THERMOPHILIC ANAEROBIC TREATMENT OF VINASSE IN A TWO STAGE SYSTEM: SULFETOGENIC BIOREREACTOR FOLLOWED BY METHANOGENIC BIOREACTOR

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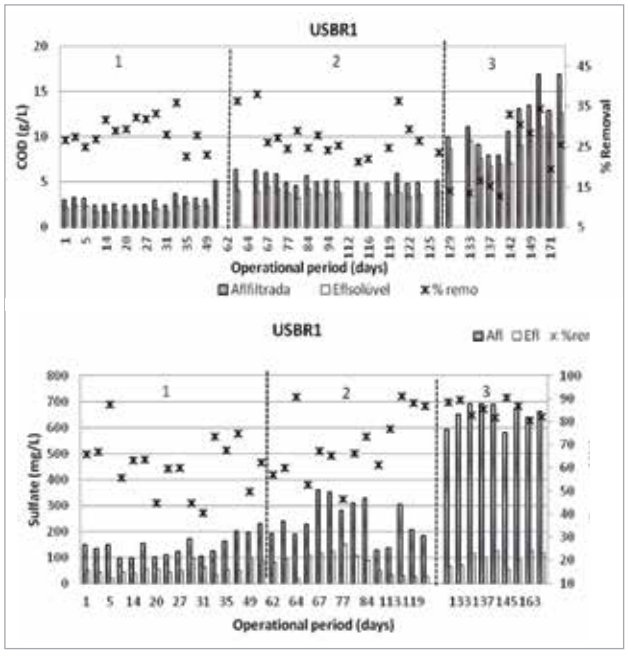

Figure 1. Concentration and removal of COD (a) and Sulfate (b) during the operational time of USBR 1

Alternative energy sources are becoming more and more important, and hydrogen (H_2) and methane (CH_4) production from biomass and residues are options for renewable energy. Currently, research is focused on optimization of H_2 and CH_4 production from vinasse, the liquid residue left in the distillation of ethanol from sugarcane derivates. Due to its high biochemical oxygen demand (17,000 to 50,000 mg/l), vinasse has the potential to be converted into renewable energy. However, gaps related to the process, e.g. removal of sulfate, configuration, operation and stability of reactors and limited knowledge of the involved microbiota need to be overcome in order to evaluate the potential application of anaerobic technology for the treatment of vinasse and bioenergy production. In this research, structured fixed bed reactors were operated at 55 ºC fed with vinasse in order to and improve organic matter and sulfate removal as well as methane production.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

In order to evaluate the effect of organic loading rate (OLR) and stability of sulfetogenesis and methanogenesis, two lab-scale up-flow structured bed reactors (USBR) were operated under thermophilic condition (55 ºC) for 173 days at three different loading rates conditions: phase 1 from day 1 to day 60; phase 2 from 60 day to 128 day and phase 3 from day 128 to day 173. USBR1 was inoculated with auto-fermented vinasse and USBR2 was inoculated with anaerobic sludge from UASB reactor treating vinasse and sewage. Polyurethane foams were used as support bed in both bioreactors. USBR1 was continuously fed with diluted sugarcane vinasse, in order to obtain the desired values of COD and OLR. USBR2 was continuously fed with the effluent of USBR1. Hydraulic retention time of USB1 was 2h and of USBR2 was 48h. COD and OLR´s applied for USBR1 were: phase 1 COD of 2.0-3.6 g/L (OLR 24-43Kg COD/m^3*day); phase 2: 5-6.3 COD g/L (OLR 60-75.6 Kg COD/m^3*day); phase 3: 9-16.9 COD g/L (OLR 108-202 Kg COD/m^3*day).For USBR2, the values of COD and ORLR´s were: COD: 1.6-2.6 g/L (OLR 0.8-1.3 Kg COD/m^3*day); phase 2: COD of 3.2-4.5 g/L (OLR 1.6-2.25 Kg COD/m^3*day); phase 3: COD 7.6-12.6 g/L (OLR 3.8-6.3 Kg COD/m^3*day).

Values of pH of influent of USBR1 ranged from to 6.0 to 6.5, and effluent pH were stable during all operational period with values ranged from 6.5 to 7.0 The pH of effluent with values superior when compared with affluent show the formation of alkalinity, characteristic of sulfate respiration. These results are important for application of anaerobic technology since it is not necessary to add alkalinizing to send the effluent to methanogenic reactor. Organic matter removal was stable during all operational period, with values of COD removal ranged from 22 to 36% (*Figure 1a*). Removal of sulfate increased with ORL applied with values ranged from 40 to 90% (*Figure 1b*). These results show that sulfate removal was improved by availability of organic electron donors, such as valeric, butyric, acetic, fumaric and malic. Valeric was present in vinasse and metabolized in USBR1. Organic acids butyric, acetic, fumaric and malic were produced and consumed by microbial community of USBR1. This is the first report that shows the stability of a sulfetogenic bioreactor operated with vinasse and with low hydraulic retention time (2h), and so the potential to apply compact anaerobic reactors.

pH of USBR2 was stable during all operational period with values ranged from 7.0 to 8.0. The predominant organic acids acetic and butyric, from USBR1, were metabolized by microbial community of USBR2 with removal of residual of organic matter (COD) with values ranged from 60 to 75% (*Figure 2a*) and sulfate removal ranged from 40 to 100% (*Figure 2b*). Methane was produced and increased with the increase of OLR applied, with values ranged from 0.5 umol to 3.8 umol.

MAIN PUBLICATIONS

Lima CMO, Saia FT.2015. Análise e operação de biorreatores termofílicos para a produção de metano e hidrogênio através de metano e hidrogênio através do uso da vinhaça. Congresso Acadêmico da Unifesp, 2015.

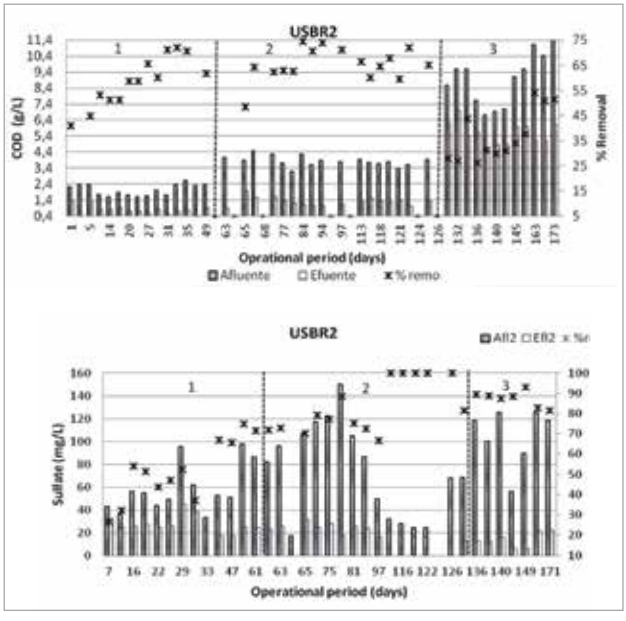

Figure 2. Concentration and removal of COD (a) and Sulfate (b) during the operational time of USBR 2

Perspectives: Structure of microbial community of USBR1 and USBR2 of each operational phase is being analyzed by DGGE. Phylogenetic identification of both bioreactors at the end of operational period is in progress.

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