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NOVEL DIFFUSION APPROACHES IN ENHANCING THE EFFECTIVENESS OF CO2 CAPTURE, CO2 CONVERSION AND DESALINATION PROCESSES

ABSTRACT

The requirement of more energy-efficient water treatment and CO_2 capture and conversion technologies are major global challenges and one of the most promising approaches to address them is the development of "next-generation" high diffusivity membranes and their deployment in novel "next-generation membrane intensified" CO_2 capture and desalination units.

Regarding the desalination challenges, it is estimated that by 2025 almost 1.8 billion people worldwide will live in absolute water scarcity, mainly due to the high energy demand of the conventional reverse osmosis desalination systems. For example the 30 desalination plants in Saudi Arabia use about 300,000 barrels of crude oil equivalent a day and there is a great need for a significant reduction of the energy consumption rates from 3 kWh/m^3 down to 0.5 kWh/m^3 by replacing the high energy demand conventional reverse osmosis systems with innovative combination systems of "next-generation" high diffusivity nanofiltration/forward osmosis /membrane distillation membranes. The main concept in the development of the "next-generation" membranes is to mimic the function of biological aquaporins (AQPs)[1] and achieve and surpass their astonishing large water diffusion rates, enhancing at the same time their salt rejection selectivity. To this end several membranes are very promising, namely synthetic water channel nanofiltration membranes[1] mimicking protein channels, graphene membranes[2] , single-[3] and multi-[4] wall carbon nanotube membranes and mixed-matrix membranes.

Regarding the second major global challenge of the global warming, it is estimated that a total cumulative mass of approximately 100 Giga-tonnes CO_2 will be required to be captured and stored or converted cost-effectively between 2030 and 2050. *One major need is the reduction in the required energy capture down to 1.5 GJ/ton* CO_2 *captured and to this end the development of high* CO_2 *diffusivity mixed matrix membranes and their deployment of novel hybrid membrane/* rapid diffusion vacuum temperature swing adsorption (RVTSA) systems[5] can provide a cost-effective solution. In addition, regarding the disposal of the CO_2 captured, the development of cost-effective membrane intensified conversion processes of captured CO_2 , based on novel high CO_2 diffusivity CVD modified nanoporous ceramic membranes[3] , can provide the required loe-energy demnd conversion to fuels and chemicals of the CO_2 captured.

[1] M. Barboiu et.al, *Nature Communications* volume 5, Article number: 4142 (2014)

[2] G.Pilatos et.al, Journal of Applied Physics **119**, 064303 (2016)

[3] A. Labropoulos et al., Chem. Mater. 27 (2015) 8198-8210

[4] E.C. Vermisoglou et al., Advanced Materials 22 (2010) 473-477.

[5] "Tailor-made 3D printed structures based on CNTs and MOFs materials for efficient CO2 capture"Horizon project, Grant agreement ID: 760884, 2018-2021, https://carmof.eu.