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Novel Staged Anaerobic Fluidized Bed Ceramic Membrane Bioreactor: Energy Reduction, Fouling Control and Microbial Characterization

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Abstract

Aluminum dioxide (Al_2O_3) flat-tubular ceramic membrane was applied in a novel staged anaerobic fluidized bed ceramic membrane bioreactor (SAF-CMBR) for low-strength wastewater treatment. Granular activated carbon (GAC) particles were fluidized by bulk recirculation through the membrane reactor to control membrane fouling without any biogas sparging. The SAF-CMBR was operated for 350 days at 25 ^oC with total hydraulic retention time (HRT) between 1.3 and 2.1 h. A net permeate flux of 22 $L/m^2.h$ was achieved during the reactor operation combined with periodic maintenance cleaning using 25 mg/L of sodium hypochlorite solution under GAC fluidization. The overall chemical oxygen demand (COD) removal efficiency was 93 %; with average SCOD was less than 30 mg/L in membrane permeate. Energy requirement to operate the SAF-CMBR was 0.024 kWh/m^3 and it was only 10 % of the electrical energy converted from methane produced by the reactor. Biosolids production averaged 0.01 g volatile suspended solids per g COD removed. With SAF-CMBR, microbial classification revealed that anaerobic treatment was achieved mainly by microbial communities grown on the GAC particles fluidized in which propionate-degrading syntrophs, aceticlastic/DIET-dependent CO_2 reduction methanogens *Methanothrix* and exoelectrogenic *Geobacter* are dominated.

Keywords: Ceramic membrane, Energy recovery, Granular activated carbon, Domestic wastewater, Anaerobic fluidized membrane bioreactor