# Osmotically-Driven Membrane Processes for Sustainable Water Reuse and Resource Recovery: Exploration of Branched Polyethyleneimine as Osmotic Agent

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**Abstract**

Forward osmosis (FO) is a promising membrane process with the potential to offer energy-efficient separation technologies for various environmental and industrial applications including (i) water reuse, (ii) desalination, and (iii) resource recovery. However, a major and unresolved challenge in FO remains the availability of effective draw solutions that could be (i) implemented using nanoporous FO membranes with tunable ion selectivity and (ii) reconstituted using a low-energy separation process. This presentation summarizes the potential use of a branched polyethyleneinime (PEI) macromolecule [Molecular weights $M_n$ of 10000 Da and $M_w$ of 25000 Da] as osmotic agent to formulate new draw solutions that could be deployed nanoporous FO membranes and its applications for water reuse and resource recovery. To assess the potential of PEI-based draw solutions, we combine (i) osmotic pressure measurements, (ii) membrane preparation and characterization, (iii) water flux and reverse solute permeation measurements and (iv) draw solution concentration

experiments using ultrafiltration (UF) and nanofiltration (NF). Furthermore, we demonstrate the PEI-based FO process for the separation/recovery of microalgal-based colloidal suspensions which is considered as a major challenge in microalgae biotechnology for water reuse and resource recovery applications. The overall results of this study suggest that i) branched PEI macromolecules (Mw of 25000 Da) are promising building blocks for the development of draw solutions for osmotically-driven membrane processes using nanoporous FO membranes and ii) the PEI-based FO process has a potential to be utilized in microalgae biotechnology for water reuse and resource recovery.