

PYROTransformer - Gas measurement on Flex400 reactor and preliminary results

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Overview

To investigate the effect of wood ash addition on pyrolysis of biomass, a custom built reactor setup (Figure 1) was modified to incorporate the analytical setup for permanent gas analysis (Figure 2). Therefore, the main objective was to develop a method for permanent gas measurement throughout the entire process. At the same time, potential changes through the addition of wood-ash to beech wood samples were investigated. During method development, several issues were encountered, including corrosion of sealing material, gas leaks and clogging of the gas cleaning setup. This poster shows the first successful implementation of the method and preliminary test results.

Method – experimental setup

For the first time, at-line gas measurement using a Agilent 8890 gas chromatography (GC) system was performed on the GreenCarbon Lab (GCL) flex400 reactor.

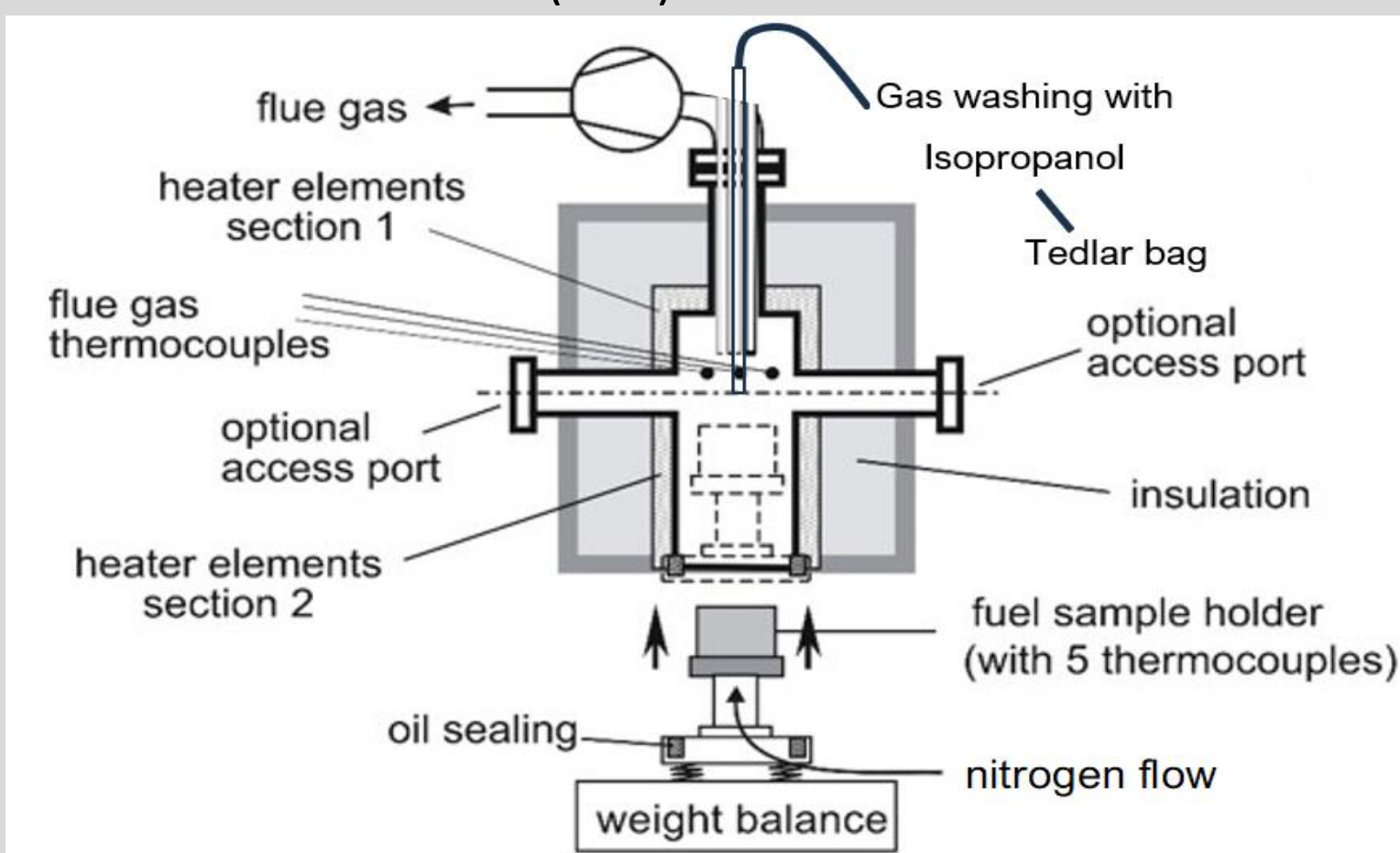


Figure 1. Scheme of GCL flex400

At the upper area of the reaktor, the gas atmosphere (consisting of purged nitrogen and generated pyrolysis gases) was sampled and drawn through several cooled gas washing bottles into a tedlar bag using a pump. Every bag was filled for 5 minutes at approximately 1 L/min and then measured with the GC.



