Forward osmosis followed by reverse osmosis for the removal of contaminants of emerging concern using a CO_2-responsive draw agent

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Contaminants of emerging concern (CECs) are an unmonitored and unregulated class of chemicals found in the environment that negatively impact the health of living organisms. CECs are pervasive in private and public domains as consumer products and enter the environment primarily through wastewater effluent streams from wastewater treatment plants (WWTPs), which remove harmful organisms but cannot remove most CECs. This study's chosen method for removing CECs from an aqueous solution was forward osmosis followed by reverse osmosis (FO-RO) using a CO_2-responsive draw agent, poly(N,N-dimethylallylamine (PDMAAm). A solution of this CO_2-responsive material has a high osmotic pressure (π) in the presence of CO_2 for ease of filtration by FO and a low π in the absence of CO_2 for ease of recovery by RO. The CECs investigated were ciprofloxacin (CIP), sulfamethoxazole (SMX), atenolol (ATN), trimethoprim (TMP), acetaminophen (ACM), and carbamazepine (CBZ). PDMAAm is a reusable and recoverable base, making it preferable to inorganic salts for improving the removal efficiency of anionic CECs. This study demonstrated that using FO-RO with a CO_2-responsive draw agent resulted in high CEC removal efficiencies over multiple filtration cycles.