Energy valorisation of Polyethylene Glycol (PEG) rich industrial wastewater by OFMSW anaerobic co-digestion

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Abstract

Anaerobic Codigestion (AcoD) of OFMSW from an industrial AD plant of Barcelona (Spain) and a PEG rich industrial wastewater from pharmaceutical industry located in the same area was studied in this paper. Two lab-scale anaerobic digesters treating OFMSW were operated at mesophilic conditions and an HRT of 20 days. When the Specific Methane Production (SMP) of both digesters were nearly the same, AcoD was implemmented in one of them until reaching an OLR increased by 29% (on VS basis). Under these conditions, AcoD stable operation leads to an increase of the SMP by 50% without affecting the digestate quality.

Keywords: Anaerobic co-digestion, Biogas, Industrial wastewater, OFMSW, Polyethylene Glycol.

INTRODUCTION

Polyethylene glycol (PEG) has many applications, from industrial manufacturing to medicine production, and can be found in some industrial wastewaters. Some studies have showed that PEG can be anaerobically metabolized in order to recover energy in the form of biogas [1]. Biomethanisation of pure PEG could be limited by the lack of nutrients, negligible alkalinity, and the generation of large amounts of Volatile Fatty Acids (VFA), mainly acetic acid, by substrate degradation. Anaerobic Co-Digestion (AcoD), which is the simultaneous digestion of two or more substrates, is a feasible option to overcome the drawbacks of mono-digestion of PEG and to improve plants economic feasibility [2]. Therefore, PEG could be co-digested with other substrates, such as Organic Fraction of Municipal Solid Waste (OFMSW), in order to create a synergistic effect to overcome the limitations of its mono-digestion. This paper is focused on the study of AcoD of OFMSW treated in an industrial AD plant of Barcelona (Spain) and a PEG rich industrial wastewater from pharmaceutical industry located in the same area.

MATERIALS AND METHODS

Two jacketed mechanical stirred AD lab-scale reactors (4 L) were operated at an Hydraulic Retention Time (HRT) of 20 d under mesophilic conditions (35±0.1 ºC) in order to simulate the industrial plant operation. Both reactors were equipped with a biogas counter (gas tip meters) and a thermostatic bath. At the first stage, both reactors (A and B) were daily fed with real OFMSW, which was collected twice a week from an AD treatment plant. When both reactors reached the Specific Methane Production (SMP) reported at the industrial plant of Barcelona (Spain), AcoD with PEG wastewater was implemented in reactor B. For the co-substrates mixture, the percentage of PEG wastewater was increased gradually, until a maximum percentage of 3.5% on volume basis. This was the maximum percentage tested since it represents the real treatment requirements of the PEG wastewater generating industry. All the analyses of the substrates and effluents from the digesters were performed according to the Standard Methods.

RESULTS

Figure 1 shows the Organic Loading Rate (OLR) applied and the results of SMP for the period of OFMSW mono-digestion and co-digestion with PEG rich wastewater in reactors A and B. On the first stage, simulating the real industrial OFMSW AD process, the production was similar between both reactors, with an average SMP of 0.29 and 0.31 $m^3CH_4 \cdot (kg\ VS \cdot day)^{-1}$, for reactor B and A, respectively. In the second stage, as a consequence of AcoD implementation, SMP clearly increased in reactor B reaching 0.44 $m^3CH_4 \cdot (kg\ VS \cdot day)^{-1}$, in front of 0.30 $m^3CH_4 \cdot (kg\ VS \cdot day)^{-1}$ of the AD control reactor. It represents an increase of 50% in relative production, with just a 29% increase of the OLR. At the same time, reactor B showed stability throughout the AcoD implementation. The VFA generation did not influence the pH stability due to high system alkalinity (over 5g $CaCO_3$/L) and the nutrients content of the OFMSW compensated its deficit on the PEG rich wastewater. The fast degradation of the PEG implied that effluent quality was nearly the same of AD process, with neither increase of VS nor significant variations in nutrients and heavy metals content.

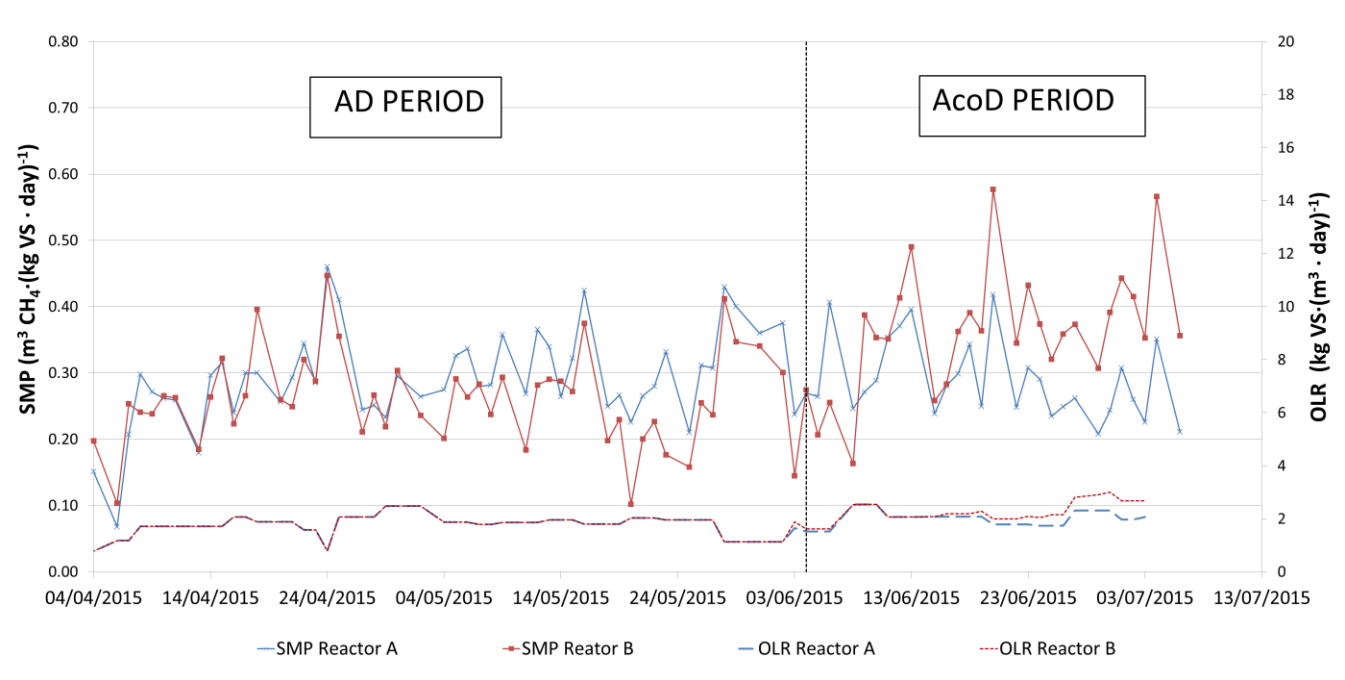

Figure 1 –SMP and applied OLR in reactors A and B in the periods of anaerobic mono-digestion of OFMSW and co-digestion of OFMSW and PEG rich wastewater.

CONCLUSIONS

AcoD of OFMSW and a PEG-rich industrial wastewater as co-substrate has been assessed as a feasible alternative to improve biogas production in AD of OFMSW without affecting the reactor stability. When the OLR was increased by 29% (on VS basis) due to co-substrate addition, an increase of the SMP by 50% was registered without affecting the digestate quality.

REFERENCES

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