NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE
Singapore Membrane Technology Centre
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Development of High-Performance Membranes for the Recovery of Methane from Anaerobic Digestion Processes

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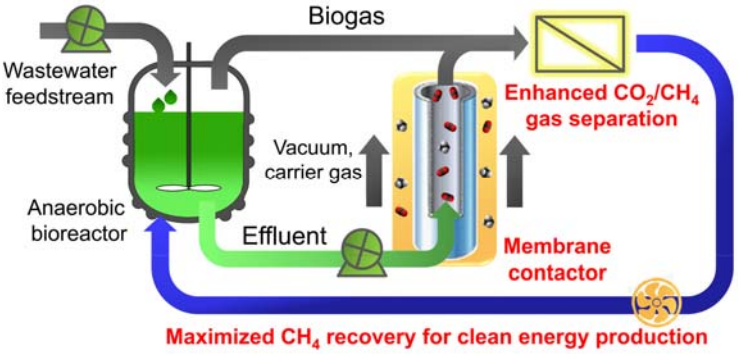
Introduction



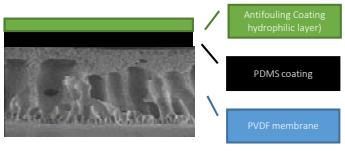
Carefully designed membranes are fabricated to recover methane (CH_4) from two sources in an anaerobic bioreactor. Strategically, our focus is primarily targeted on the CH_4 recovery from the anaerobic effluent, which can capture a maximum of 45% of the CH_4 produced. Besides, efforts are made to enhance the CO_2/CH_4 separation performances of the membranes.

Our approach

Anaerobic digestion is a widely employed process for sewage and domestic wastewater treatment. Among the products generated, CH_4 gas is a renewable energy source which can be recycled to offer an eco-friendly and energy self-sufficient wastewater treatment. To realize this goal, maximizing CH_4 recovery from anaerobic bioreactors is of paramount importance.

Results & discussion

Membrane contactor (MC)



An anti-fouling and -wetting membrane was fabricated to achieve outstanding performance in long-term operations of dissolved CH_4 recovery from discharged effluents. The membrane was made of high porosity polyvinylidene difluoride (PVDF) substrate coated with a polydimethyl-siloxane (PDMS) and anti-fouling additives outer layer.

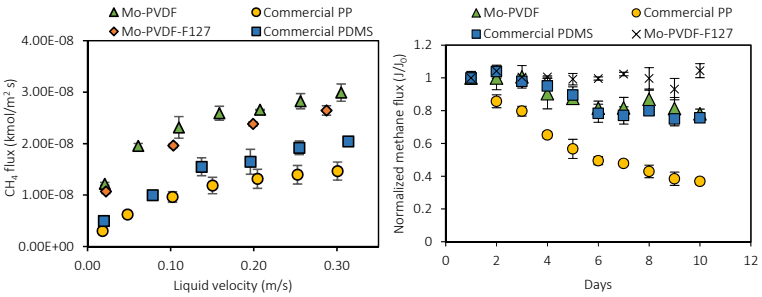


Fig. 1. CH_4 desorption fluxes and long-term performance.

From Fig. 1, CH_4 flux tends to decrease with length of operation due to fouling from the anaerobic UASB effluent. Our PDMS modified PVDF (Mo-PVDF) membrane demonstrated the highest CH_4 flux but the Pluronic-F127 incorporated PDMS modified PVDF (Mo-PVDF-F127) membrane gave the most stable methane flux over a 10 day period, suggesting the effectiveness of our strategy.

Enhancing CO_2/CH_4 gas separation

Emerging materials with two-dimensional structures, micro- and meso-porosities are undertaken for flat sheet mixed-matrix (MM) membranes. These include graphene oxide (GO) nanosheets and metal-organic frameworks. Enhanced CO_2/CH_4 gas separation performances exceeding the Robeson upper bound were achieved with these materials as fillers.

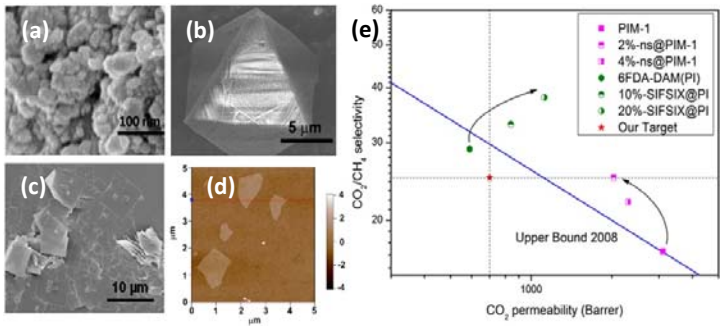


Fig.2: FE-SEM images of (a) SIFSIX, (b) HKUST-1, (c) CuBDC, (d) GO nanosheets and (e) the demonstrated CO_2/CH_4 gas separation membrane performances.

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