

# **Title: Feasibility study of powdered activated carbon membrane bioreactor (PAC-MBR) for source-separated urine treatment**

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## **Abstract:**

Micropollutants (MPs) such as pharmaceuticals and personal care products are a group of emerging environmental contaminants, which are structurally complex and can cause adverse physiological effects on human health at low concentration. This study demonstrated that a hybrid process of powdered activated carbon and microfiltration membrane bioreactor (PAC-MBR) could be utilized for efficient removal of metronidazole, acetaminophen, naproxen, ibuprofen, carbamazepine, estriol (> 99%) from source-separated urine via physical adsorption and biodegradation in a single step, without compromising the operating system stability. Further, it improved organic removal efficiency from  $88.6 \pm 2.9\%$  to  $96.0 \pm 1.2\%$ , promoted rapid biomass growth, and increased sludge floc size growth by 17%. In addition, membrane fouling is the biggest challenge in membrane-based technology operation. This work shown that continuously adding virgin PAC into the system maximized the interaction between PAC and activated sludge, thus, reducing the membrane fouling propensities from pore blocking or pore constriction caused by particles adsorption in the membrane. To add 2 g. L<sup>-1</sup> PAC in MBR at replenishment ratio of 1.6% reduced the activated sludge viscosity, resulting in lower membrane filtration resistance, improved critical flux and permeate quality, and longer system operation at higher flux for PAC-MBR to treat source separated urine.

**Keywords:** fouling; micropollutant; powdered activated carbon; urine; membrane bioreactor