Stability of UASB reactor under shock loads

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ABSTRACT – Anaerobic digestion is a key area in wastewater treatment. Especially in treating high concentration wastewater such as dairy wastewater. It is crucial because dairy waste water can change in COD and BOD values drastically. This work compares the overall performance and biogas production of intermittent UASB reactor treating dairy wastewater and subjected to shock loads. Stable reactor showed a slight increase in methane gas production under applied fat shocks. Moreover, the intermittent systems did not present significant variations on the effluent COD removal efficiency consequent of the fat shock. The shock lasted for two intermittent cycles. Results from the anaerobic reactor which was intermittently operated confirm the effect on reactor performance under fat shocks in detail.

KEYWORDS: UASB; Shock loads; Anaerobic digestion

INTRODUCTION

Waste Management has become a significant issue in today's world. Especially in the industrial sector where large amounts of waste is produced as a byproduct of many industrial processes. Most of the time, this waste is mixed with water and discharged into natural waterways. However, this trend has now become a severe environmental issue, especially in developing countries, where the rules and regulations are not strictly adhered to. According to the estimations, of major industrial parks of Sri Lanka generate around 30 million cubic meters of wastewater per year. The Central Environmental Authority of Sri Lanka has already laid down standards for effluent discharge, which also act as the regulatory body in this regard.

The aerobic treatment of wastewater although widely spread in Sri Lanka, might not be the optimum solution for wastewater treatment. Aerobic treatment requires aeration of the wastewater which would mean high energy consumption.

This is where the anaerobic treatment of wastewater comes in. As the name implies, anaerobic treatment of wastewater does not require air, which means significant reductions in energy consumption is made in treating the wastewater. Up flow Anaerobic Sludge Blanket reactor or the UASB reactor is one such anaerobic digestion reactor which is widely used for water treatment purposes.

METHODOLOGY

A lab scale UASB reactor was fabricated using the most suitable design configuration and it was modified to fit the requirement of the experiment. Organic sludge inoculum was obtained from the UASB reactor at the Ceylon Cold Stores in order to create the sludge bed of the reactor. Synthetic wastewater was developed which mainly corresponds to the dairy wastewater generated at Ceylon Cold Stores. The reactor was fed with the dairy wastewater intermittently where a specified volume of wastewater was provided to the reactor. The response of the reactor was monitored. Afterwards, a continuous feed of wastewater was supplied, and the reactor was allowed to become stabilized.

RESULTS AND DISCUSSION

From the experiments carried out, we were able to identify that the methane production rate and COD removal rate

from the wastewater occurs at a higher efficiency when the reactor is not subjected to any form of shocks.
However, when subjected to fat shocks, the reactor did perform adequately in order to reduce the COD content of the wastewater even though the reduction of it was slightly lower compared with the reactor performance when no shock was applied.

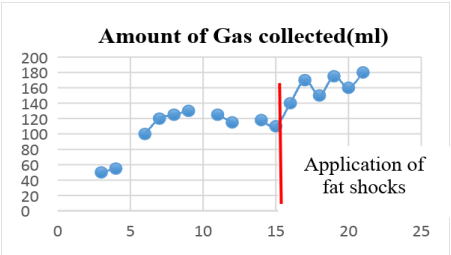

Figure 2: COD Removal

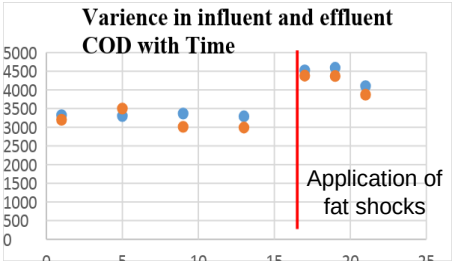

Figure 3: Gas Production

CONCLUSION

In this work, we have analyzed the performance of an intermittent UASB reactor when subjected to a fat shock of two intermittent cycles with a special focus on its effect on the biogas production rate and COD removal. The applied fat shock consisted of a rise in average feed fat content from 5.4 g/L to 9.5 g/L in the intermittent system.

Fats are substrates which have higher biogas production capacity than substrates like protein and hydrocarbons. Theoretically, we can expect that rise in feed fat content should cause a raise in biogas production. However, fat concentrations which are too high results in an opposite outcome. This minimum fat concentration which impedes the production of biogas also called the "inhibition threshold" value.

In this experiment, we avoided the inhibition threshold values which are reported in the literature.

The intermittent systems did not display significant variations on the effluent COD removal efficiency consequent of the fat shock, but the reactor showed a slight increase of methane gas production under shock loads but at a lower efficiency. So we can observe that after the shock period, the intermittent reactors presented a methane production efficiency slightly lower than observed before the shock.

So we can conclude that under fat shocks, a UASB reactor which was operated intermittently can also perform similarly to normal conditions. Moreover, we can observe slightly increased biogas production (If fat shocks do not exceed threshold values).

Effects would have been different if we operated a continuous reactor under similar fat shocks. Both intermittent and continuous operations need to be analyzed under these different types of shocks. By comparing those values we can better understand the stability of UASB reactors under various shock loads and their optimum operating conditions.

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