INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	VELUCHAMY C
Roll Number	:	146104032
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Name of Thesis Supervisor(s)	:	Dr. AJAY KALAMDHAD
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SHORT ABSTRACT

Anaerobic digestion (AD) of pulp and paper mill sludge (PPMS) was studied with and without pretreatment, in biochemical methane potential (BMP) assay, batch and with a semi-continuous lab scale reactor. Initially, AD of PPMS without pretreatment (as control) was carried out by using cow dung as inoculum in a BMP test. Results indicated that PPMS has a high potential for energy recovery in the form of biogas. Based on the experimental result on gas production, volatile solids (VS) reduction, F/M ratio 2.0 was perceived as best and achieved higher methane production (264±5 mL CH_4/g of VS degraded). As PPMS contain inherent recalcitrant characteristics of lignocellulose content, turns hydrolysis step into a rate-limiting stage AD. Therefore, further experiment was carried out to overcome the hydrolysis step, different pretreatment were studied. The chemical and instrumental (FT-IR, XRD, FESEM) analyses exposed that all the pretreatment methods have shown improvement in solubilization. Among the pretreatments studied, in thermal pretreatment-hot air oven (80^{o}C for 90 min), in electrohydrolysis (15 V for 45 min), in biological pretreatment (Bacillus mojavensis (CDb1)) showed the highest impact on sludge solubilization. Further, screened pretreatment (in the previous experiment) were tested for enhanced methane production in BMP assay. The result revealed that the specific methane production potential was increased from 264±5 to 303±4 mL of CH_4/g VS degraded (thermal), 301±3 mL of CH_4/g VS degraded (electrohydrolysis), and 295±3 mL of CH_4/g VS degraded (biological). A net energy of 8,735 kJ was gained after thermal pretreatment and 13,224 kJ was gained after electohydrolysis pretreatment. In addition to that three kinetic models were studied. Among that Gompertz and logistic function models represents and reproduce the experimental data, while earlier has better fit. Designed anaerobic auger plug flow reactor (AAPFR) experimental studies were carried out in two places: one at India, IITG (Environmental lab) campus and another one at Canada, University of Guelph Ridgetown Campus. At India, the AAPFR was operated for 75 d with thermal pretreatment (30 d) and without pretreatment (30 d) at 21 d HRT with specified OLR (6.3 kg VS/m^3/d). The CH_4 yield obtained from the continuous study was not significantly different from the BMP and batch study, and experimental CH_4 yield was an equal to 310 mL CH_4/g of VS degraded in AAPFR operation. At Canada, study was majorly emphasized on the effect of increasing OLR on the CH_4 production in long-term experiments (130 d) in corn silage. The increase in biogas production was observed with an increase in OLR. In addition to this, increase in OLR resulted in a decrease in CH_4 content and increase in H_2S concentrations. However, the reactor showed a stable operation at an OLR 6.5 kg/m^3/d. The reactor lost its stability at an OLR 8.8 kg/m^3/d, which was apparent by decrease in biogas yield and its CH_4 content. Further, a development of mathematical modeling on a mass diffusion on effect of moisture content (MC) for the solid-state anaerobic digestion (SS-AD) was carried out. This model proposed that the decreased MC causes augmented mass diffusion resistance by the accumulation of hydrolytic product and lead to the reduced methane gas production.