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Feasibility of Biological Hydrogen Production from Kitchen Waste via Anaerobic Baffled Reactor (ABR)

A. Tawfik [a,b], A. Salem[b], M. El-Qelish[b], Aboubakr M. Abdullah [a], E. Abou Taleb[b]

[a]*Egypt-Japan University for Science and Technology (E-Just); School of Energy and Environmental Engineering; P.O. Box 179 – New Burg El Arab City – Postal Code 21934 - Alexandria – Egypt*

[b]*National Research Center; Water Pollution Research Department, El-Tahrir St., P. Box 12622; Dokki; Cairo, Egypt*

Abstract

Bio-hydrogen production from diluted food waste (FW) via a laboratory-scale five chambered anaerobic baffled reactor (ABR) was investigated at a temperature of 26 °C. The reactor was operated at an HRT of 2.2 and 1.1 d, corresponding to OLR of 31.4 and 60.3 kgCOD/m^3.d. The results obtained indicated that, hydrogen production rates increased from 4.3 to 7.7l/d as the HRT increased from 1.1 to 2.2 d respectively. The calculated hydrogen production potential amounted to 41.2 ml/gVS removed/day at an HRT's of 2.2 d and 35.3 ml/gVS removed/day at an HRT's of 1.1 d. The average H_2 and CO_2 contents were 57 and 43%, respectively. Methane content was not recorded indicating that full acidogenesis process was taken place.

The pH values of the FW were decreased from 6.5 to 5.0 at an HRT of 2.2 and 1.1 d. This mainly can be due to the increase of VFA levels in the treated effluent. At an HRT of 2.2 and 1.1 d, the VFA was increased from 2.4±1.3 g/l to 6±3.4 g/l and from 2.3 ±1.5to 4.9 ±4.7g/l respectively. The accumulation of VFA can be due to the conversion of $COD_{particulate}$. Moreover, decreasing the HRT from 2.2 to 1.1 d negatively affecting on the performance of the reactor for removal of COD fractions, BOD_5 fractions, TS, VS, oil and grease. Therefore, it is recommended to operate such a system at an HRT of 2.2 d and a temperature of 26 °C for bio-hydrogen production from diluted food waste.

Keywords: *bio-hydrogen; food waste; ABR; VFA, profile*

1. Introduction

The main concern about global climate change is the greenhouse effect caused by excess carbon dioxide in the atmosphere, which relates directly with fossil fuel combustion from coal-fired power plants or automobiles. As a sustainable energy source, hydrogen is a promising alternative to fossil fuels. It is a clean and environmentally friendly fuel, which produces water instead of greenhouse gases when combusted. Furthermore, it has a high energy yield (122 kJ/g), which is about 2.75 times greater than that of hydrocarbon fuels, and could be directly used to produce electricity through fuel cells [1-2]. Hydrogen can be generated in a number of ways, such as electrochemical processes, thermo chemical processes, photochemical processes, photo catalytic processes, or photo electrochemical processes, [3-4] . However, these processes do not accomplish the dual goals of waste reduction and energy production. Furthermore, these methods require electricity derived from fossil fuel combustion. For global environmental considerations, bio-hydrogen production from renewable organic waste sources represents an important area of bio-energy production [5]. Many studies have reported on the ground work for creating renewable bio-hydrogen production systems through either photosynthesis [6-9] or fermentation [1—11]. Hydrogen production by fermentative bacteria is technically simpler than by photosynthetic bacteria. Also, the fermentation process generates hydrogen from carbohydrates obtained as refuse or waste products [12].

As a major burden to the environment, the generation of food waste (FW) is approximately 60% of the household garbage in Egypt. Landfill and incineration are the most common methods for FW management, in Egypt however, disposal of FW by landfill occupies large-scale areas and incineration of wet FW consumes a lot of energy. Moreover, FW is the main source of decay, odor and leachate in collection and transportation due to its high volatile solids (VS) (85–95%) and moisture content (75–85%). However, as food waste has a high energy content, energy generation while reducing the waste seems ideal. Hydrogen recovery from food waste also has a potential to

[*] Corresponding author. Tel.: +2-0106165176
Fax: +2-03-4599520 E-mail: tawfik8@hotmail.com

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