CODIGESTION OF THE LIQUID FRACTION OF FOOD WASTE WITH WASTE ACTIVATED SLUDGE

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1. Keywords

Anaerobic Digestion, CSTR, Biofuels, Food Waste, Biogas

2. Highlights

- Suitable mixing of different waste streams to achieve high performing Anaerobic Digestion.
- CSTR achieves >90% COD removal for mixed feed of wastes.
- Biogas productivity >20L/d, with a methane content of up to 80%.

3. Purpose

Anaerobic Digestion (A.D.) is the biological process during which complex organic compounds of wastes are decomposed in the absence of oxygen, by anaerobic microorganisms. Through the intricate sequence of actions of these microorganisms (disintegration, hydrolysis, acidogenesis, acetogenesis, methanogenesis), the organic substrates are converted into renewable energy, in the form of biogas, while the residue meets the specifications for disposal in the soil or conversion into useful by-products [1]. This study aims to suggest a novel approach for simultaneous treatment of municipal waste sludge and the liquid fraction of food waste, in order to render the A.D. process more stable, increase the biogas yield and treat the mixed waste stream more effectively.

4. Materials and methods

Anaerobic Sludge obtained from the Municipal Wastewater Treatment Plant of Attica, Greece was used as inoculum for the A.D. reactor during start-up. The substrates to be co-digested were Waste Activated Sludge (W.A.S.), obtained from the same treatment plant, and the liquid fraction of household food waste. The food waste undergoes a rapid shredding, drying and condensation process and the liquid fraction (condensate), rich in organic load, is mixed with W.A.S. and used as substrate to be fed in the bioreactor. The digestion process of the mixed substrates takes place in a 100 L anaerobic bioreactor in continuous operation mode. The CSTR is kept at a constant hydraulic retention time (HRT) of 20 days, constant temperature at mesophilic conditions of 35^{o}C and is monitored through frequent observation of various measurements according to Standard Methods. The Analytical methods used for characterizing the mixed feedstock and digested outlet of the bioreactor include pH, alkalinity, solids, total and soluble Chemical Oxygen Demand (COD) measurements, Total Organic Carbon (TOC) and Total Nitrogen (TN), dissolved and Total Kjeldahl Nitrogen (TKN), Volatile Fatty Acids and alcohols [2]. The biogas production is measured through an oil displacement technique and the methane content is quantified using a GC-TCD.

5. Results and discussion

Condensate samples are extracted every hour of the pretreatment process in order to analyse the temporal distribution of the waste characteristics. Figure 1a depicts the tCOD of condensate extracted in relation to its moisture content, while Figure 1b shows the TOC and TN of the samples. These results are utilized for the determination of the mixed feedstock characteristics. During start-up, the inoculum

included a mixture of Anaerobic Sludge, W.A.S. and Condensate in ratios 1:17:2 respectively, based on previous studies [3].

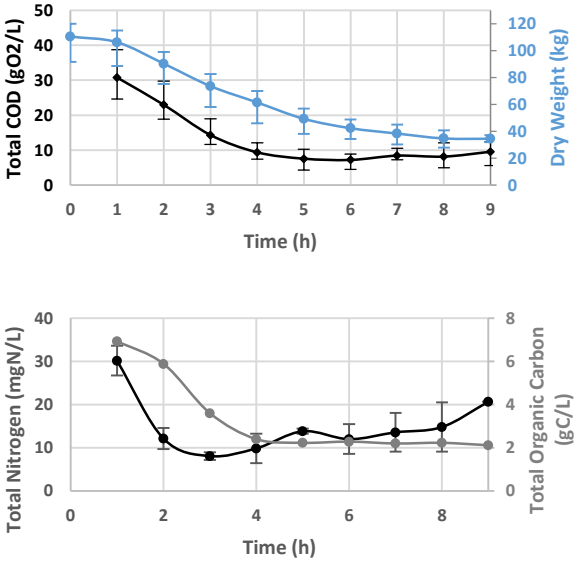

Figure 1: The condensate effluent characteristics versus time showing a) its dry weight (right y-axis) and tCOD (left y-axis) content and b) its TOC (right y-axis) and TN (left y-axis) load.

Following the start-up in batch mode, the bioreactor was shifted to continuous mode. The influent was maintained constant at 5 L of mixed W.A.S. and condensate in 2:1 ratio, based on the annual global Municipal Solid Waste generation rate [4]. Figure 2 shows the continuous operation sCOD at the inlet and outlet of the bioreactor, indicating that the organic matter COD removal exceeds 90% .

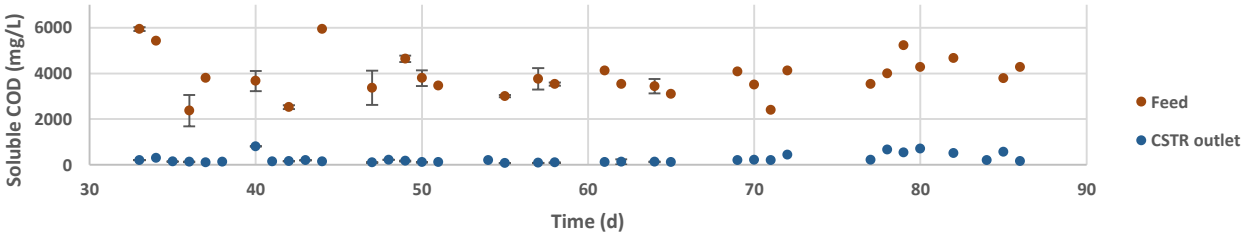

Figure 2: The sCOD of the CSTR inlet and outlet versus operation time.

As a result of the digestion of the mixed feed, biogas is produced. Figure 3 depicts the total biogas productivity, as well as its methane content.

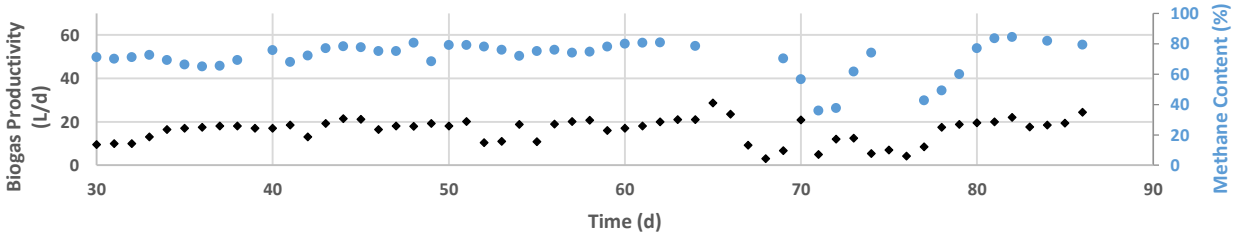

Figure 3: The CSTR daily biogas productivity (left y-axis) and its methane content (right y-axis) versus operation time.

6. Conclusions and perspectives

Most of the organic matter of the mixed feed is digested. The COD removal was over 90%. The steady state operation yielded over 20L biogas per day with a methane content of 80%. Future perspectives include the optimization of the CSTR operation, in terms of Organic Loading Rate, search for optimal C:N ratio for digestion of the mixed feedstock, HRT, biogas productivity and methane content within the biogas. In addition, supplementary BioMethane Potential measurements will be performed in smaller scale bioreactors for optimization of the abovementioned parameters.

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8. References

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