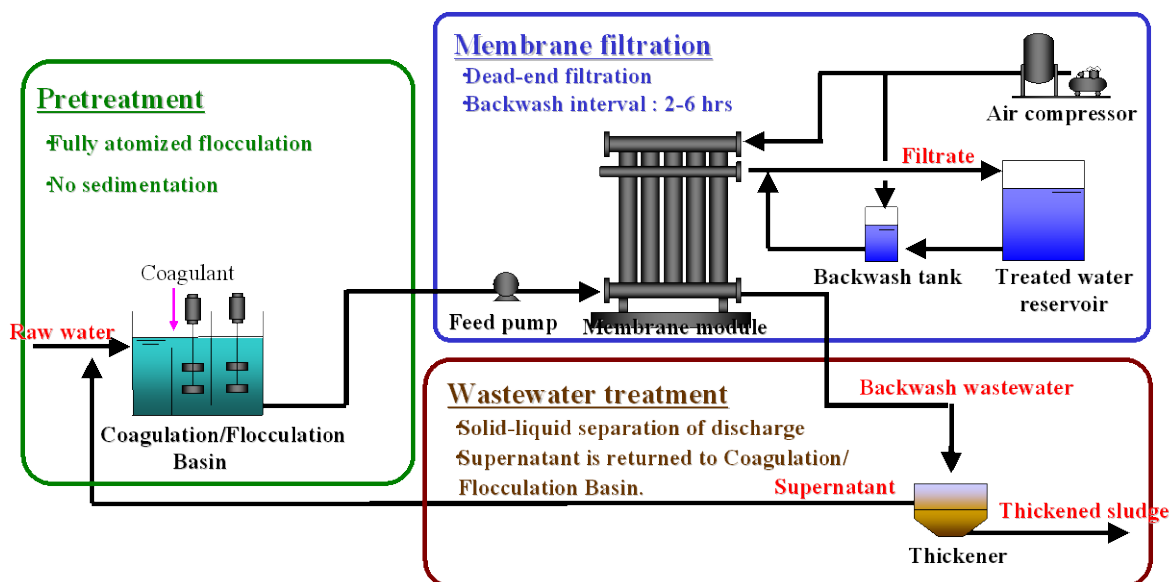
This membrane has 0.1μm as a nominal pore size, and is categorized to micro-filter (MF). Raw water is fed into 2,000 membrane filtration cells, which has 2.5mm-φ as a diameter, and totally collected as filtrate (dead-end filtration). Large volume of membrane filtration cell (in total 15 L) can store much turbid matter, and as a result, realize the long backwash (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-φ.



Picture 3. Ceramic membrane structure

3. 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 μ m, this integration filtration system can remove not only the suspended solid, but also some dissolved material, bacteria, protozoa and virus.

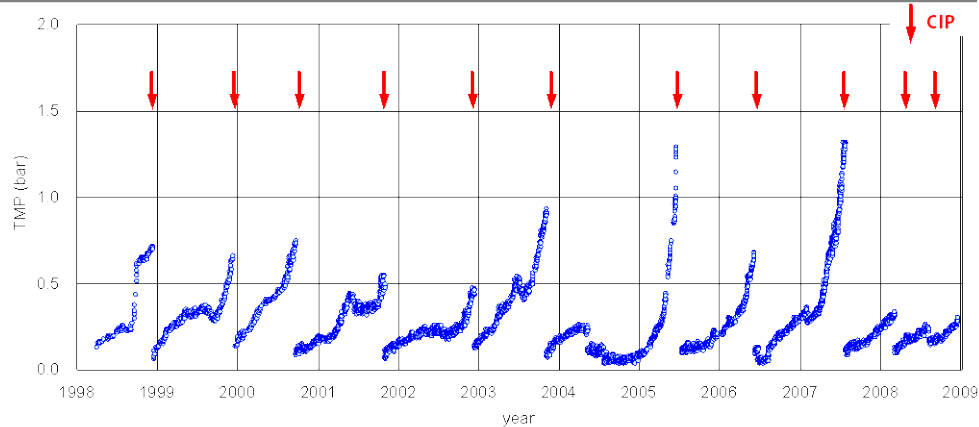
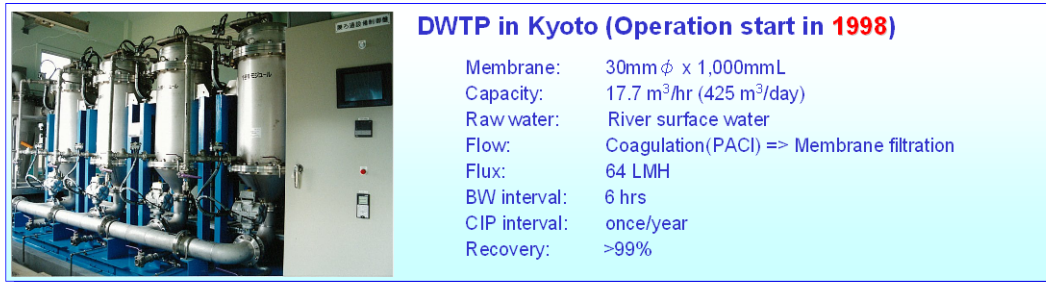


