CELLULOSE VALORIZATION IN BIOREFINERY: INTEGRATION OF FAST PYROLYSIS AND FERMENTATION FOR BUILDING BLOCKS PRODUCTION

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A combination of thermochemical and biological conversion of cellulosic materials is a promising alternative for the production of biofuels and building blocks in an integrated biorefinery. Indeed, enzymatic depolymerization is selective but slow and expensive. It would be of interest to associate thermochemical conversion for a fast depolymerization of biomass with biochemical conversion for a selective conversion of depolymerized liquid streams. In this work, cellulose is pyrolyzed to produce sugars that can be used as substrate for a fermentation process. This work is the result of a scientific collaboration between ICFAR (London, Canada) and CNRS (Nancy, France).

Pyrolysis was performed in a fluidized bed reactor at 475°C with a bio-oil yield of 73.4 wt.% (Figure 1). Different fractions of bio-oil were recovered with a set of 5 condensers. Levoglucosan and total sugars were quantified by GC-FID-MS and phenol/sulphuric acid method respectively. The maximum yields of levoglucosan (43.7 %) and total sugars (80.4 %) were found in the first condenser that was kept at 70°C.

Due to the non-fermentable condition of levoglucosan, all the oil fractions, as well as a mixture of them, were hydrolyzed to obtain fermentable glucose. The different bio-oil fractions and a mixture of all fractions were used as substrate in a fermentation reactor to produce acetone, butanol and ethanol (ABE). The talk will present the mass yields obtained for the integrated process combining pyrolysis, hydrolysis and fermentation (figure 2).
The microorganisms were not able to grow in the mixture of all fractions. On the contrary, fractions from condenser 1 and 2 lead to normal bacterial growth and fermentation products pattern. Maximum yields (per gram of oil) of acetone=4.6 %, butanol=13.2 % and ethanol=0.1 % were found for the bio-oil collected in the first condenser. These results put in evidence the importance of pyrolysis with staged condensation as an entry for fermentation processes.
The methodology proposed in this work could be applied to other biochemical conversion of bio-oils to produce higher added-value products.

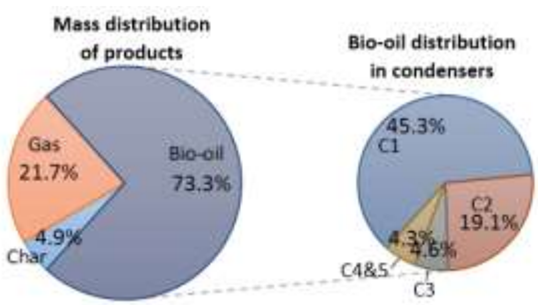

Figure 1. Product distribution of cellulose pyrolysis and condenser mass fractions of bio-oil. C=Condenser. C1=70°C, C2=45°C, C3, C4&5=5°C.

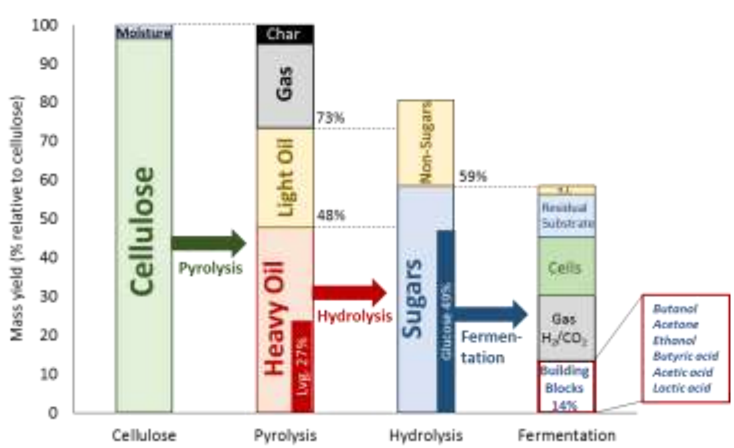

Figure 2. Fate of cellulose and its products along the integrated process including pyrolysis, hydrolysis and fermentation