Figure 2. Gas washing with glass wool, glass frit in IPA and silicagel (1), sampling of permanent gas in tedlar bags (2)

Method – mass balance calculations

Char yield:

- Based on input and output masses
- Ash content was analyzed through complete combustion and gravimetric measurement

Gas yield:

- Density based on the assumption of ideal gases and standard conditions
- Volume based on the set Nitrogen flow rate (assuming that Nitrogen is not produced in relevant quantities)
- Relative composition based on weighted mean relating to the volumes in all collected bags

Results

The preliminary results suggest, that most pyrolysis gases are formed during the steepest section of the mass loss curve, with diminishing yields after mass loss stops. Figure 3 shows the mean mass flows of methane, C2-C5 hydrocarbons, carbon dioxide, carbon monoxide and hydrogen for an experiment conducted at 700°C.

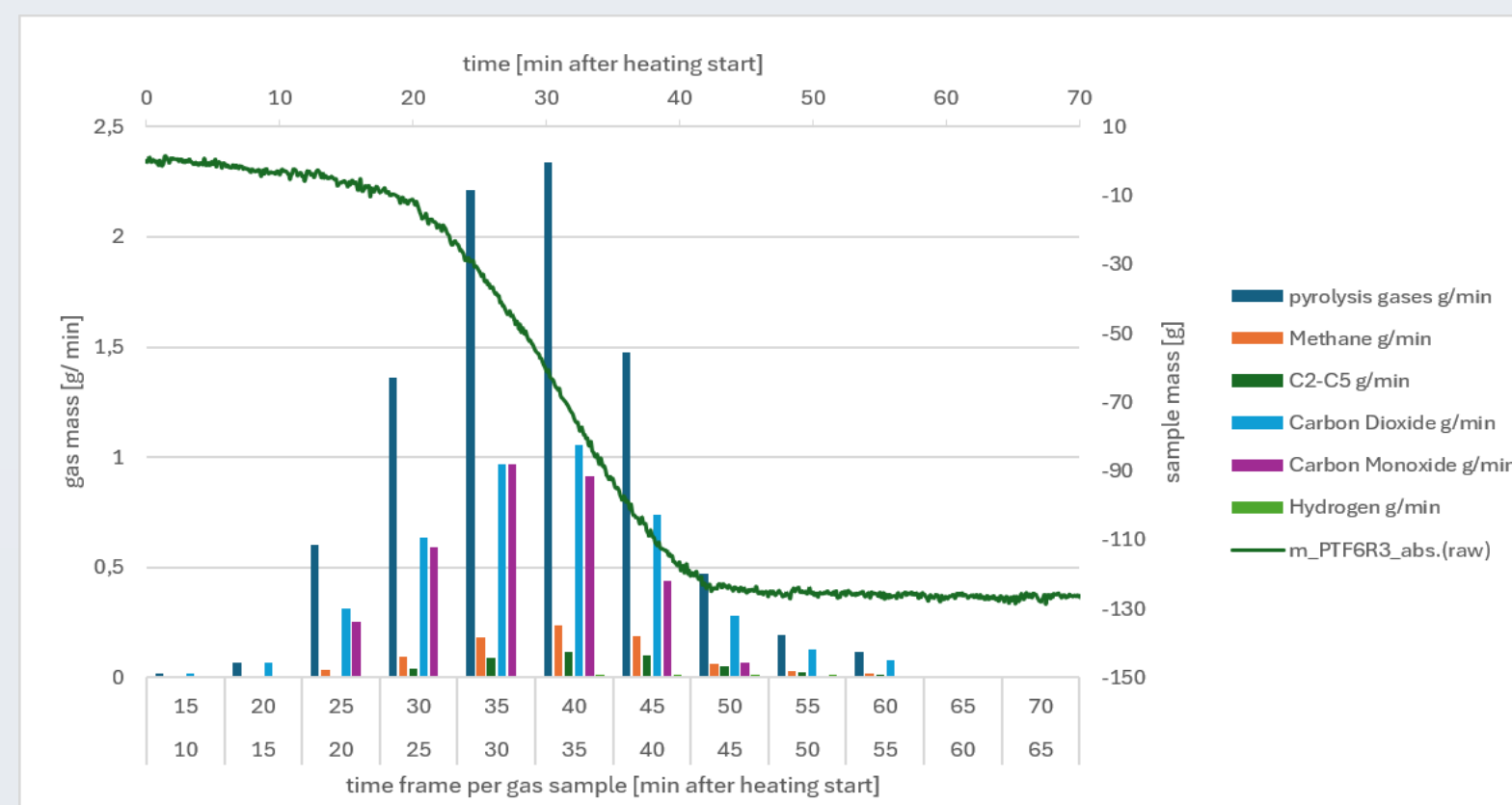


Figure 3. Gas and sample mass during one experiment at 700°C without ash addition, using Beech wood as a feedstock

The data in Table 1 indicate that the addition of wood-ash promotes the release of hydrogen, both at a pyrolysis temperature of 400°C and at 700°C.

pyrolysis temperature	sample	char yield dry and ash free [m%]	Methan [v%]	C2+ [v%]	Carbon Dioxide [v%]	Carbon Monoxide [v%]	Hydrogen [v%]
400°C	beechwood (n=3)	31,96	4,84	1,17	59,74	34,30	-
	beechwood with 16,4% ash addition (n=2)	33,43	3,86	0,73	61,89	33,13	0,33
700°C	beechwood (n=4)	22,47	16,81	4,21	30,69	38,06	11,41
	beechwood + 16,4% ash addition (n=4)	23,86	15,67	4,11	33,95	29,01	17,25

Table 1. Comparison of average char yields and relative gas composition with respect to ash addition and pyrolysis temperatures at 400°C and 700°C for beech wood

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