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DEPARTMENT OF BIOLOGICAL AND ENVIRONMENTAL SCIENCE • ENVIRONMENTAL SCIENCE AND TECHNOLOGY

FUEL-PELLET RESEARCH IN CENTRAL FINLAND

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INTRODUCTION

Central Finland is home to a multi-faceted pellet business sector. A study funded by the Finnish Centre of Expertise Programme (OSKE) was conducted in order to survey current pellet research activities in Finland and abroad. The objective of the study was to draw-up a local development agenda which identifies research needs. The research proposals will assist in the formation of competitive pellet research clusters in Central Finland among relevant companies and research organisations.

At present, the global industry uses mostly dry sawdust and cutter shavings, from spruce and pine species, to make its pellets. To foster healthy growth in the sector and to alleviate a strong dependence on the wood-processing industry, raw material diversification is needed. The goal is to economically produce fuel-pellets from less-ideal yet more abundant raw materials.

MATERIALS AND METHODS

A survey of recent international pellet-related research was conducted. The main focus was raw material research and emerging technologies related to pellets production. Discussions with local pellet producers took place in order to identify needs of the industry. The project's steering committee consisted of members from the University of Jyväskylä (JYU), the Technical Research Centre of Finland (VTT), Jyväskylä Innovation Oy and Vapo Oy. The main tasks within the study were carried out by JYU and VTT.

PROPOSED RESEARCH

NEW RAW MATERIALS

New raw materials will help alleviate the fuel-pellet sector's strong dependence on the wood-processing industry. In Finland, the most obvious choice, and also one indicated by pellet producers, is forest-based materials such as forest residues (needles and branches). Utilising these materials in pellet production will go hand-in-hand with upgrading technologies (i.e. torrefaction) and new harvesting and drying methods to improve economics.

PELLETISATION

Pelletisation is the final step in a series of processes in which raw materials are prepared for densification. Depending on the material these may include crushing, grinding, drying, mixing and pre-compaction. For a given raw material, there is an optimal production recipe in order to balance pellet quality with economics. Theory and modelling of the process are therefore important and a useful tool is the single-pellet press (Figure 1) with which dynamic process parameters can be better understood.

Basic pelletisation research involves the study of physical and chemical mechanisms in the densification of biomass materials such as: modelling of forces in pellet presses, energy of formation, properties of additives, optimal blends of raw materials. Research begins with use of a single-pellet press and will progress to larger commercial units.

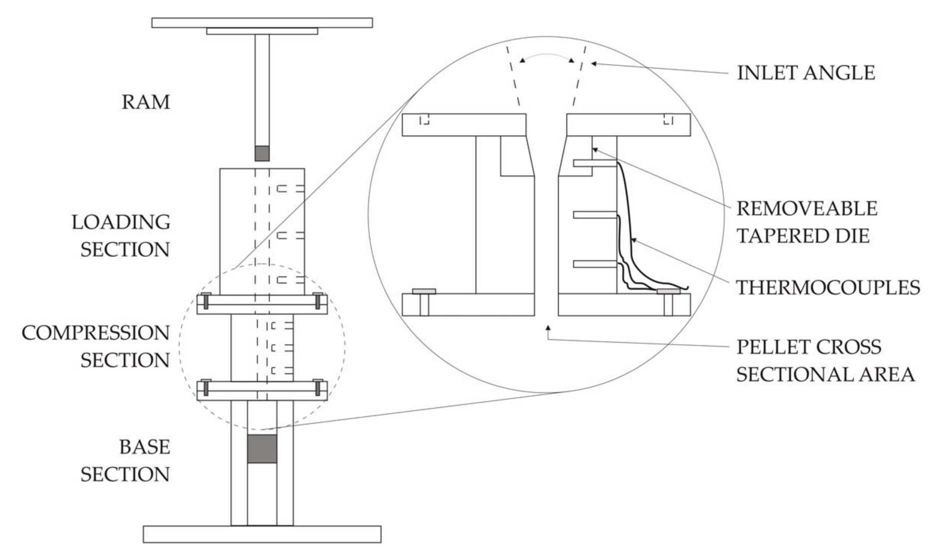

Figure 1. A single-pellet press for study of the physical processes in pellet making. This model has a removable tapered die and allows temperature measurements along compaction channel. Design adapted from [1].

TORREFACTION

The main barriers to utilising non-woody biomass for pellet raw materials are its low energy density, volatile nature in storage and combustion problems. Torrefaction partly solves these problems. The basis of this thermo chemical process is the heating of biomass (both wood and non-wood) over 200 degrees Celsius in the absence of oxygen. The light volatile compounds (i.e. torgas) are removed. The result is an increase in the energy density of the material (Figure 2). Torrefied biomass has more "coal-like" properties and requires less energy for milling. The moisture content of the product is very low. It is also hydrophobic, meaning it won't absorb water, and it is no longer susceptible to biological degradation. Torrefied biomass can be used directly in co-firing or gasification applications or as a feedstock for fuel-pellets.

When combined with pelletisation, torrefaction greatly improves the economics of transporting the fuel (Table 1). In fact, given a raw material of wet sawdust it has been shown that the production of torrefied wood pellets is a markedly better economic investment than that of conventional wood pellets [3]. In this case, the benefits stem from three aspects of the process: the utilisation of torgas as a fuel in the drying process, the reduced energy requirements of milling and the improved economics of transportation (due to greater energy density).

