Biohydrogen from food waste in a discontinuous process: Effect of HRT and microbial community analysis

Iván Moreno-Andrade*, Julián Carrillo-Reyes, Sonia G. Santiago, Martha C. Bujanos-Adame

Laboratory for Research on Advanced Processes for Water Treatment, Unidad Académica Juriquilla, Instituto de Ingeniería, Universidad Nacional Autónoma de México, Blvd. Juriquilla 3001, 76230 Querétaro, Mexico

Abstract

There are several parameters that affect the hydrogen (H₂) production when using organic solid waste in a discontinuous process, such as the hydraulic retention time (HRT). To optimize the process, it is necessary to determine the HRT such that the H₂ production is maximized. The objective of this study is to evaluate the effect of different HRTs on the hydrogen production in an anaerobic sequencing batch reactor (ASBR) using food waste as the substrate. The microbial community was analyzed and correlated with the reactor performance. The results showed that the highest percentage of H₂ in biogas, maximum volumetric H₂ production, and maximum H₂ production rate was obtained with an HRT of 24 h. The percentage of H₂ in biogas varied from 22 to 53%, which depended on the HRT. Acetic acid was the main volatile fatty acid obtained. The highest propionic acid production was observed with an HRT of 6 h, which was related to a decrease in H₂ generation, where a low diversity and low evenness were obtained compared with those of the reactor samples obtained from different HRTs. The genus Megapsphaera was found to be the dominant genus in the microbial community.

Copyright © 2015, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

Introduction

Hydrogen (H₂) is considered to be an energy vector that has a high heating value of 285.8 kJ/mol and a maximum electricity production of 237.2 kJ/mol (produced by a fuel cell) [1]. Hydrogen can be stored as a fuel and used in transportation and distributed heat and power generation using fuel cells, internal combustion engines, or turbines with only water as a subproduct [2]. It is possible to produce H₂ from organic waste, biomass, and/or wastewater through dark fermentation using microorganisms, which has proven to be a relatively simple, inexpensive process [3]. One type of waste that can be used in hydrogen production is the food waste derived from restaurants, food processing industries, etc [4]. This residue represents an environmental problem, particularly in large cities where the typical method of disposal is landfills. Food waste is primarily composed of carbohydrates (abundant amounts cellulose and starch), lipids and proteins; all of these complex polymers are useful for fermentation. Therefore, it is possible

* Corresponding author. Tel.: +52 442 1926171; fax: +52 442 1926185.
E-mail address:imorenoa@ii.unam.mx (I. Moreno-Andrade).
http://dx.doi.org/10.1016/j.ijhydene.2015.04.084
0360-3199/Copyright © 2015, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.