Combined production of biogas and volatile fatty acids from a pure primary sludge: preliminary results of a pilot test

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The management of sewage sludge originated from municipal wastewater treatment plants (WWTPs) is an actual and urgent issue. Sewage sludge is the solid, semisolid, or slurry residual material that includes both primary and secondary sludge. The annual sewage sludge production into the EU-28 in 2017 was in the order of 9.0–9.5 million tons of dry substance.

Anaerobic digestion (AD) remains the preferred route for stabilization and valorization of sewage sludge. The studies carried out in the last ten years have focused, alternatively, on the two main products that can be obtained from AD, namely biogas and volatile fatty acids (VFAs). VFAs are intermediates of anaerobic digestion with high value and wide range of applications, such as in the production of bio-energy and the biological removal of nutrients from wastewater as carbon source. The production of VFAs from the fermentation of sewage sludge can be boosted by co-digestion processes, where sewage sludge is mixed with organic waste (Owusu-Agyeman et al., 2020), or by putting an alkali pre-treatment before the fermentative reactor (Liu et al., 2018). In the studies involving a mixture of primary and biological sludge or pure primary sludge, the main focus was the production of VFAs, with the utilization of fermenters with hydraulic retention times (HRTs) in the order of 10-12 days. The aim of this study is to find the optimal operating condition to maximize the production of both VFAs and methane.

We used the possibility of separating the phases of an AD process in two reactors to dedicate one of them to the production of VFAs (fermenter) and the other to complete the AD process with the production of a methane-rich biogas (two-stage system). The experimentation was carried out at a pilot scale, by using a series of two 10-L reactors. The HRTs of the fermenter and of the main digester were of 2 and 20 days, respectively. The biogas produced in the two reactors was monitored every day, the partial and final digestate was characterized (total solids, volatile solids, ratio between total acidity and alkalinity, VFAs content) every two days. The performances of the two-stage system in biogas production was compared with that of a conventional mesophilic reactor. The outcomes of the study, in terms of both VFAs and biogas production, are very encouraging and comparable to those obtained in studies that made use of co-digestion or alkali pre-treatment.

References

Liu H., Han P., Liu H., Zhou G., Fu B., Zheng Z., 2018. Full-scale production of VFAs from sewage sludge by anaerobic alkaline fermentation to improve biological nutrients removal in domestic wastewater, Bioresource Technology 260, 105–114, https://doi.org/10.1016/j.biortech.2018.03.105

Owusu-Agyeman I.,Plaza E., Cetecioglu Z., 2020. Production of volatile fatty acids through co-digestion of sewage sludge and external organic waste: Effect of substrate proportions and long-term operation, Waste Management 112, 30–39, https://doi.org/10.1016/j.wasman.2020.05.027