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Anaerobic membrane bioreactor: A waste-to-energy solution in a zero liquid discharge system

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Introduction: The depletion of freshwater resources has spurred conscious awareness among citizens to conserve water and develop cost-effective strategies for water treatment and recycle. The zero-liquid discharge (ZLD) is a specially designed system for industries to restrict liquid waste discharge and maximise water-reusability. Conventional ZLD systems employ multiple sequential unit operations such as chemical precipitation, activated carbon adsorption, micro-filtration, reverse osmosis and multi-effect evaporators to achieve reusable-quality water (1). These energy-intensive processes contribute to high capital and operational costs. The anaerobic membrane bioreactor (AnMBR) combines anaerobic treatment with membrane technology to effectively remove organic pollutants while producing solids-free effluent (2). The objective of the present study was to demonstrate the capacity of AnMBR to effectuate wastewater treatment in a single stage with notable efficiency thereby eliminating multiple unit processes. The AnMBR was employed for the treatment of raw potato processing effluent.

Methods: The Chemical Oxygen Demand (COD) and 5-day Biological Oxygen Demand values in potato chips processing effluent ranged between 3 – 9 g/L and 0.9 – 5.4 g/L respectively. The average suspended solids concentration was 10 g/L and the feed pH was between 6 – 7. The reactor was operated at mesophilic conditions and the pH was maintained between 7 – 7.5. Tubular polyvinylidene fluoride membrane with polypropylene as support material was integrated to the bioreactor for solid-liquid separation. The feed, reactor and permeate samples were analysed daily for pH, COD, suspended and dissolved solids. The BOD_5, volatile fatty acid and alkalinity were estimated weekly. All the analytical methods were performed following the procedure described in standard methods for the examination of water and wastewater

Results & Discussions: The high solids handling capacity of AnMBR facilitated direct feeding of raw wastewater without prior treatment. The maximum degradation efficiency of 93% was achieved during the operation and the F/M ratio was recurrent at 0.48 during the process. The biogas production increased as COD removal efficiency improved in the system and a maximum biogas yield of 0.414 $L/gCOD_{added}$ was obtained. Clear and non-turbid permeate was obtained and the suspended solids in permeate was consistently below 5 ppm despite an increase in mixed liquor suspended solids in the reactor.

Conclusions: The AnMBR was capable of handling untreated and raw wastewater because of its ability to withstand high solids and organic concentration. The reactor functioning was unaffected by changes in organic load as stable methanogenic population developed in the reactor and generated favourable biogas yield from high OLR. The membrane filtration yielded clear and solids-free permeate. The competency of AnMBR performance serves as a compendious solution to pollutant degradation and the consistent output in terms of suspended and dissolved solids makes this technology a cost-effective approach in ZLD operation.

Keywords: *Anaerobic membrane bioreactor, energy-neutral process, reverse osmosis, zero liquid discharge*

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