

## Refining of new products and raw materials by gasification of biomass

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### 1 Introduction

Research project “Refining of new products and raw materials by gasifying of biomass (High-Bio)” is carried out as a joint project between Kokkola University Consortium Chydenius (coordinator), University of Oulu, Department of Chemistry, Central Ostrobothnia University of Applied Sciences (Centria, Ylivieska), Luleå University of Technology and ETC Piteå. Project is financed by EU Interreg IV A Pohjoinen programme in years 2008–2011. Information on the project is available at: <http://www.chydenius.fi/yksikot/luonnontieteet/tutkimus/highbio-interreg-nord>, where the info sheets can also be downloaded.

### 2 Objectives of the research

Bioenergy and environment are the focus areas of HighBio research project, as shown in Figure 1. HighBio project consists of five work packages (WP), which are 1) development of the gasification process, 2) effect of raw materials on the gasification process, 3) utilisation of end-products, 4) evaluation and techno-economical analysis of process, and 5) delivery of information. The information produced and know-how developed will be integrated by the research groups.

### 3 Bioenergy from biomass by gasification

#### 3.1 Development of the gasification process (WP1)

WP1 involves the studies of gasification processes (Entrained-flow gasifier and Down draft-flow gasifier, see Figure 2). The pressurised feed system for biofuel (e.g. wood chips) is developed. The chemical analysis of secondary products of gasification, e.g. condense water and wash water, is also considered.

#### 3.2 Effect of raw materials on the gasification process (WP2)

The effect of raw materials on the gasification process is studied. WP2 involves the following steps: pre-treatment of biofuel, the optimisation of the gasification process and the study of the effects of raw materials on the gas quality.

In the gasification process, the significant fuel (wood) parameters are moisture and ash content of wood and the particle size. In addition of fuel properties, the gas properties are also significant and they strongly affect the utilisation of raw gas, as described in Section 3.3. These properties involve gas temperature, product gas energy content, chemical composition and impurities (e.g. tars and alkali earth metals). High efficiency of the gasification process and low sensitivity to load fluctuations are also required.

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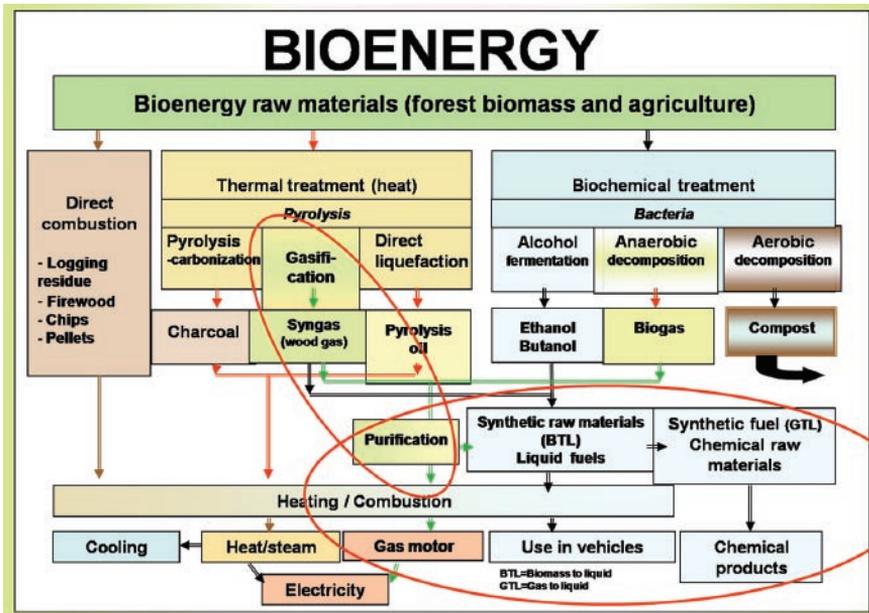


Figure 1 Main areas of research within the HighBio project.

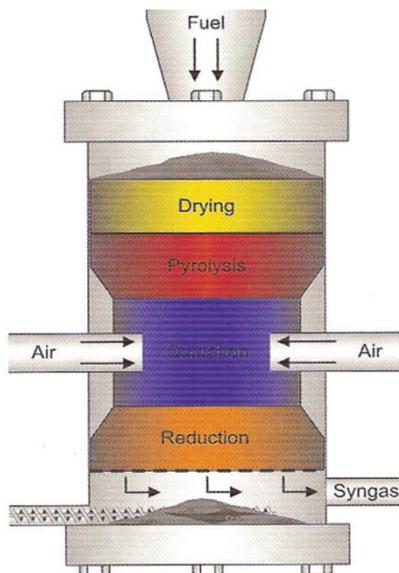
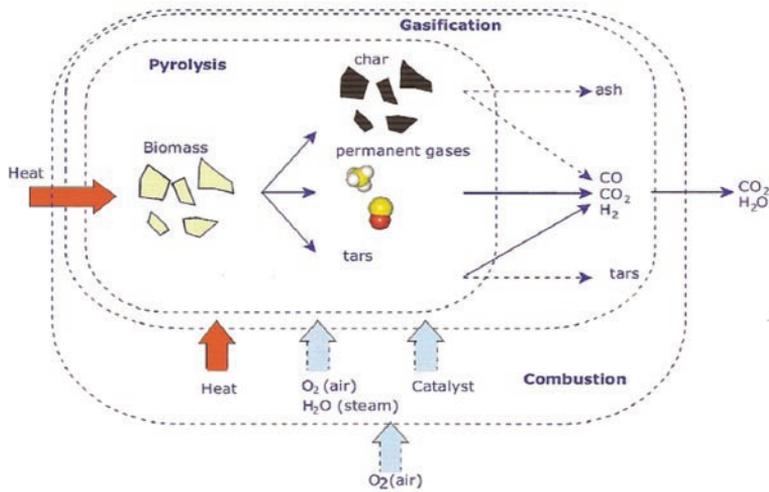


