A STRATEGIC ASSESSMENT OF LIQUID FUELS FROM BIOMASS

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ABSTRACT

A technical and economic study of the conversion of renewable feedstocks to liquid fuels has been initiated. The main objective of the project is to identify and evaluate all alternative technologies for liquid fuel production from biomass and solid wastes in order to identify the more promising technologies and R&D needs as a strategic planning aid to the European Community. The methodology adopted is to construct a robust techno-economic computer simulation of the whole range of thermochemical, biochemical and physical conversion processes. Each of the processes is divided into "process steps", each process step being defined as a self-contained processing operation. A model is being constructed of each process step, calculating the material balance, energy balance and capital cost of the step. Whole processes will then be constructed from the individual step models and the economics of each process evaluated. Some process steps are well established and commercially available, such as methanol synthesis, and state-of-the-art technology will be used in the model. Others steps, however, are still at the research or development stage, such as pyrolysis liquid upgrading. These unproven steps will be compared and evaluated to identify the more technically and economically promising alternatives. This will aid identification of further R&D needs. The scope, methodology and some early results are presented.

INTRODUCTION

The main objective of this project is to identify and evaluate all alternative technologies for liquid fuel production from biomass on a consistent basis. This will be achieved by evaluation of alternative technologies, followed by construction of a robust techno-economic computer simulation of the full range of thermochemical, biochemical and physical conversion processes. This will permit exploration of the performance and costs associated with each process route. The more promising
technologies will thus be identified, and areas where further research and
development is needed will also be highlighted by assessing the uncertainties of
the range of technologies considered and carrying out sensitivity analyses on
process performance and product cost. A parallel project will carry out an
analogous procedure for liquid fuels from coal by indirect liquefaction. This will
provide a consistent comparison of biomass and coal as feedstocks.

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framework of the New Energy Vectors research programme.

CONVERSION TECHNOLOGIES

There are four main conversion routes, each of which has a number of different
processes within the general scheme. The four basic routes are shown in Table 1,
together with some of their variations. The full range is shown in Figure 1.

Table 1 Basic Process Routes to Liquid Fuels

<table>
<thead>
<tr>
<th>Products</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDIRECT THERMOCHEMICAL ROUTES (via synthesis gas)</td>
<td>gasoline, diesel, fuel oil</td>
</tr>
<tr>
<td>Gasification + Fischer-Tropsch synthesis</td>
<td>gasoline, diesel, fuel oil</td>
</tr>
<tr>
<td>Gasification + alcohol synthesis</td>
<td>methanol, ethanol, fuel alcohol</td>
</tr>
<tr>
<td>Gasification + methanol synthesis + Mobil synthesis</td>
<td>gasoline, diesel</td>
</tr>
<tr>
<td>DIRECT THERMOCHEMICAL ROUTES (via a liquid intermediate)</td>
<td>gasoline, diesel, fuel oil</td>
</tr>
<tr>
<td>Pyrolysis + Mobil synthesis</td>
<td>gasoline, diesel, fuel oil</td>
</tr>
<tr>
<td>Pyrolysis + hydrogenation</td>
<td>gasoline, diesel, fuel oil</td>
</tr>
<tr>
<td>Direct liquefaction + hydrogenation</td>
<td>gasoline, diesel, fuel oil</td>
</tr>
<tr>
<td>BIOCHEMICAL ROUTES</td>
<td>ethanol</td>
</tr>
<tr>
<td>Wood hydrolysis + fermentation</td>
<td>ethanol</td>
</tr>
<tr>
<td>Starch hydrolysis + fermentation</td>
<td>ethanol</td>
</tr>
<tr>
<td>Sugar extraction + fermentation</td>
<td>diesel substitute</td>
</tr>
<tr>
<td>PHYSICAL ROUTES</td>
<td>diesel substitute</td>
</tr>
</tbody>
</table>

A wide range of other process routes for converting biomass to liquid fuels may be constructed, but
these are either similar to processes shown above and will give similar results, or they are not currently
being investigated or are not available. An example is the biochemical production of ethanol with
Mobil synthesis to make gasoline, diesel, and fuel oil.

An overview of biochemical routes is shown in the right hand half of the overall
plan in Figure 1. It should be noted that while the versatility and variations in
thermochemical conversion technologies lie in the downstream processing, for
biochemical conversion technologies these lie in pretreatment and feed
preparation.

METHODOLOGY

Biomass conversion processes have been analysed by function and operation in a
systematic methodology that is described below. This approach will permit the
subsequent process synthesis and evaluation procedure to be readily modified
and extended so that technical developments and a wider range of alternatives
may readily be incorporated.