Estimating the biogenic energy content of mixed waste materials

These projects were funded by the Technology Strategy Board [TSB] through the Small Business Research Initiative [SBRI] along with the Department for Environment, Food and Rural Affairs [Defra] and the Department of Energy and Climate Change [DECC]. The projects aimed to demonstrate a novel yet effective method of calculating the biogenic biomass fraction of mixed wastes, and the energy yield from this renewable biogenic material. The project was led by Cranfield University and was in collaboration with the National Physical Laboratory [NPL], based in Teddington, Middlesex.

The need

Energy from waste has an important role to play in tackling climate change, by displacing the use of fossil fuels and by providing a more environmentally sustainable method of disposing of residual wastes, where recycling is not practical. Energy can be recovered from waste using a number of processes, including anaerobic digestion [AD], combustion, gasification and pyrolysis; each capable of delivering sustainable methods of waste treatment and a clean source of energy.

The recovery of energy from waste materials is supported by the Renewables Obligations [RO], as a mechanism to incentivise investment in suitable technologies. Where a heterogeneous fuel, such as mixed wastes, is used there is a requirement to understand what proportion of the total energy recovered is from a renewable resource, such as biomass. The aim of the projects funded by TSB/SBRI with Defra and DECC was to develop appropriate methods of assessing the biogenic biomass content of mixed wastes, and the energy outputs from this fraction.

The results

The methods developed demonstrated the capability to determine the biogenic proportion of mixed waste materials, and also to reliably estimate the net calorific value [CV] of this fraction, which is indicative of the energy yield before process efficiency is taken into account. The net energy potential is calculated from measurements of the moisture content, which enhances the accuracy of the method.

The developed system would be mounted above mixed waste prior to energy recovery and would enable facility operators with the capability of determining the renewable energy potential of the input fuel. The biogenic fraction of each waste component was determined by Carbon-14 analysis, which is a highly accurate method of measuring the ratio of ‘new’ carbon ($^{14}\text{C}$) to ‘fossil’ carbon ($^{12}\text{C}$). The relationship of waste composition, net CV and $^{14}\text{C}$ is illustrated below.

<table>
<thead>
<tr>
<th>Waste Component</th>
<th>% Composition</th>
<th>% Net Energy</th>
<th>% of Energy from Biogenic C for each component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textiles</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% Energy from Biogenic C for overall sample

1%

> 90%

> 90%

80-90%
We were first made aware of the first SBRI project by the Environmental Sustainability KTN, and are hopeful that this work will enable us to further develop our renewable energy capabilities and continue to collaborate with industrial partners.

Dr Stuart Wagland, Cranfield University

Understanding the composition of fuel mixes is central to managing a stable renewable energy supply. Enhancing our understanding the properties, and the feasibility, of contemporary fuels compared to those comprised of fossil carbon, helps the control and promotion of renewable sources.

Dr Phil Longhurst, Cranfield University

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The Environmental Sustainability KTN

The Environmental Sustainability Knowledge Transfer Network is accelerating the UK’s transition to a low carbon, resource and energy efficient economy by connecting businesses, universities, other research organisations and government agencies, and catalysing innovation across a wide range of environmental technologies.

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