Aerobic and anaerobic decomposition of wood sludge from pulp production with enzyme additions

J. Rusín, K. Chamrádová

VSB - Technical University of Ostrava, Institute of Environmental Technologies, 17. listopadu 2172/15, Ostrava - Poruba, 708 33, Czech Republic

1. Introduction

In the production of viscose pulp from wood by an acidic magnesium-bisulfite process, bulky waste biomass is produced in the form of wood sludge with very fine and short fibers. The energy utilization of this sludge is problematic. For direct combustion, the moisture content is too high, so the sludge is co-composted or torrified. Wood sludge is often processed by agricultural biogas plants, but there are also operational problems. The sludge increases the agitation difficulty and creates floating crusts. The first objective of the work was to verify the possibility of reducing the amount of wood sludge by decomposing the solids under aerobic conditions using enzymes, which would be the method applicable in an industrial wastewater treatment plant. The second objective was to verify the possibility of increasing the production of biogas and CH_4 from wood sludge under the anaerobic conditions of the mesophilic biogas plant.

2. Experimental

The aerobic test was performed in plastic containers for 100.0 g ± 0.1 g of sludge, placed on the shaker at 100 osc. / minute for 21 days. The aeration was only natural - the containers were not covered by the lids. Three containers contained only wood sludge, 3 containers contained 1% addition of cellulase solution and 3 containers contained mixture of 4 enzyme solutions (marked as Enzyme1) mixed according to the organic solids composition of the sludge. Organic solids (loss on ignition) reduction was evaluated. The anaerobic test of discontinuous mesophilic biogas and methane production was performed using 1 L glass-bottle bioreactors placed in water bath at 40°C ±0.5°C and closed by gas-filled burettes, based on the EN ISO 11734:1995 standard [1]. Reacting liquid slurry from the 1st stage of the mesophilic agricultural biogas plant was used as inoculum. All the reactors were incubated for a time period of 40 days. Biogas production was recalculated to normal conditions (101.3 kPa and 0°C). With sufficient amount of biogas in the burette (>150 mL), the measurement of CH_4 content was carried out by infrared analyzer. Missing daily data on biogas volume and CH_4 content were interpolated linearly. The yield was calculated based on the theoretical value according to Richards' modified Buswell formula [2].

3. Results and Discussion

When aerating sludge with a total solids content of 2.75% for 21 days, there was an average organic solids weight reduction of 23.9%. When aerating the sludge with a 1% addition of Cellulase, the weight of the organic slurry of wood sludge decreased by an average of 38.8%. In the case of a 1% addition of the Enzyme1 mixture, the weight of organic solids of wood sludge decreased by an average of 41.0%.

4. Conclusions

Under aerobic conditions, the use of cellulase or a mixture of multiple enzymes has significantly reduced the organic solids content of wood sludge. The wood sludge sample was characterized by a relatively high 40-day mesophilic production of biogas based on total dry matter: 0.367 $m_N^3\ kg_{TS}^{-1}$ and CH_4 production of 0.198 $m_N^3\ kg_{TS}^{-1}$. The 10% addition of cellulase to sludge did not significantly increase yields. With the 10% addition of the Enzym1 mixture to the sludge, a 10.5% higher biogas production and 15.7% higher CH_4 production was achieved.

5. References

[1] EN ISO 11734:1995 Water quality - Evaluation of the complete anaerobic biodegradability of organic compounds from anaerobic stabilization sludge - Method for the determination of biogas production.

[2] Richards, B. K. et. al. (1991) Methods for Kinetic Analysis of Methane Fermentation in High Solids Biomass Digesters. Biomass and Bioenergy, 1 (2), 65-73.