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Comparison of non-agitated and agitated batch, thermophilic anaerobic digestion of sugarbeet tailings

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HIGHLIGHTS

- Thermophilic, non-agitated and agitated digestion showed marked differences in performance.
- Methane yield from agitated digester was 74% of that from non-agitated digester.
- Non-agitated digester produced methane at twice the rate of agitated digester.
- Performance of agitated digester inoculum quickly improved when used in non-agitated digester.
- Agitated digester exhibited a high abundance of hydrogen-producing microbial community.

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ABSTRACT

Sugar beet tailings were anaerobically digested at non-agitated and agitated conditions in identical thermophilic batch reactors. The average methane yield in the agitated digester was only 74% of that in the non-agitated digester. Ninety percent of the ultimate methane yield was produced in approximately 5 days in the non-agitated digester whereas it took 12 days in agitated digester. Even upon using an active inoculum from non-agitated digester the methane rate and yield was low in the agitated digester. On the other hand when the poorly performing inoculum from the agitated digester was transferred to the non-agitated digester, its activity was immediately enhanced. The non-agitated digester harbored a diverse microbial community with phylotypes *Methanoculleus* and *Methanosarcina* being dominant methanogens. *Methanosaeta* was the only methanogen detected in the agitated digester. It also contained a hydrogen-producing bacterial phylotype *Petrotoga* in high proportion which was not detected in the other digester.

1. Introduction

Sugar production from sugarbeets generates significant quantities of both solid (tailings, spent beet pulp) and liquid (raffinate, wastewater) organic wastes and by-products. Raw sugar beets are first washed and separated from "tailings" which mainly consist of pieces of beets, weeds, sugar beet tops, debris and soil held by sugar beets when harvested. These sugarbeet tailings were used as the model substrate for experiments reported in this paper. It has been shown that this feedstock was efficiently and rapidly digested in a thermophilic, non-agitated batch system, provided the tailings are adequately bulked during digestion and a method of removing the rapidly solubilizable fraction was implemented (Polematidis, 2007; Liu et al., 2006). To prevent compaction and flotation of the tailings in a non-agitated digester it was necessary to bulk with a bulking agent (Polematidis, 2007). Otherwise compaction of the bed adversely impacted digestion performance as it prevented contact between tailings and microorganisms, and trapped biogas within the bed causing liquid to be expelled followed by bed flotation. In large scale digestion systems it would be expensive and cumbersome to introduce, recover and reuse bulking materials and so may not be a viable option. Another approach would be to mix digester contents so as to keep the tailings dispersed preventing compaction and flotation. Thorough agitation of digester contents also helps particle size reduction and evolution of biogas, distributes microorganisms and nutrients uniformly, and improves mass and heat transfer; therefore is regarded as essential for high rate anaerobic digestion.

Agitation is usually accomplished by mechanical mixers, slurry recirculation or biogas recirculation (Karim et al., 2005). The significance of agitation in anaerobic digestion has been reported in many studies (Hoffmann et al., 2008; McMahon et al., 2001; Stroot et al., 2001; Vavilin and Angelidaki, 2005). Factors effecting agitation

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