pH control in anaerobic bioreactors using fly-ash based geopolymers as buffer material

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1. Introduction – In anaerobic digestion (AD) processes of organic wastes to their energetic valorization into methane, pH is one of the parameters that greatly influences the performance, affecting both chemical reactions and microbial activity. Therefore, it is essential to promote pH control to ensure anaerobic process stability, especially when dealing with easily biodegradable substrates [1]. Currently, the most used method to control pH is the addition of chemical compounds, to prevent process inhibition [2]. A new approach is the use of fly ash containing geopolymers spheres (GS), which have the ability to promote pH regulation over time, through continuous OH- leaching [3]. Hence, the present work had as main objective the study of the long-term use of GS for pH control in anaerobic processes for methane production, treating easily biodegradable and acidifiable substrates.

2. Experimental – It was performed a study in two parts, using 1L batch reactors and cheese whey as substrate at high loads applied to intentionally worsen the AD process to promote acidification conditions. The first study was performed to optimize the concentration and level of porosity of the GS to achieve a higher methane production. After this selection, the second study had successive additions of substrate to evaluate the long-term GS performance. During both studies, pH, chemical oxygen demand (COD), volatile fatty acids (VFA) and biogas were monitored.

3. Results and Discussion – In the first study, where different porosities and concentrations of GS were used, it was observed a similar pH evolution in all reactors, reaching favorable values for methane production (range between 6.5 and 7.2). The reactor with the highest addition (16 g/L) of GS with higher porosity (HPGS) produced the highest methane volume, contrary to the reactor with lowest addition (12 g/L) of GS with lower porosity (LPGS). Thus, considering the results from this study, the use of HPGS at the highest concentration tested (16 g/L) were the conditions selected for the second part of the experimental work. In this second study, with four additions of substrate at high loads, it was observed a lower decrease in pH values after each AD cycle, suggesting a good adaptation of the microbial culture for methane production. In addition, the time needed to remove most of the organic matter between substrate additions also decreased, presenting organic matter removals of about 90%. Moreover, the VFA were rapidly consumed after their formation, which corroborates the increased recovery capacity of the system. These results confirmed that it is possible to control the pH for methane production in AD processes using GS containing fly ash. Additionally, using these sustainable waste-based materials instead of commercial alkaline materials result in environmental sustainability.

4. Conclusions – This work demonstrated the usefulness of GS addition in AD processes. Besides, it brings new insights to the current problems associated with pH control in AD and contributes to the valorization of fly ash residues, decreasing the needs for its landfill disposal and the associated environmental problems.

5. References

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