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Possibility of Membrane Filtration to Treatment of Effluent from Digestate

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Abstract : The problem with digestate management is one of the most important factors influencing on the development and operation of biogas plant. Turbidity and bacterial contamination negatively affect the growth of algae, which can limit the use of the effluent in the production of algae biomass on a large scale. These problems can be overcome by cultivating of algae species resistant to environmental factors, such as Chlorella sp., Scenedesmus sp., or reducing load of organic compounds to prevent bacterial contamination. The effluent requires dilution and/or purification. One of the methods of effluent treatment is the use of a membrane technology such as microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO), depending on the membrane pore size and the cut off point. Membranes are a physical barrier to solids and particles larger than the size of the pores. MF membranes have the largest pores and are used to remove turbidity, suspensions, bacteria and some viruses. UF membranes remove also color, odor and organic compounds with high molecular weight. In treatment of wastewater or other waste streams, MF and UF can provide a sufficient degree of purification. NF membranes are used to remove natural organic matter from waters, water disinfection products and sulfates. RO membranes are applied to remove monovalent ions such as Na^+ or K^+. The effluent was used in UF for medium to cultivation of two microalgae: Chlorella sp. and Phaeodactylum tricornutum. Growth rates of Chlorella sp. and P. tricornutum were similar: 0.216 d^{-1} and 0.200 d^{-1} (Chlorella sp.); 0.128 d^{-1} and 0.126 d^{-1} (P. tricornutum), on synthetic medium and permeate from UF, respectively. The final biomass composition was also similar, regardless of the medium. Removal of nitrogen was 92% and 71% by Chlorella sp. and P. tricornutum, respectively. The fermentation effluents after UF and dilution were also used for cultivation of algae Scenedesmus sp. that is resistant to environmental conditions. The authors recommended the development of biorafinery based on the production of algae for the biogas production. There are examples of using a multi-stage membrane system to purify the liquid fraction from digestate. After the initial UF, RO is used to remove ammonium nitrogen and COD. To obtain a permeate with a concentration of ammonium nitrogen allowing to discharge it into the environment, it was necessary to apply three-stage RO. The composition of the permeate after two-stage RO was: COD 50–60 mg/dm³, dry solids 0 mg/dm³, ammonium nitrogen 300–320 mg/dm³, total nitrogen 320–340 mg/dm³, total phosphorus 53 mg/dm³. However compostion of permeate after three-stage RO was: COD < 5 mg/dm³, dry solids 0 mg/dm³, ammonium nitrogen 0 mg/dm³, total nitrogen 3.5 mg/dm³, total phosphorus < 0,05 mg/dm³. Last stage of RO might be replaced by ion exchange process. The negative aspect of membrane filtration systems is the fact that the permeate is about 50% of the introduced volume, the remainder is the retentate. The management of a retentate might involve recirculation to a biogas plant.

Keywords : digestate, membrane filtration, microalgae cultivation, Chlorella sp.
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