

Enhancement of methane production by applying electrolysis pretreatment in anaerobic digestion of OFMSW

Y. Kabakci^{1,2}, O. Dogan², F.G. Uctug³, O.A. Arıkan¹

¹Department of Environmental Engineering, Istanbul Technical University, Istanbul, Ayazaga, 34467, Türkiye

²Department of Climate Change and Sustainability, TUBITAK Marmara Research Center, Kocaeli, Gebze, 41400, Türkiye

³Department of Mechanical Engineering, Izmir University of Economy, Izmir, Balçova, 35330, Türkiye

Keywords: OFMSW; electrolysis; pretreatment; methane production; anaerobic digestion

Presenting author email: yagmurkabakci@outlook.com

Introduction

Biomass resources are essential renewable and carbon-neutral energy sources. Since organic fraction of municipal solid waste (OFMSW) is high in content, doubtfully it is preferable to use this waste as biomass source within the scope of 'waste-to-energy'. Due to collection procedure applied to OFMSW, end product is heterogenous, and it is not preferable to send the waste directly to processing because of its heterogeneity. For this reason, OFMSW is subjected to the mechanical separation, however there are still remaining impurities in the waste that extends the biodegradation process. Pretreatment is needed before applying anaerobic digestion (AD), at the stage of hydrolysis which is limiting step for the AD process. Pretreatment is often required during the hydrolysis phase to reduce the existing lignocellulosic structural barrier of the OFMSW and enables faster microbial breakdown.

For this reason, pretreatment application to support anaerobic degradation are critical and suggested in many studies. Within the scope of pretreatment methods, there are physical, chemical, biological and hybrid studies. Higher liquefaction and delignification of the lignocellulose substance can be achieved by electrolysis pretreatment, and resulted in an increase of biogas production during anaerobic digestion (Zheng et al., 2014). Veluchamy and Kalamdhad (2017) showed that pretreatment is necessary for pulp and paper mill sludge to accelerate the rate of limiting hydrolysis step.

The aim of this study was to investigate the effect of electrolysis pretreatment method on methane production during anaerobic degradation of OFMSW by assessing the methane yield.

Materials and Methods

OFMSW, substrate, was taken from a full scale mechanical biological treatment (MBT) plant with 300 ton/day of capacity. OFMSW samples were collected from the inlet stream of anaerobic digester.

Electrolysis of 20 V was performed for 30- and 60-minutes during pretreatment of the OFMSW. A 1 liter of custom-made reactor was used for the electrolysis pretreatment as experimental setup which is shown in Figure 1.

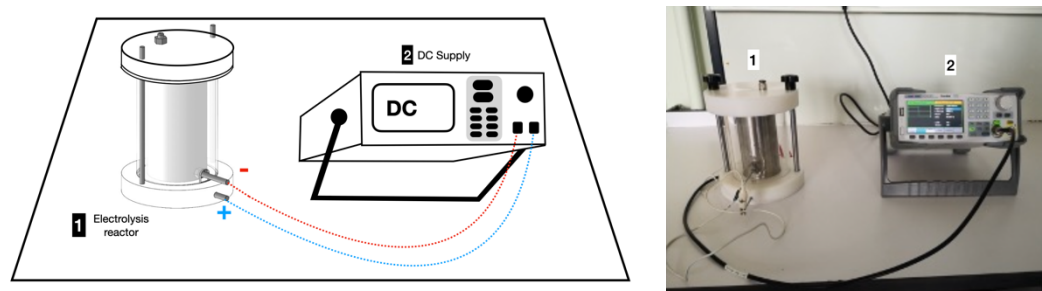


Figure 1 Electrolysis pretreatment experimental setup

pH, total solids (TS), volatile solids (VS), and conductivity experiments were carried out in accordance with the APHA standard methods (APHA, 2017) to show the physicochemical properties of OFMSW. All relevant tests were conducted with fresh samples (Table 1). BMP experiments were carried out with an automated device (ECHO ER12_D6691, Echo Instruments Slovenia EU) at 55°C and were conducted twice to show repeatability. Due to the inoculum substrate compatibility, inoculum was collected from the same plant with the OFMSW. A positive control test was applied with microcrystalline cellulose (from Sigma Aldrich CAS 9004-34-6) at the beginning of the study to validate the inoculum activity.

