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Effect on biogas production due to the presence of six conductive materials

Maurizio Cuomo, Roger König, Annarita De Corso, Alessandro De Carolis, Pamela Principi
University of Applied Sciences and Arts of Southern Switzerland (SUPSI), Switzerland

Abstract

Statement of the problem To overcome the reduced metabolic efficiency of anaerobic pathways, the microorganisms involved in Anaerobic Digestion (AD) cooperate in a mutualistic relationship called syntrophy. A well-known syntrophic process is Direct Interspecies Electron Transfer (DIET), where chemical energy is exchanged among microorganisms through an electron flow in order to improve AD and biogas production compared to a "classic" AD. Several studies (Lin et.al. 2017, Park et.al. 2017) report the advantage of adding graphene or activated carbon to an AD process in small scale tests. The aim of this work was to characterize different conductive materials and quantify their effect on biogas production in medium sized scale tests.

Methodology Six materials (zeolite, graphene, Powdered Activated Carbon (PAC), biochar, carbon nanotubes, carbon fibers) were characterized for conductivity and morphology by Scanning Electron Microscope (SEM) analysis. In a first BioMethane Potential (BMP) test, two concentrations for each material have been tested in 120 ml vials, the most performing conditions were scaled up in 3.5l BMP reactors. Experiments were run at 38° until steady state was reached with daily manometric assessment of biogas production. Tests were set with 1:1 Volatile Solids (VS) based ratio between ethanol as carbon source and inoculum anaerobic sludge from a Continuous Stirred Tank Reactor (CSTR) digester, Chiasso CH WWTP and the chosen conductive material. Kinetic analysis was performed on cumulative biogas production using a modified Gompertz equation (Lay et.al., 1997) to estimate theoretical maximum biogas production, maximum production rate and lag time.

Findings The screening step showed the most promising materials and concentrations: graphene 0.5 g/l, PAC 20 g/l, biochar 10 g/l were therefore tested in 3.5l reactors. Also in this second testing, an increased biogas production compared to their respective control (with no material added) was confirmed. Moreover, the only test with a decreased biogas production was the zeolite one, with a measured conductivity set on zero.

Conclusions and Significance Kinetic analysis by non-linear regression fitting (GraphPad Prism 8, GraphPad software, La Jolla, CA-USA) showed that, compared to the control, the addition of the conductive material tested resulted in an improved biogas production process.

Biography:

Maurizio Cuomo is currently doing PhDr in University of Applied Sciences and Arts of Southern Switzerland.

Recent Publications:

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3. Liu, Fanghua, Amelia-Elena Rotaru, Pravin M. Shrestha, Nikhil S. Malvankar, Kelly P. Nevin, and Derek R. Lovley. 2012. "Promoting Direct Interspecies Electron Transfer with Activated Carbon." Energy & Environmental Science 5 (10): 8982. https://doi.org/10.1039/c2ee22459c.

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5. Yang, Yafei, Yaobin Zhang, Zeyu Li, Zhiqiang Zhao, Xie Quan, and Zisheng Zhao. 2017. "Adding Granular Activated Carbon into Anaerobic Sludge Digestion to Promote Methane Production and Sludge Decomposition." Journal of Cleaner Production.

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