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Effect of Pretreatment on the Biogas Production from Energy Plant Using Batch Reactor

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Abstract

The proposed study aims at biogas potential estimation of sugar beet using different total solid concentration and pretreatment methods. The effect of alkali (Sodium hydroxide), acid (Hydrochloric acid) and mechanical (particle size reduction) pretreatment of sugar beet over un-pretreated substrate have been investigated for the potential of biogas production using biphasic continuous bio digester–TEAM (TERI's Enhanced Acidification and Methanation) process (50 kg/day capacity) developed by TERI+. The estimation of biogas potential of sugar beet has also been studied in single phase batch digester (2 L capacity) using three different Total Solids (TS) concentration viz. 5%, 7.5% and 10%. However the effect of particle size reduction was also studied in two phase digester. The biogas yield from single phase batch digester fed with 5% TS, 7.5% TS, 10% TS, were recorded as 44 m3 /ton, 58 m3 /ton, 57 m3 /ton of substrate fed respectively whereas the yield from un-pretreated, Hcl (6%; v/v) pretreated and NaOH (1%; w/v) pretreated sugar beet are, 72 m3 /ton, 60 m3 /ton and 61 m3 /ton respectively. The biogas yield from mechanically pulverized is estimated to be 90 m3 /ton which is 25% more than not pretreated substrate that too in Total Hydraulic Time (HRT) of less than six days.

Exhaustive usage of fossil fuel has compelled the human society to look for alternate sources of renewable energy for sustainable growth. Animal wastes are generally used as source of clean energy. However, the availability of these substrates is one of the major problems hindering the successful operation of biogas plants . Hence there is a need for identification of alternate feedstock and agro residues which can be used for biogas production and to meet the energy demand. He two most important parameters in the selection of particular plant feed stocks are the economic considerations and the yield of methane . Sugar beet is considered to be an important energy crops for biogas production because of the high organic content. Additionally, it contains a high fraction of degradable components. Moreover, sugar beets can be stored and used for the whole year. Another advantage of sugar beets is the low dry matter which makes it easily conveyable and hence the possibility of easy feeding. Several studies have been reported on the use of wastewater and solid wastes from sugar beet processing namely sugar beet pulp for generation of biogas. During the process of extraction of sugar from sugar beets, approximately 25% of sugar beet processed is generated in the form of spent pulp which is a rich source of energy . Sugar beet pulp consists mainly of cellulose, hemicellulose and pectin making it suitable for biological degradation and thus biogas production . Weiland reported a methane yield of 0.3 m3 methane per kg Volatile Solid (VS) for two-stage systems under mesophilic conditions and HRT of 13 days with maceration (80% of solids were less than 0.63 mm) of beet pulp . The average methane yield from thermophilic leach-bed digester was 0.336 m3 CH4 at STP (kg VS)-1 .The methane yield for two-stage processes was about 350 L methane per kg VS which is equivalent to 94.5 m3 of methane per ton of waste assuming TS of 30% and VS of 90% . In this study, various methods of treatment of the sugar beet have been studied for the maximum production of biogas. For these studies, a biphasic bio digester developed by TERI-TEAM process was also used. TEAM is a tailor made product for treatment of different types of organic wastes including fibrous crop wastes, which are difficult to be digested in conventional systems. It fully eliminates the operational problems like scum formation and requirement of preparation of homogeneous slurry for digestion.

Maximum gas yield from batch digestion carried out with 7.5% TS of sugar beet is 58 m3 /ton of feed stock. Degradation of the not pretreated sugar beet in TEAM digester resulted in a high strength leachate. COD of the leachate attained a cumulative value of 80.2 g/L within five days. However the COD of the leachate obtained from mechanically pulverized sugar beet is 100 g/L in four days. He extraction of the organic content in the form of high strength leachate from mechanically pulverized feedstock appears to be promising option for the treatment of sugar beet. As compared to the other pretreatment methods, the gas yield from pulverized feedstock in a high rate anaerobic digester is 90 m3 /ton of feedstock. He positive aspect associated with the pretreatment process is considerable reduction in the residence time of 4.75 days (4 days for acidification process and 18 hours for methanation process) compared to batch digestion and other models of continuous digestion. However, further studies are essential for optimizing other design parameters.

Keywords: Biogas; TEAM process; Biphasic digester; Pretreatment

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