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Testing the effect of different enzyme blends on increasing the biogas yield of straw and digested manure fibers

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The Re-Injection Loop Concept

In this study, enzymatic treatment was tested to increase the biogas yield of wheat straw (WS) and digested manure fibers (DMF) in the Re-Injection Loop Concept, which combines anaerobic digestion with solid separation to enhance the biogas yield per ton of manure by:

1. Digestion of the easily degradable fraction of manure in the biogas process.
2. Separation of the residual recalcitrant digested fiber fraction project.
3. Ultrasound and/or enzymatic treatment of the digested fiber fraction.
4. Recirculation of the treated fiber fraction into the reactor.

Enzymatic Treatment of WS and DMF

- All tests were conducted in batch tests as separate enzymatic hydrolysis prior to the anaerobic digestion (AD) process. The enzymatic hydrolysis (EH) was performed at the following conditions: T = 50°C, t = 0.5/1.0/72 h, dosage = 0.1/2.5/5.0% g-enzyme/g-TS, 10%TS, pH (adjusted) = pH 5/7, pH (non adjusted) = pH > 8.

- The following enzyme blends were tested:

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Activity</th>
<th>pH range</th>
<th>Temp range (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZ-P</td>
<td>Protease</td>
<td>8.0-10.0</td>
<td>60-70</td>
</tr>
<tr>
<td>ES-C5000P</td>
<td>Neutral cellulase</td>
<td>6.5-8.5</td>
<td>50-70</td>
</tr>
<tr>
<td>ES-CX19K</td>
<td>Cellulase and endo-xylanase</td>
<td>2.5-7.0</td>
<td>40-70</td>
</tr>
<tr>
<td>NZ-Car</td>
<td>Celulase</td>
<td>N/D</td>
<td>N/D</td>
</tr>
<tr>
<td>NZ-CBG</td>
<td>Celulase</td>
<td>4.5-6.0</td>
<td>40-55</td>
</tr>
<tr>
<td>ES-HC</td>
<td>Endo-xylanase</td>
<td>5.0-6.0</td>
<td>50-80</td>
</tr>
<tr>
<td>NZ-CBG1</td>
<td>Celulase</td>
<td>4.0-6.0</td>
<td>50</td>
</tr>
<tr>
<td>ES-LA</td>
<td>β-glucanase &amp; endo-cellulase</td>
<td>4.5-6.0</td>
<td>40-50</td>
</tr>
<tr>
<td>NZ-X</td>
<td>Xylanase</td>
<td>4.5-6.1</td>
<td>50-70</td>
</tr>
<tr>
<td>NZ-BG</td>
<td>β-glucanase</td>
<td>5.0-7.0</td>
<td>50-65</td>
</tr>
<tr>
<td>ES-CX900T</td>
<td>Cellulase + xylanase</td>
<td>6.5-8.0</td>
<td>50-70</td>
</tr>
<tr>
<td>ES-3000L</td>
<td>Celulase</td>
<td>4.0-7.0</td>
<td>30-60</td>
</tr>
<tr>
<td>ES-8000P</td>
<td>Celulase</td>
<td>4.5-6.5</td>
<td>50-60</td>
</tr>
</tbody>
</table>

NZ: enzyme blend from Novozymes A/S, ES: enzyme blend from EnzymeSupplies Ltd.

- The subsequent biomethane potential (BMP) tests were performed at 37°C for 60 days. The inoculum used was taken from Hasheji biogas plant, Denmark, treating manure and industrial organic waste.

- Screening of the different enzymes (50°C, pH 5.0, 72h) on WS showed an increasing effect on the BMP mainly for enzyme blends containing both cellulase and xylanase activity:

- EH (50°C, pH 7.0/5.0, 0.5/72h) using the best performing and low cost enzyme blends (CX900T/3000L) at low dosage (0.1% g-enzymeg/g-TS) had an increasing effect mainly on the BMP of DMF, while the effect on WS was only limited:

- EH with no pH adjustment (pH > 8) and 0.1% dosage showed an increasing effect of the enzyme addition (8000P) compared to treating DMF at 42/50°C without enzymes only for 72h of EH.

Conclusions

- Addition of combined cellulase and xylanase activity showed highest effect to enhance the intrinsic hydrolytic activity of the AD process.
- The relative effect of enzyme addition was higher for DMF with low BMP.
- pH adjustment to pH < 7 showed higher effect of the enzyme addition.

Acknowledgements

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