Effective mass transfer of hydrogen into digester mixed liquor for biomethanisation of biogas CO\textsubscript{2}

<table>
<thead>
<tr>
<th>Project Staff</th>
<th>Principal investigator: Prof Charles Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Researcher: William Nock</td>
</tr>
<tr>
<td>Start year</td>
<td>2015</td>
</tr>
<tr>
<td>Finish year</td>
<td>2016</td>
</tr>
<tr>
<td>Funding body</td>
<td>BBSRC through Anaerobic Digestion Network</td>
</tr>
<tr>
<td>Related website</td>
<td><a href="http://www.anaerobicdigestionnet.com">www.anaerobicdigestionnet.com</a></td>
</tr>
</tbody>
</table>

The addition of H\textsubscript{2} into anaerobic digesters or methanogenic bioreactors to produce biomethane is an innovative energy storage solution which improves the carbon utilisation of anaerobic digestion. The high methane content in the gas produced after H\textsubscript{2} addition (>95 % CH\textsubscript{4}) can be used as a replacement for natural gas.

The installation of renewable energy technologies such as wind and solar are helping to reduce CO\textsubscript{2} emissions, however in many cases the electricity grid is unable to fully utilise the renewable energy produced. One of the main challenges with these renewable energy technologies is the lack of control over when the electricity is produced and storing this energy for use when needed. The electrolytic production of H\textsubscript{2} has been proposed as a solution for energy storage; however there is currently a lack of infrastructure for storage and usage of H\textsubscript{2}. The supplementation of H\textsubscript{2} in anaerobic digesters or separate methanogenic bioreactors could utilise this H\textsubscript{2}, which would biochemically react with CO\textsubscript{2} in biogas to produce CH\textsubscript{4}. The biomethane produced could be utilised in the current natural gas infrastructure and there would also be benefits with an increased utilisation of carbon from the waste biomass.

The limiting step which has been identified in the biochemical conversion of H\textsubscript{2} and CO\textsubscript{2} into CH\textsubscript{4} is the mass transfer of H\textsubscript{2} from the gaseous phase into the liquid phase. The conversion of CO\textsubscript{2} into CH\textsubscript{4} will also reduce the bicarbonate concentration in the digester, reducing the pH buffering capacity of the digester liquor. The effects of this will be considered in this research project which aims to develop a robust system for H\textsubscript{2} injection into food waste digesters to achieve in-situ gas upgrading and efficient feedstock carbon utilisation.

Objectives

- To select a hollow-fibre membrane (HFM) diffuser suitable for use in a digester liquor
- To quantify the mass transfer efficiency of the device and to size it in relation to the anticipated H\textsubscript{2} demand within the digester
- To assess the kinetics of H\textsubscript{2} uptake in a hydrogenotrophic-adapted digestate derived from food waste treatment
- To assess any inhibition as a result of disruption of syntrophy in the system biology
To test the diffuser system in a modified continuously-stirred tank reactor (CSTR) digester

To operate the digester continuously with a food waste and H₂ feed with the objective of producing an output concentration equal to natural gas (>95% CH₄)

The research is funded by a Proof of Concept grant from the BBSRC AD Network

**Partners**

`UNIVERSITY OF Southampton`

*Water and Environmental Engineering Group*
Faculty of Engineering and the Environment
University of Southampton, UK

**Funding agency**

*Anaerobic Digestion Network*

*BBSRC - Biotechnology and Biological Sciences Research Council*