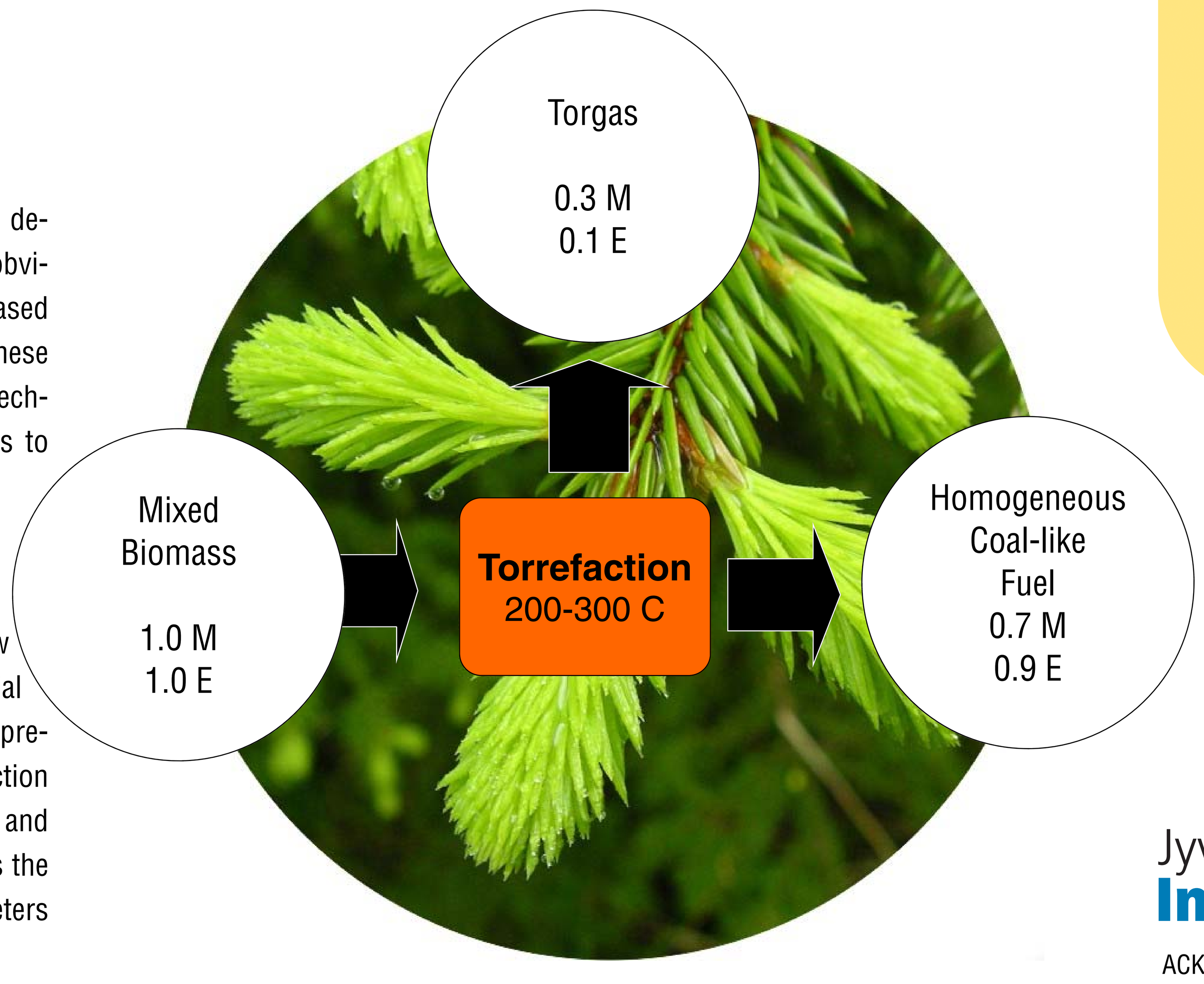

Figure 2. Mass (M) and energy (E) balance of a typical torrefaction process. The solid product has coal-like properties and can be used in co-firing plants or turned into fuel-pellets. Through process optimisation, the energy content of torgas can be utilised in the drying of incoming biomass along with a utility fuel. Adapted from [3]

Properties	Wood chips	Torrefied wood	Wood pellets	Pellets made from torrefied wood
Moisture content (%)	35	0	10	3
LHV (dry)	17.7	20.4	17.7	20.4
LHV (as received)	10.5	20.4	15.6	19.9
Bulk density (kg/ m^3)	475	230	650	750
Energy density (GJ/ m^3)	5.0	4.7	10.1	14.9

Table 1. Physical properties of conventional wood chips and pellets as compared to torrefied wood and pellets made from torrefied wood. Adapted from [2]. LHV = Lower Heating Value

BIOMASS STORAGE ISSUES

The self-heating, or spontaneous heating, of fuel-pellets and biomass raw materials is a problem in pellet production. Self-heating is considered a health risk, due to emissions (CO, CO_2), and a fire hazard. Research of these issues will include: emission of volatile organic compounds from biomass fuels, self-heating mechanisms and prevention and effects of storage on fuel quality. Related subjects of study including: suitable maturity indicators for sawdust and economic assessment of storage costs for different types of biomass fuels (deemed a significant cost-savings factor in torrefied biomass production).

CONCLUSIONS

Global pellet production will continue to expand and utilise new raw materials and technologies. The industry will lessen its dependence on wood-processing by-products and utilise more diverse raw materials.

Pellet research investment is proposed in the following four areas: new raw materials; pelletisation; torrefaction upgrading process and biomass storage issues.

The University of Jyväskylä and VTT will play a central role in collaboration between research and business entities in the formation of a pellet research cluster in Central Finland.

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