Effect of biofilm growth in anaerobic reactor treating dairy wastewater

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ABSTRACT – In this study, attention was given to anaerobic digestion of dairy wastewater, which has higher COD levels and a nutritional rich media for microbial growth. Generally, Fixed Bed Biofilm Reactors are significant in treating dairy wastewater due to its capability of retaining microorganisms. This research is being carried out to examine the stability of biofilms under different shock load conditions. Initially, a lab scale reactor was experimented. Next, a pilot scale reactor with packing material was run and variations of the parameters were observed. However, due to several issues, a stable point was not obtained throughout the operation of the pilot scale reactor. Recommendations could be made on studies carried out as further research on biofilm formation, its stability under shock loads and COD reducing efficiency.

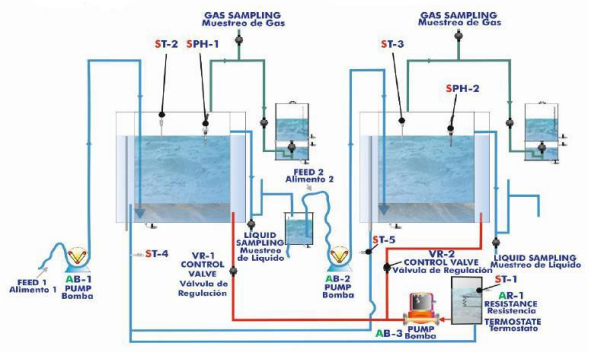

Figure 1 Flow diagram of the PDANC

KEYWORDS: Biofilm stability; Dairy wastewater; FBBR; Anaerobic digestion

INTRODUCTION

This research is mainly based on dairy wastewater which contains huge amounts of carbohydrates, proteins, lipids and other organic matter. The COD and BOD levels of dairy wastewater is very high. With respect to the treatment methods available, physical and chemical treatment methods are not very suitable for dairy wastewater. Due to the COD concentrations and varying organic loads and temperature, anaerobic biological treatment methods are more appropriate.

Anaerobic digestion is a widely used method of wastewater treatment where the organic matter is being converted into biogas with the aid of bacteria in the absence of oxygen. Out of many anaerobic treatment methods Anaerobic Fixed Bed Biofilm Reactor (AFBBR) works on the principle of immobilizing microorganisms on a support which has proven results on treating wastewater.

In a FBBR the bacteria are attached to each other and also to a surface which is known as biofilm carriers to increase the surface area in order to achieve a higher rate of degradation.

METHODOLOGY

Initially a lab scale bioreactor was developed with the help of the glass wooden lid container which consists with a medium to grow microbes. As the medium the most suitable microbe culture was selected from Ceylon Cold Stores (Pvt) Ltd, one of the leading dairy industry in Sri Lanka. Next, a synthetic wastewater was developed which mainly corresponds to dairy wastewater from milk powder and generated different feeding conditions.

In order to determine the general stability

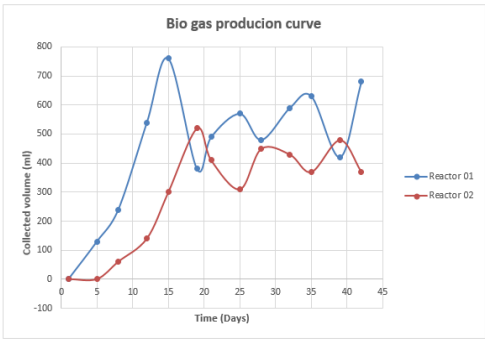

Figure 2 Bio gas production curve vs. time

time for a given feeding condition, results were obtained on variations of pH, COD, and the amount of biogas collected during the microbial growth period. pH was measured using a pH meter while COD was measured manually by titrations. The amount of gas collected was measured using the downward displacement of water.

Simultaneously, operation of the pilot scale FBBR (PDANC) was started with a semi-continuous feeding mechanism with two reactors. In this reactor plastic bio balls were used. The same procedure was carried out in the pilot scale reactor in order to obtain variations for the parameters measured. The results were analyzed using the SCADA system.

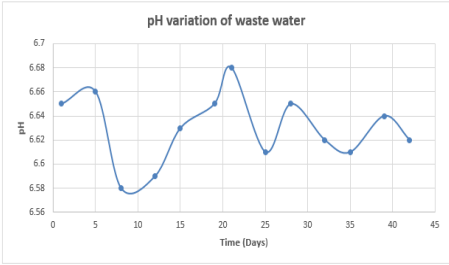

Figure 3 pH variation of wastewater with time

RESULTS AND DISCUSSION

According to the results obtained in the pilot scale reactor, following figures represent the variations in parameters.

According to Figure 2, the pH value of the initial sample was 6.65. Since the optimum pH for Methanogenic bacteria is in between 6.5 - 7.5 KOH was manually added. However, with time as the Acetogenic and Acidogenic bacteria digests the organic molecules to VFA, the pH gradually drops. Hence, it was noted and the pH was altered by adding KOH while feeding the reactor.

According to Figure 3, the gas collection from reactor 1 is higher than that of reactor 2. This is mainly due to having high COD levels in reactor 1 which gets the feed. Hence, bio gas production is proportional to the COD level in the effluent.

Figure 4 represents the COD variation of the feed and the effluent. As per the results obtained the feed has been treated reducing the COD levels.

CONCLUSION

Anaerobic digestion technology has received much attention over the past decades in order to treat wastewater. The technology converts the waste into biogas which is a very useful energy source when produced in industrial scale. Dairy industry, one of the largest generators of waste water produces waste with high COD which needs to be reduced as per the standards. One of the main burning issues in the dairy wastewater treatment is the stability of the biofilm when the reactor is affected with shock loads or in other words high COD level inputs.

The main aim of this research was to analyze parameters such as pH, COD and the stability of the biofilm with respect to the shock loads given. In order to conduct the research a lab scale system was developed to analyze the stability of the growth of microorganisms without a biofilm. Through that, all the parameters to be analyzed were taken into account and determined with respect to the pilot system.

As the first step of the research, a bioreactor was developed and then the

synthetic wastewater was made such that the parameters of the synthetic wastewater is compatible with the parameters of the actual dairy wastewater. Following the lab scale reactor, a pilot scale reactor was used to find the effect of biofilm in treating dairy wastewater.

During the first half of the research it was seen that a time of around 23 days were utilized for the system to reach the stable stage. However, in the pilot scale reactor a stable point was not observed due to the time limitation and human errors occurred by contamination of the reactors from atmospheric air. Hence, further research must be done to find the Effect of biofilm growth in anaerobic reactor treating dairy wastewater.

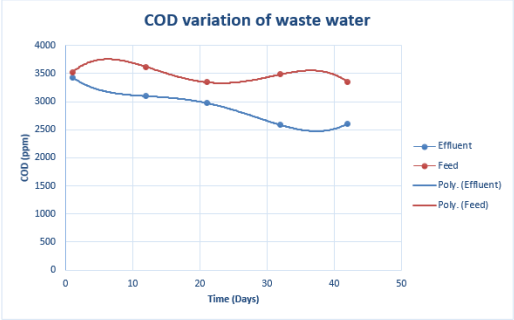

Figure 4 COD variation of wastewater with time

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