Picture 4. Ceramic membrane filtration system

4. Membrane performance of commercial plant

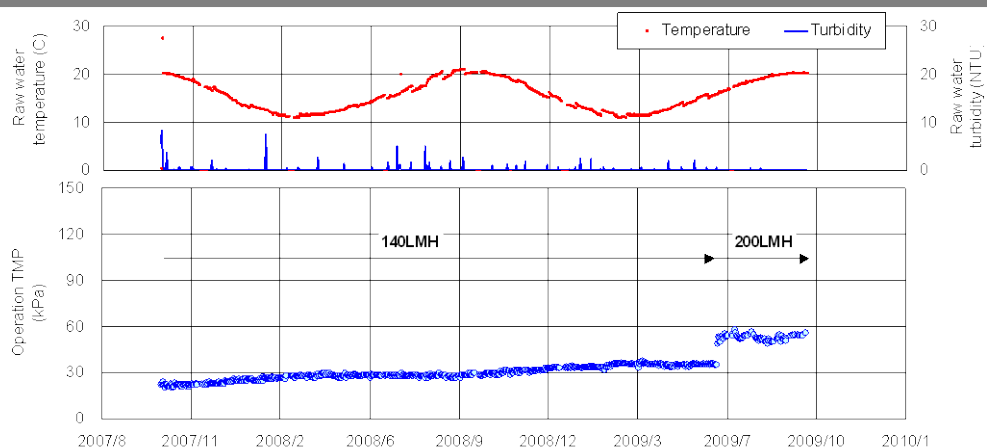
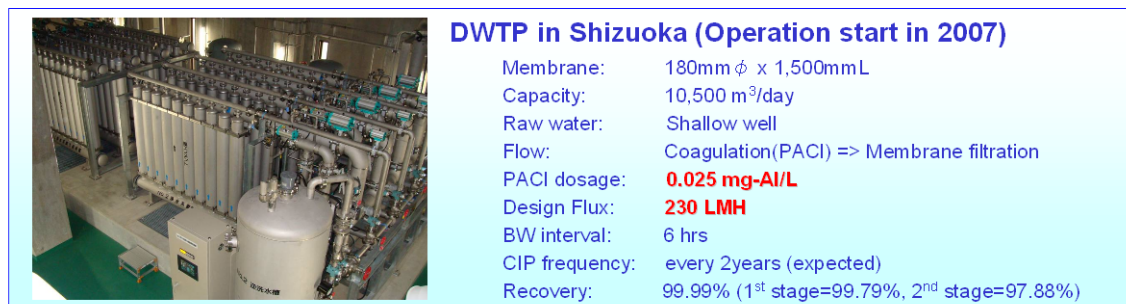
By integrating pre- and post-treatment with ceramic membrane filtration, many kinds of water can be treated. The common treatment method is coagulation and filtration. In case of high organic raw water, PAC was dosed before coagulation. Not only the normal PAC, but also sub-micron PAC, which is 10 times smaller than normal PAC, can be applied.

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.



