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Ghofrani Isfahani, Parisa; Valverde Pérez, Borja; Alvarado-Morales, Merlin; Mohammadifar, Mohammad Amin; Vossoughi, Manouchehr ; Angelidaki, Irini

Published in:
Sustain Conference 2018

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

Control of anaerobic reactor treating cattle manure for maximal biogas production under dynamic conditions

Parisa Ghofrani Isfahani[1,2], Borja Valverde-Pérez[1], Merlin Alvarado-Morales[1], Mohammad Shahrokhi[2,*], Manouchehr vossoughi [2], Irini Angelidaki[1,*]

[1] Department of Environmental Engineering, Technical University of Denmark, Kgs. Lyngby, DK-2800, Denmark

[2] Department of Chemical and Petroleum Engineering, Sharif University of Technology, Tehran, Iran

*Corresponding authors email: iria@env.dtu.dk, shahrokhi@sharif.edu

Anaerobic digestion (AD) is a friendly environmental technology that relies on metabolic activity of a diverse group of microorganisms for degradation of bio-wastes. Efficient and stable operation of AD process it is feasible only by proper control and monitoring. Recently, several indicators have been used for monitoring, and several control strategies have been proposed to control AD [1]. For systems with high buffer capacity (i.e., treating manure), volatile fatty acids (VFA) concentration is more sensitive and reliable than other parameters (pH, alkalinity, etc.) as an imbalance indicator in AD [2]. The control aim is maximizing methane production and keeping the reactor stable in presence of disturbances (e.g., overloading by addition of glucose).

The experiment was carried out in a 9 L total volume (7.5 L working volume) CSTR at thermophilic conditions (54 ± 1 °C). Control strategy was programmed in LabVIEW2016 software. In order to prevent wash out of microorganisms the minimum hydraulic retention time (HRT) is set at 5 days. The control strategy consists of a supervisory structure where the inner loop is a proportional controller that manipulates the feed flow rate in order to achieve the desired gas flow rate. The outer loop is a supervisory controller that defines the set point for the inner loop according to methane production and VFA content and pH in the digester. The digester was fed only with diluted cattle manure, 2% volatile solids (V.S.), for 39 days (Fig. 1). The feed V.S. content was increased from 2% to 6% by addition of glucose to the feed at 39th day. Methane production increased instantly and VFA accumulated in the reactor due to the acidification as a result of quick glucose fermentation. The controller manipulated the loading rate to set back VFA to the same level as before glucose addition, while methane production was maximized and tracked the set point.

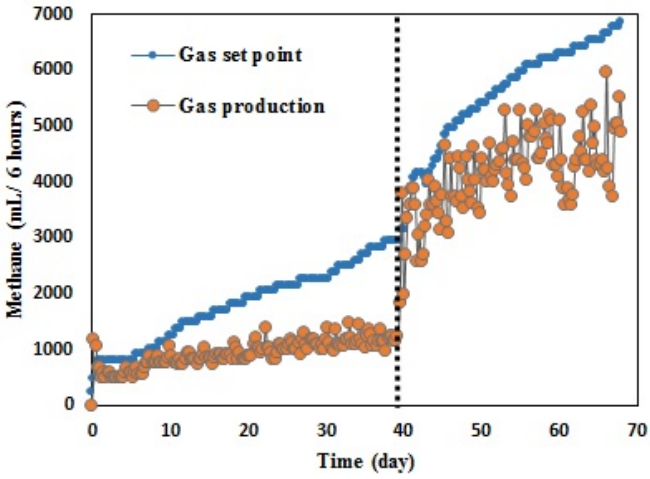

Figure 1. Methane production and set point during reactor operation. Vertical line indicates glucose addition (change from 2 to 6 % V.S.)

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