

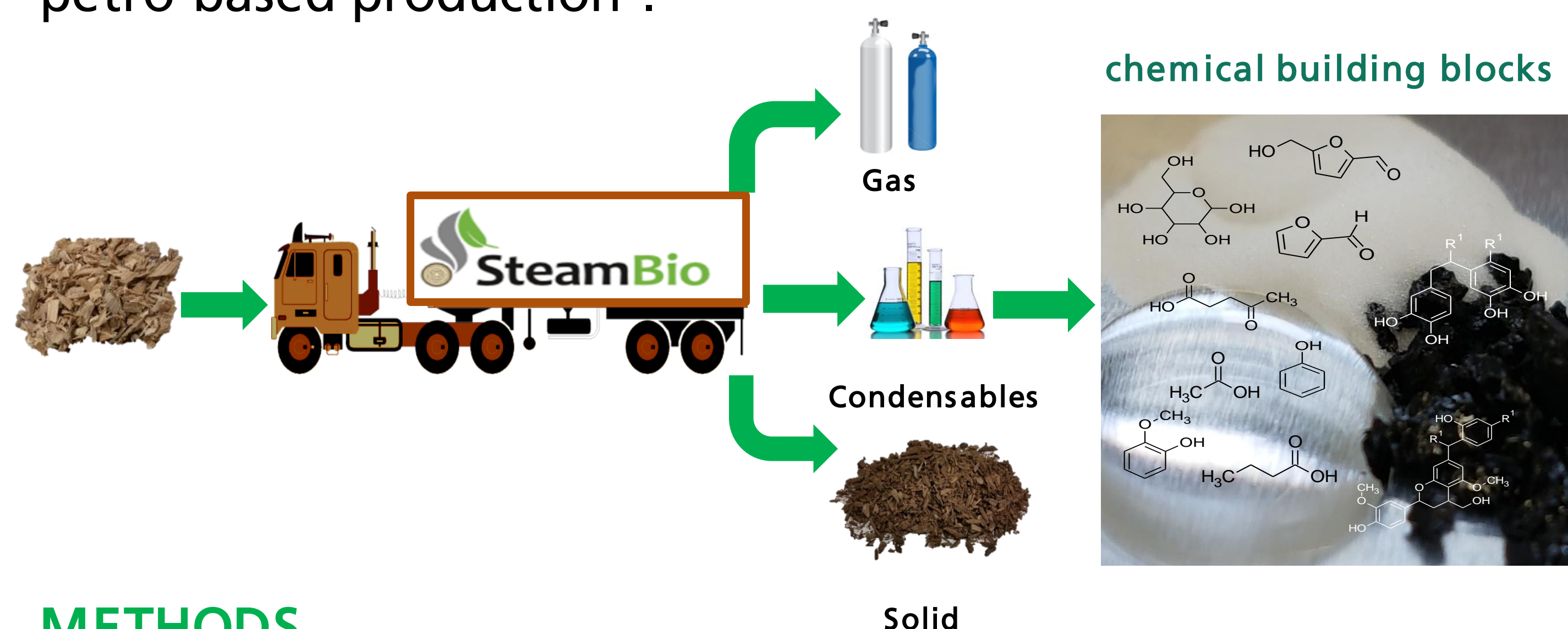
REVALORIZATION OF THE VOLATILE FRACTION FROM SUPERHEATED STEAM TORREFACTION OF INDIGENOUS BIOMASS TO PLATFORM CHEMICALS

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MOTIVATION

The scope of the European project SteamBio is the demonstration of the Superheated Steam Torrefaction (SST) of indigenous biomass to produce bio-based chemicals and energy applications. In order to improve the economy and the environmental impact of SST, the revalorization of the condensable fraction generated during the torrefaction as intermediate for the production of green chemicals and alternative to the petro-based chemicals is the main challenge. This justifies the definition of a purification strategy to obtain valuable chemicals in commercially suitable purities and concentrations. Special attention has been paid to 5-hydroxymethylfurfural (5-HMF) and furfural as the most valuable and promising platform chemicals and alternatives to petro-based production¹.



METHODS

A first concept for the fractionation was developed based on the analytical results of the condensable volatiles from semi-continuous SST trials treating beech wood with bark. SST were carried out in two steps, first drying at 150° C / 5 min and finally torrefaction at 280° C / 40 min. The material was fed in to the semicontinuous reactor at certain time intervals and the organic components released during the process were continuously collected.

The obtained condensate was rectified at up to 200° C using the apparatus shown in Figure 1 equipped with a packed column. Samples were analyzed by GC-TCD.



Figure 1. Batch rectification column with initial condensate and obtained furfural fraction.

RECOVERY OF VALUABLE COMPOUNDS

Analysis showed that the condensed off-stream of volatiles from two-stage semi-continuous SST trials contains 30 wt% to 40 wt% of organic compounds. The main organic component detected was acetic acid (up to 240 g/L). Other compounds like methyl acetate, butyric acid, formic acid, levulinic acid, ethanol, formaldehyde, furans (furfural and 5-HMF) and phenolic components (like guajacol, syringol and vanillin) were found in lower concentrations.

