Use of Microaeration to Remove Sulfur from Sulfate Rich Latex Wastewater

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ABSTRACT: Latex processing industry generates wastewater with high sulphate content which is converted into hydrogen sulphide in an anaerobic digester. Disposal of this latex wastewater has created severe environmental and health hazard. This study develops a strategy to remove sulphate by performing microaeration. Two lab scale anaerobic reactors were operated, as fully anaerobic and anaerobic with microaeration. These reactors are semi-continuously fed with synthetic latex wastewater contains COD/SO_4^{-2} ratio of 3. After the stabilization, oxygen loading conditions as 4, 6, 7 mg/day were performed stepwise to enable the microaeration condition without inhibition. Bio gas composition, COD, SO_4^{-2}, S^{-2}, H_2S and oxygen reduction potential (ORP) are the measured parameters.

Keywords: Microaeration, Anaerobic, Latex wastewater

INTRODUCTION:

Wastewater generated from latex processing industry consists of high amount of organic compounds and sulphates. Discharging of these wastewaters without proper treating causes severe impact on environment. Sulfuric acid is added as a coagulation agent in latex processing. This results the presence of sulphate ions in latex processing wastewater. Sulphate is converted in to sulphide by Sulphur reducing bacteria (SRB) at their microbial degradation cycle (Krayzelova et al., 2015). Although sulfate does not impact on the environment directly, H_2S formation causes severe threat on the environment. At concentration 200 ppmv, H_2S poses severe toxic effects to humans after a 1-min exposure period (Nghiem et al., 2014). SRB compete with methanogenic bacteria (MB) for available substrates in an anaerobic reactor. SRB are more dominant than MB in sulphate rich wastewater due to the negative Gibbs energy value. This reduces the bio gas quality as it is contaminated with formed hydrogen sulphide (Thanapong et al., 2012).

Physico-chemical methods for the removal of hydrogen sulfide from biogas need additional chemicals and they need to work under high temperatures and pressures. These methods are energetically demanding and expensive due to this reason (Lenns et al.,2013). Comparatively, biological methods have lower or none utilization of chemicals with lower operational costs (Mohammadi et al., 2010). Biological methods are most often based on the biochemical oxidation of sulfide to sulfate, thiosulfate or elemental sulfur(guyen et al.,2012).

Microaeration is a strategy which has already gained a growing interest as a new trend in desulfurization process. (Lucie et al., 2015)

Microaeration is defined as the introduction of small amount of oxygen which is less than the oxygen requirement for complete aeration in to an anaerobic biochemical process. It enables both anaerobic and aerobic biological activities to occur within a single bio reactor (Lenns et al., 2013)

This research experiments are conducted to investigate the effect of microaeration for the removal of sulfur from sulfate rich latex wastewater.

METHODOLOGY:

Setting up experimental apparatus

Two suspended grown anaerobic glass reactors were operated in this study. Working volumes of both anaerobic reactors are 2.5L with 500ml head space. There are three outlets on the top of the reactors. One is for organic loading and effluent removal for the analysis. The other outlet is to collect the generated biogas to a 100ml volumetric flask inverted in a water bath with water displacement method. Whereas the other one is to perform micro aeration. Both reactors were kept at room temperature nearly 32°C. The pH of the reactor maintained in between 6.5-7.5.

Preparation of synthetic latex waste water

Experiments were conducted using synthetic media made of Acetic Acid. Sulphate concentrations were adjusted using Sodium sulphate. The composition of basal nutrient solution consists of (174 g/l), (28g/l) and. Whereas the composition of the trace nutrient solution is (50mg/l),, , Zn(CH3CO, , and %(1ml/l) After synthetic wastewater solution was prepared, it was stored under 4°C temperature until was fed to the reactor.

Acclimation of the reactor

The reactors were inoculated with sludge taken from a well operated anaerobic reactor in wastewater treatment facility of skim latex processing industry. Volume of the reactor was taken up to the functional level gradually, by adding 100 ml of synthetic waste water per three days with COD/SO_4^{-2}ratio 3.

Experimental procedure

- Perform micro aeration on distilled water to achieve an optimum oxygen diffusion rate.
- Perform micro aeration on experimental setup while controlling oxygen load, pH and temperature.
- Monitor relevant liquid phase and gas phase parameters while semi continuously feeding the reactor.

Analytical methods

Influent and Effluent of the both reactors were analyzed for pH, COD and total gas volume. pH was measured using pH meter, COD was analyzed according to the standard method and gas volume was measured from the water displacement through an inverted measuring cylinder.

RESULTS AND DISCUSSION

Results obtained after performing micro aeration on distilled water, is shown in the figure 1 below.

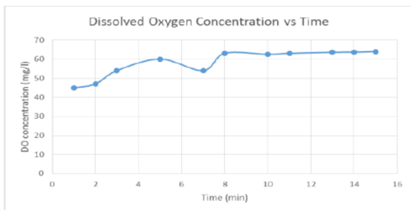

Figure 1: Results obtained from DO test

According to the graph obtained from experimental results it can be seen that distilled water sample got saturated after 8 minutes of continuous supply of air through a diffuser. So, this will be helpful to identify the maximum time required for the continuous air supply to the reactor.
COD variation of semi continuously fed

reactor with time is shown in figure 2.

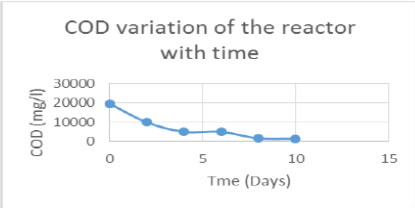

Figure 2 : COD variation of the reactor with time

According the graph shown in figure 2, COD level of the reactor shows a reduction with time. COD removal efficiency enhancement may be obtained due to the microorganism multiplication in an exponential growth phase of the reactor.

Conclusion

According to the results it can be concluded that the reactor has reached to its' functional level.

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