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Effects of pyrolysis on biogas production of solid-state anaerobic co-digestion using corn stover

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1. Introduction

Anaerobic digestion using biomass as a raw material decreases the environmental burden of waste and allows energy to be recovered from waste, helping to decrease the amounts of greenhouse gases emitted. Corn stover has excellent potential as a biomass feedstock due to its constituent which includes carbohydrates, pectin, proteins, salts, and minerals. However, high cellulose and hemicellulose contents of corn stover form a recalcitrant lignocellulose complex with lignin to limit the effective conversion. Pyrolysis offers the advantages that no chemicals are required, and this method is environmentally benign. It has previously been found that cellulose, hemicellulose, and lignin in corn stover can be thermally decomposed under appropriate conditions. However, most previous studies have been focused on assessing pyrolysis pretreatments by measuring the removal rates of various components. Therefore, the objective of this study was to assess the effects of pyrolysis pretreatment on solid-state anaerobic co-digestion using corn stover as a result of changing its physical properties.

2. Methods

The feedstock was prepared from pretreated corn stover and food waste, and the effects of pyrolysis pretreatment on biogas production were studied by the batch-type and semi-continuous anaerobic co-digestion system in this study. The corn stover thermal property was investigated by performing thermogravimetric analysis. The corn stover aliquots pretreated in an electric furnace at 100° C for 360 min, 200° C for 15 min and 300° C for 5 min were used. Untreated and pretreated corn stover samples were analyzed by scanning electron microscopy, and the bulk densities, component ratios were compared to identify changes caused by the pretreatments. The amounts of total solids, volatile solids, volatile fatty acids, and total ammonia nitrogen produced when the stover samples were anaerobically digested were measured. The biogas production rate and the methane concentration in the biogas were determined. The SMY (substrate-specific methane yields) were determined, and the relationships between the yields and pretreatment conditions were assessed.

3. Results and Discussion

The highest yield of SMY was found in when corn stover pretreated at 300℃ for 5 min was used. The pretreatment generally changed the corn stover composition ratios by decreasing the moisture content and volatile solid content, and the cracks on the stover surfaces become more severe as the pretreatment temperature increased. In addition, a straight line fitted a plot of the total solid bulk densities and SMY well (R^2: 0.94).

4. Conclusion

The pretreatments decreased the corn stover bulk density, increased the specific surface area, and porosity of the corn stover. Contact between the raw material and microorganisms therefore increased, and this increased biogas production of the anaerobic co-digestion process coupled with pyrolysis. The methane production rate was found to be affected by the total solid bulk density.