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Long-term monodigestion of crude glycerol in a UASB reactor

Miroslav Hutňan *, Nina Kolesárová, Igor Bodík, Marianna Czölderová

Institute of Chemical and Environmental Engineering, Faculty of Chemical and Food Technology, Slovak University of Technology, Radlinského 9, 812 37 Bratislava, Slovak Republic

HIGHLIGHTS

- Anaerobic processing of crude glycerol in UASB reactor was monitored.
- Long-term anaerobic degradation of g-phase as single substrate is possible.
- Granulated sludge is suitable for inoculation.
- Accumulation of salts have to be considered.

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ABSTRACT

The aim of this study was to discuss the experience from long-term operation of a laboratory UASB reactor inoculated with suspended or granulated biomass for the treatment of different kinds of crude glycerol in undiluted or diluted state. The UASB reactor was operated under mesophilic conditions. It was demonstrated that the anaerobic treatment of crude glycerol as the only substrate in the UASB reactor is feasible, although the specific inhibition effects and requirements resulting from the nature and composition of the g-phase have to be considered. Deficient concentrations of nutrients had to be compensated by their supplementation into the digester. Long-term microbiological treatment of undiluted crude glycerol led to the process inhibition due to the accumulation of dissolved inorganic salts. When dosing diluted g-phase previously treated by acidulation, very good removal efficiency of COD, stable biogas production and high share of methane in the biogas were observed at the organic loading rates of up to 12 kg/(m^3 d).

1. Introduction

Considering the increasing energy consumption and depletion of fossil sources, renewable energy sources have gained increasing attention recently. Implementation of biofuels and renewable energy sources has been generally incorporated in national and international legal standards and government programs of developed countries (Janaun and Ellis, 2010).

Biodiesel is a prominent candidate as alternative diesel fuel. It is a liquid fuel based on methyl esters of long chain fatty acids and it is usually produced by the process of base-catalyzed transesterification of vegetable oils, animal fats or waste oils with methanol (Leung et al., 2010). Biodiesel offers a few advantages compared to petroleum diesel fuel, including the status of a renewable energy source, lower emissions (lower content of sulfur and aromatic substances) and higher biodegradability. However, sustainable implementation of biodiesel depends on the development of costs on the world market. Utilization of by-products for the production of biogas offers a perspective of further energy generation, which may improve both economic and environmental status of biodiesel itself (Lora et al., 2011; Kolesárová et al., 2011a).

One of the most important by-products generated during biodiesel production is crude glycerol (g-phase). It is a heavier separate liquid phase composed mainly of glycerol. In general, for every 100 kg of biodiesel, about 10 kg of the g-phase are produced. The composition and characteristics of the g-phase depend on the source of oil used for the production of biodiesel and on the processing technology. Crude glycerol generated by the most common homogeneous base-catalyzed transesterification process and separated from biodiesel by settling contains approximately 50–60% of glycerol, 12–16% of alkalies (in the form of alkali soaps and hydroxides), 15–18% of methyl esters, 8–12% of methanol and 2–3% of water (Kocsisová and Cvengros, 2006). A variety of other components, such as calcium, magnesium, phosphorus or sulfur, is also contained in the g-phase (Thompson and He, 2006). In some biodiesel production plants, crude glycerol is treated with strong mineral acids (most usually phosphoric or hydrochloric acid) in the process of acidulation, in which mainly the long-chain fatty acids are removed from crude glycerol and returned into the biodiesel

* Corresponding author. Tel.: +421 259325387; fax: +421 59325792.
E-mail address: miroslav.hutnan@stuba.sk (M. Hutňan).

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