After a preliminary simulation (with CHEMCAD) the batch rectification was selected as the most promising fractionation method. Preliminary tests on a batch rectification column were carried out obtaining six different fractions. The maximal purity achieved was 37% for methanol, 9% for furfural and 56% for acetic acid. The purification of furfural was limited by the formation of their azeotrope with water. Based on these results, the batch rectification was improved by increasing the separation performance. Improvements included variation of packing material, temperature profile and reflux ratio. Several fractions could be isolated leading to defined product specifications (Figure 2).

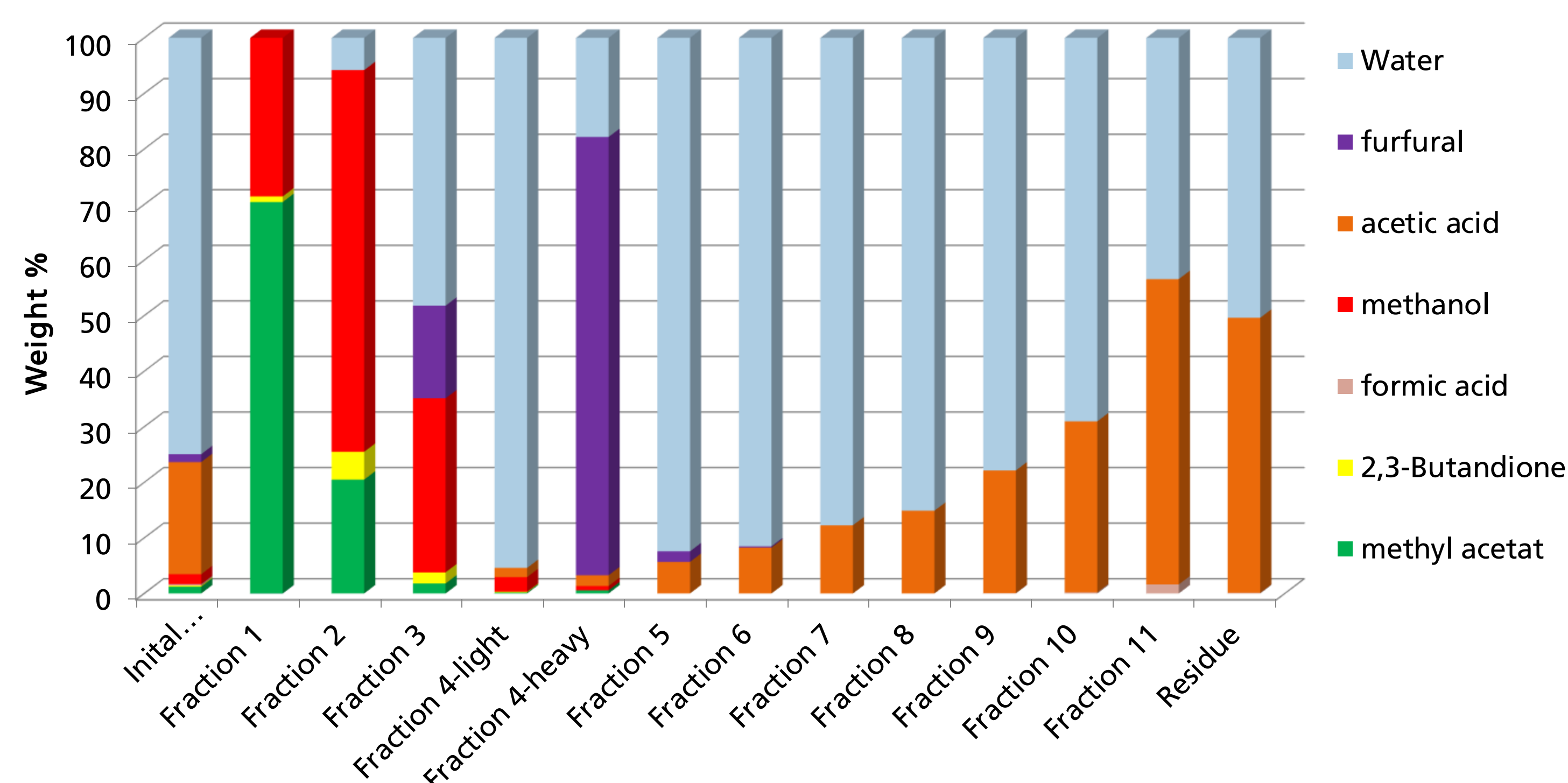


Figure 2. Composition of each fraction obtained after rectification of the SST condensate.

CONCLUSION & OUTLOOK

Furfural can be recovered from SST condensate in a purity of 78 wt% by means of batch rectification. A mixture of methanol and methyl acetate can be recovered as well. By changing the operation conditions during the SST process it might be possible to obtain a higher concentration of the valuable chemicals namely furfural or 5-HMF.