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Start-up and operation of continuous stirred-tank reactor for biohydrogen production from restaurant organic solid waste

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ABSTRACT

The hydrogen production from a variety of substrates, including organic solid waste (OSW), has been studied at different organic loading rate (OLR), finding different behavior on the hydrogen production rate (HPR) that can be related to the particular waste characteristics and particular operational conditions. The objective of this study was to evaluate the start-up and operation of a continuous stirred-tank reactor (CSTR) to generate hydrogen from food waste applying different OLR in order to determine the operational conditions to obtain the maximal HPR. Three OLR, controlled via the influent flow rate, were studied: 19, 38 and 57 $gVS/L_{reactor}/d$. It was found that the OLR has an influence on the hydrogen production in the CSTR. The increase of OLR results in a decrease of COD removal, protein removal, and hydrogen yield (YH_2). The highest HPR (19.8 mmol $H_2/L_{reactor}/d$) and YH_2 (0.6 mmol H_2/gVS) were obtained at the OLR of 37.1 and 19.8 $gVS/L_{reactor}/d$, respectively. The H_2 percentage in biogas had variations between 25 and 55% independently of the OLR. The VS and COD removal efficiencies were 51 ± 9% and 27 ± 9% respectively. Acetic acid was the principal VFA produced during the CSTR operation.

Introduction

Hydrogen (H_2) has been widely recognized as an alternative energy source to substitute fossils fuels. H_2 gas comprises a clean fuel with no carbon dioxide (CO_2) emissions and can easily be used in fuel cells for the generation of electricity [1]. The H_2 has a high energy yield of 122 kJ/g, which is 2.75 times greater than hydrocarbon fuels [1–4]. Among the H_2 production methods, the most promising and eco-friendly approach is dark fermentation from organic solid waste (OSW), especially food waste [2,5].

Dark fermentation is a biological process where a microbial consortium degrades the organic matter at anaerobic condition to produce biogas composed of H_2 and CO_2, and a digestate rich in volatile fatty acids that can be used in other biological processes such as photofermentation. Dark fermentation is a step intermediate in anaerobic digestion, which is performed in four stages: hydrolysis, fermentation, acetogenesis and methanogenesis [1]. H_2 is a key intermediate consumed mainly during the methanogenic stage. For this

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