

# Organic matter removal for reverse osmosis fouling mitigation: from lab prototype to pilot plant

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## Abstract:

In this study, a prototype microgranular adsorptive filtration ( $\mu$ GAF) system was constructed employing a 7-bore ceramic membrane as the primary membrane and either heated aluminum oxide particles (HAOPs) or powdered activated carbon (PAC) as the pre-deposited dynamic membrane (DM). The system was used to pre-treat membrane bioreactor (MBR) effluent from a full-scale MBR-reverse osmosis (RO) water reclamation plant. The downstream RO performance and membrane fouling potential of the treated effluent were then assessed. The results indicated that: (i) although PAC removed more overall EfOM than HAOPs did, HAOPs were more effective in removing biopolymers such as polysaccharides and proteins, (ii) HAOPs virtually eliminated fouling of the primary ceramic membrane, whereas considerable fouling (much of it irreversible) occurred when the feed was pretreated with PAC, (iii) HAOPs removed more than 90% of the phosphorus and fluoride from the feed, but PAC removed negligible amounts of these contaminants, and (iv) HAOPs-treated effluent resulted in only a 43% decline in RO permeate water flux over 5 d of continuous filtration, as opposed to 62% flux decline for untreated or PAC-treated effluent. This study thus demonstrates the effectiveness of the HAOPs-based  $\mu$ GAF process as a pre-treatment for improving downstream RO recovery. The pilot plant has been commissioned in 2021, and optimization of operating conditions is ongoing. It locates at Ulu Pandan Reclamation Plant (under PUB, Singapore's National Water Agency).

**Keywords:** Dynamic membranes; Heated aluminum oxide particles (HAOPs); Membrane bioreactor (MBR) effluent treatment; Effluent organic matter (EfOM); Reverse osmosis (RO) fouling; Pilot plant