Thermophilic Anaerobic Granular Membrane Distillation Bioreactor for Wastewater Reuse

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Abstract : Membrane distillation (MD) is actually claimed to be a cost-effective separation process when waste heat, alternative energy sources, or wastewater are used. To the best of our knowledge, this is the first study that a thermophilic anaerobic granular bioreactor is integrated with membrane distillation (ThAnMDB) was investigated. In this study, the laboratory scale anaerobic bioreactor (1.2 litter) was set-up. The bioreactor was maintained at temperature $55 \pm 2°C$, hydraulic retention time = 0.5 days, organic loading rates of 7 and 10 kg chemical oxygen demand (COD) m^3/day. Side-stream direct contact membrane distillation with the polytetrafluoroethylene membrane area was 150 cm^2. The temperature of the distillate was kept at 25°C. Results show that distillate flux was 19.6 LMH (Liters per square meter per hour) on the first day and gradually decreased to 6.9 LMH after 10 days, and the membrane was not wet. Notably, by directly using the heat from the thermophilic anaerobic for MD separation process, all distilled water from wastewater was reuse as fresh water (electrical conductivity < 120 µs/cm). The ThAnMDB system showed its high pollutant removal performance: chemical oxygen demand (COD) from 99.6 to 99.9%, NH_4^+ from 60 to 95%, and PO_4^{3-} complete removal. In addition, methane yield was from 0.28 to 0.34 lit CH_4/gram COD removal (80 – 97% of the theoretical) demonstrated that the ThAnMDB system was quite stable. The achievement of the ThAnMDB is not only in removing pollutants and reusing wastewater but also in absolutely unnecessarily adding alkaline to the anaerobic bioreactor system.

Keywords : high rate anaerobic digestion, membrane distillation, thermophilic anaerobic, wastewater reuse
Conference Title : ICBEEE 2019 : International Conference on Biotechnology, Energy and Environmental Engineering
Conference Location : Singapore, Singapore
Conference Dates : September 10-11, 2019