Table 1. Physicochemical characteristics of OFMSW

Parameter	Unit	OFMSW (Average \pm Standard Deviation)
pH	-	6.63 \pm 0.09
Total Solids	%	44.77 \pm 1.75
Volatile Solids	%	37.83 \pm 1.39
VS/TS	-	84.56 \pm 2.54
Conductivity	mS/cm	6.70 \pm 0.42

Results and Discussions

The cumulative amounts of biogas produced during the 30 days of incubation period of OFMSW, which were pretreated by electrolysis for 30 and 60 min, were given in Figure 2. The cumulative biogas production from the reactors, which were pretreated with electrolysis for 30 and 60 minutes in the batch system, was 248.16 mL CH₄/g VS_{added} and 231.23 mL CH₄/g VS_{added}, respectively. Both electrolysis times had a positive effect on the cumulative biogas production compared to the control. Cumulative methane production was increased as 2.7% for 30 min and 10.2% for 60 min compared to control sample. The overall methane content was 42.8% and 45.9% for 30 minutes and 60 minutes of pretreatment, respectively. While for the control sample methane content was determined as 41.1%.

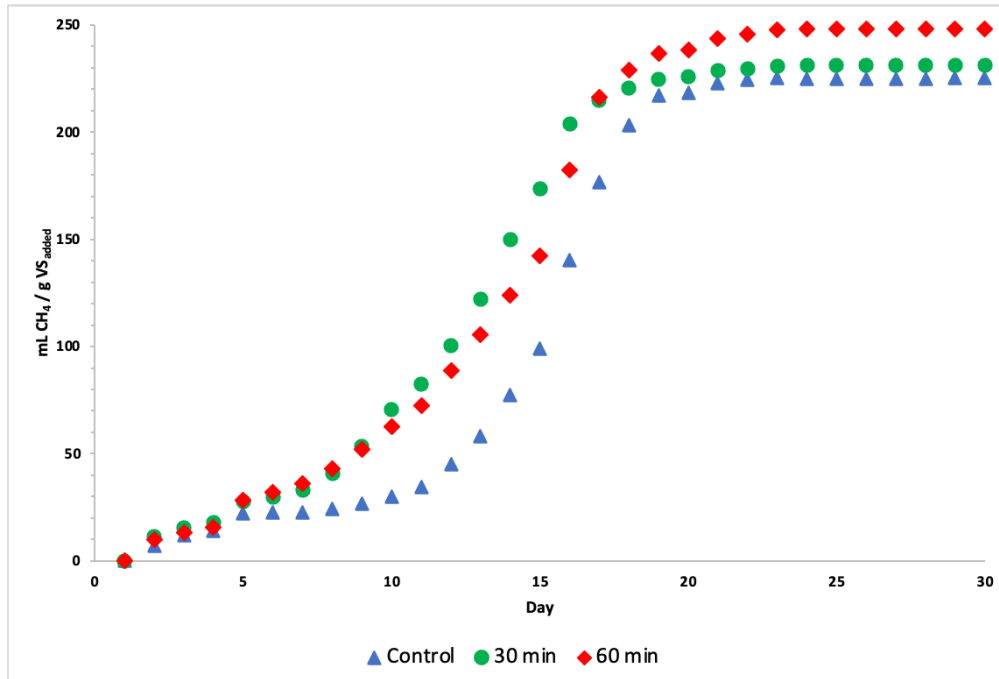


Figure 2 Cumulative methane production of OFMSW, pretreated with 30-minute and 60-minute electrolysis versus control

Conclusion

Impact of electrolysis pretreatment on OFMSW by anaerobic digestion was presented in this study. Methane yield was improved as 10.2% in the overall while hydrolysis time was shortened by applying electrolysis pretreatment. It was shown that 60 min of electrolysis was better than 30 min in terms of methane yield from the OFMSW.

References

- Veluchamy, C. and Kalamdhad, A. S., 2017. Biochemical methane potential test for pulp and paper mill sludge with different food/microorganisms ratios and its kinetics. *International Biodeterioration & Biodegradation*, 117, 197-204.
- Zheng, Y., Zhao, J., Xu, F., & Li, Y., 2014. Pretreatment of lignocellulosic biomass for enhanced biogas production. *Progress in energy and combustion science*, 42, 35-53.