Picture 5. Operation results (Long period operation)

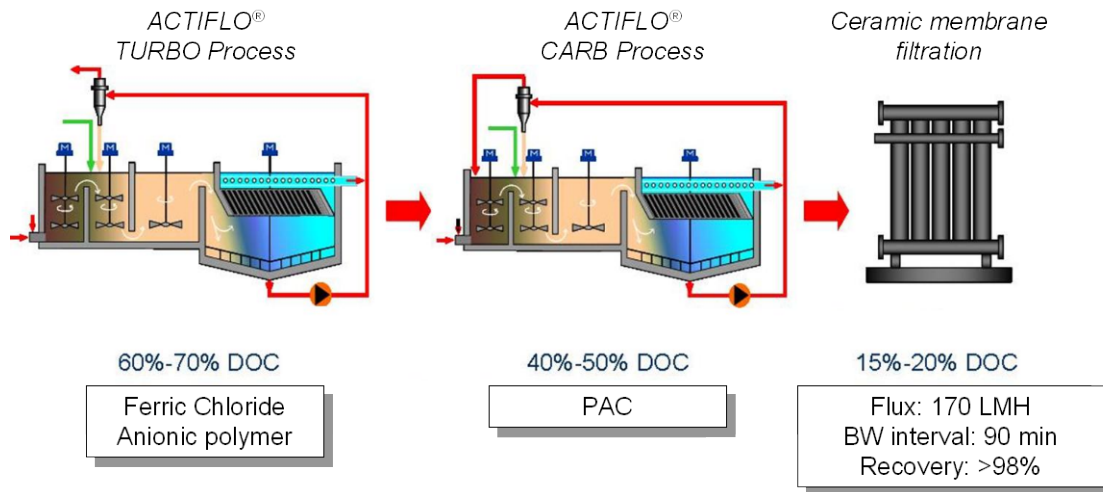
In case of clear raw water quality, such as ground water or shallow well, very tiny amount of coagulant, like 0.025mg-Al/L, is dosed, and filtrated with very high operation flux, such as 200LMH. High operation flux and long BW interval allows very high water recovery operation of 99% or more.



Picture 6. Operation results (High flux operation)

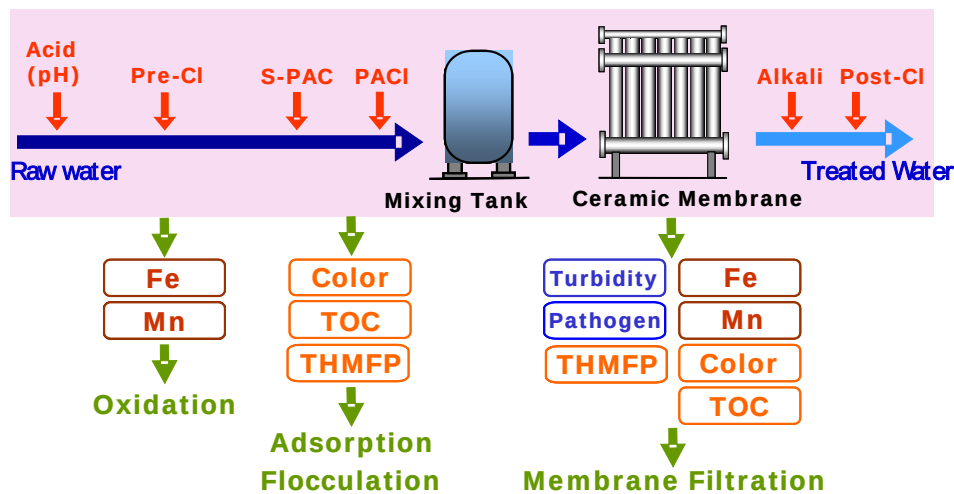
5. New application

In Parker, Colorado State/USA, ceramic membrane technology was selected in 2009 for the new DWTP construction.⁽¹⁾ Rueter-Hess reservoir will be newly constructed as a water source that will contain lots of pollutants from secondary treated water come from the existing wastewater plant. The DOC in raw water is expected 6mg/L as average, and 12mg/L in summer period. The customer's requirement of the treated DOC and turbidity level are less than 4mg/L, or if possible 2mg/L, and less than 0.05NTU respectively. In order to guarantee the high DOC and the perfect turbidity removal, two types of ACTIFLO®, TURBO-Process for the enhancement of coagulation and CARB-Process for PAC adsorption, and ceramic membrane filtration will be adopted. The confirmed DOC removability through on-site pilot was as high as 80-85%.