Figure 2 Operation principle of a down draft –flow gasifier (cf. Knoef, 2005).



**Figure 3** Biomass gasification as a part of the combustion process (cf. Knoef, 2005)

### 3.3 Utilisation of end-products of gasification (WP3)

WP3 involves the utilisation of end-products to new, valuable products. This WP involves the utilisation of product gas (after purification syngas of wood gas) to new chemicals and the use of it in new applications, e.g. in BTL (biomass-to-liquid) and in GTL (gas-to-liquid) catalysis (see Figure 4). This requires high purity of gas (low tar content, low amount of other impurities, inert gas concentration below 2 vol-%, optimised H<sub>2</sub>/CO ratio etc) depending on the application. (Boerrigter et al., 2002; Boerrigter and Rauch, 2006)



**Figure 4** Reactor system for catalytic conversion of syngas.

The purified syngas, a mixture of CO and H<sub>2</sub>, can be applied e.g. in Fischer-Tropsch synthesis over modified Co and/or Fe catalysts (Visconti et al., 2009) or in mixed alcohol synthesis over modified Cu catalysts (Hamelinck and Faaij, 2006). This WP3 also involves the utilisation of the secondary gasification products, such as ash.

### **3.4 Techno-economical analysis and information delivery (WP4 and WP5)**

Techno-economical analysis of thermochemical conversion of biofuels is carried out during WP4. Material and energy balances over the gasification process are considered. One of the main aims of the project, information delivery, is implemented through info sheets (available on internet), research meetings and common seminars biannually.

## **4 Relevance of the research**

Wood combustion for heating purposes has been a traditional way of energy production. Recently, more attention has been paid for the simultaneous heat and power production in small-scale CHP units. Down-draft gasifier used in this research opens up new possibilities not only for the efficient heat and power production (from energy intensive gas), but also opportunities for novel chemical synthesis applying the known catalytic reactions. The utilisation of by-products of gasification (e.g. wood ash) is also current and challenging.

## **Acknowledgments**

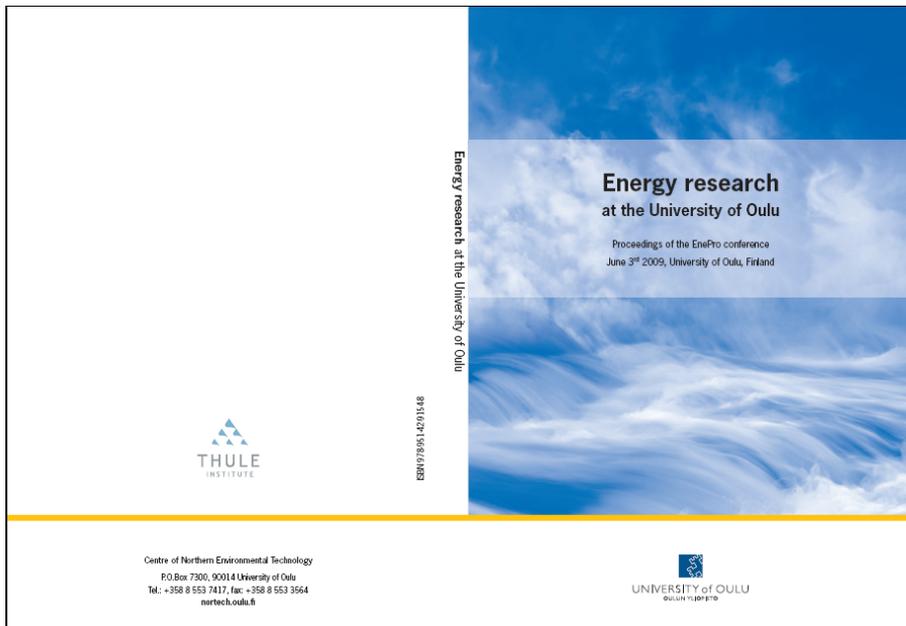
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