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Novel membrane coating methods involving use of graphene oxide and polyelectrolytes for development of sustainable energy production: Pressure Retarded Osmosis (PRO) and Enzymatic Membrane Reactor (EMR)

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Abstract

This study compares pressure retarded osmosis (PRO) and the enzymatic membrane reactor (EMR) for the production of green energy in the form of power density and biomethanol, respectively. A systematic design of the biocatalytic membrane reactor and the PRO membrane system was carried out where we combined physical adsorption of polyelectrolyte (PE) and the graphene oxide (GO) layer-by-layer (LbL) assembly system. The hybrid LbL structure is proposed as a strategy to simultaneously advance the operational stability of the enzymes in the EMR and to increase hydrophilicity and power density in the PRO approach. Using polydopamine (PDA), poly (diallyldimethylammonium chloride) (PDADMAC) and GO allowed functionalization of polysulfone (PSF) membranes for subsequent Alcohol Dehydrogenase (ADH) immobilization in the EMR and functionalization of polyamide (PA) membranes for PRO. Tailoring membrane surface chemistry allowed an increase in enzyme conversion rate in comparison to the pristine, unmodified membrane (99.6% vs 2%, respectively) without significantly compromising water permeability. Moreover, power density increased from 2.10 to 2.64 W/m2 for pristine and modified membrane, respectively. Energy production in kJ/m2·h was compared and the most efficient technology was chosen.