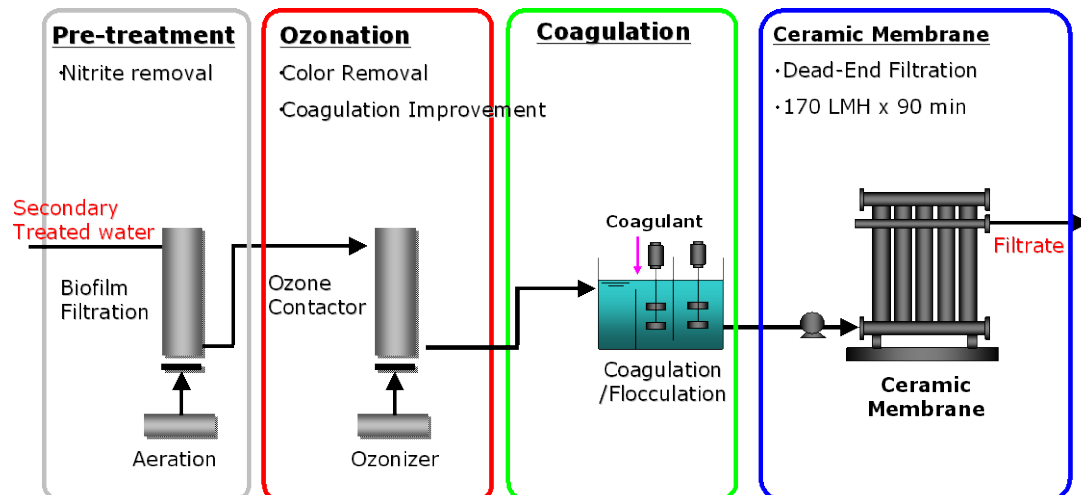
Picture 7. System in CO/USA

In Yokohama/Japan, METAWATER group, as a Special Purpose Company (SPC), got a huge DWTP project in 2008.⁽²⁾ The newly construction membrane DTWP, that has the production capacity of 171,050 m³/day, is 25-years BTO (Build-Transfer-Operation) project including 20-years operation and maintenance. As a pre-treatment, pre-chlorination, PAC dosing and coagulation will be adopted. For PAC dosing, sub-micron PAC will be used. As a result, the amount of PAC usage is dramatically reduced to 20% compared to normal PAC.



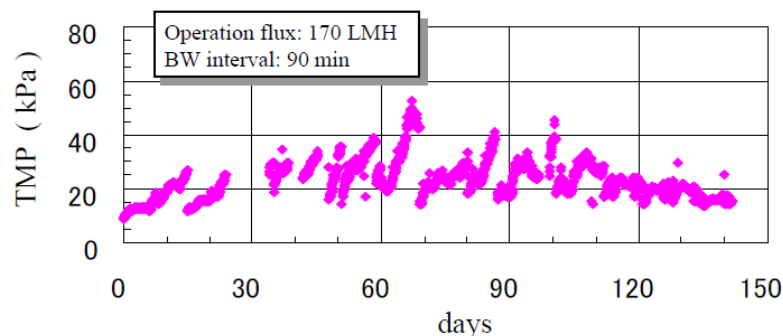
Picture 8. Treatment flow in Yokohama (171,050m³/day)

Ceramic membrane technology will be used for reuse project of secondary treated water in Tokyo/Japan.⁽³⁾ Previously, PVDF polymeric membrane system was installed at the same plant, but the performance was below their expectation, and new technology has been longed for. So, the collaboration research work between bureau of sewerage of Tokyo metropolitan government and Metawater was carried out, and new treatment system was developed. The secondary treated water from conventional wastewater treatment plant will be reclaimed by the integration treatment system of ozonation + coagulation + membrane filtration, and the crystal clear filtrate will be used in business district as toilet flushing or stream reclamation.



Picture 9. Secondary treated water reclamation system in Tokyo (7,000m³/day)

By adding ozone before membrane filtration, COD removal, color removal and SDI were improved, and also ceramic membrane performance kept very stable under the condition of 170LMH as operation flux and 90min as BW interval. The commercial plant with the capacity of 7,000m³/day will be planned to start operation in 2010.



Picture 10. TMP performance

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