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Submerged membrane filtration adsorption hybrid system for the removal of organic micropollutants from a water reclamation plant reverse osmosis concentrate

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HIGHLIGHTS

- A water treatment plant RO concentrate had 19 organic micropollutants (OMP).
- Submerged membrane filtration GAC adsorption removed all OMP to <detection limits.
- This hybrid system helps to produce additional amounts of nutrient-rich water.

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ABSTRACT

Reverse osmosis (RO) is a widespread water treatment process utilised in water reuse applications. However, the improper discharge of RO concentrate (ROC) containing organic micropollutants such as pharmaceuticals into the environment may cause potential health risks to non-target species and particularly those in aquatic environments. A study was conducted using a submerged membrane-filtration/granular activated carbon (GAC) adsorption hybrid system to remove organic micropollutants from a water treatment plant ROC by initially adding 10 g GAC /L of membrane reactor volume with 10% daily GAC replacement. The percentage of dissolved organic carbon removal varied from 60% to 80% over an operation lasting 10 days. Removal of organic micropollutants was almost complete for virtually all compounds. Of the 19 micropollutants tested, only two remained (the less hydrophobic DEET 27 ng/L and the hydrophilic sulfamethoxazole 35 ng/L) below 80% removal on day 1, while five of the most hydrophobic micropollutants were detectable in very small concentrations (<5–10 ng/L) with >89%–>99% being removed. High percentages of micropollutants were removed probably because of their high hydrophobicity or they had positive or neutral charges and therefore they were electrostatically adsorbed to the negatively charged GAC.

1. Introduction

Inadequate clean water for potable and non-potable use has become a major problem worldwide due to the increasing demand and shortage of water resources. Water recycling by treating wastewater is a useful approach to alleviate this problem. However, wastewater contains many contaminants, which need to be removed before it can be beneficially utilised. In this context, membrane technology is currently growing at a great rate due to its excellent ability to remove contaminants and smaller footprint requiring less space compared to conventional treatment technologies. Of the different types of membrane filtration, reverse osmosis (RO) is widely used in water reuse applications due to its greater efficiency in removing contaminants including organic micropollutants, for example, pharmaceuticals and personal care products (PPCPs), insecticides, surfactants, endocrine disruptors, and hormones [1]. However, the rejected micropollutants are discharged normally into surface water bodies with the RO concentrate (ROC). The improper discharge of organic micropollutants with the ROC into the environment may cause potential health risks to non-target species particularly in aquatic environments [2]. Subsequently, the application of proper treatment techniques is essential to ensure safe disposal of ROC free of organic micropollutants into the natural environment.

The concentration of various organic micropollutants in Australian waters is summarised in Table 1. These contaminants are commonly found at trace levels in the environment ranging from nanogram to microgram per litre (ng/L–μg/L) and as such are also known as trace organics. Wastewater treatment plants (WWTPs) constitute the major

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