Biomass pyrolysis: study of parameters determining the charcoal yield by thermogravimetry

INTRODUCTION

Pyrolysis of biomass produces three kinds of fuel components: charcoal, gases and bio-oil. The proportion of each of these fuels depends on experimental parameters. In order to study the influence of these parameters over the charcoal yield, the reaction of biomass pyrolysis is simulated by thermogravimetry. In this application note, three parameters are studied: the mass of sample introduced in the reactor, the heating rate and the sample size.

1. Influence of the mass introduced in the reactor

EXPERIMENT

Samples analyzed are resinous pellets. Pellets were ground, sieved and the resulting 0.125-0.250 mm size fraction was used for the pyrolysis tests. A mass of 17.96 mg (first experiment) and a mass of 199.65 mg (second experiment) were introduced in a platinum crucible. Resinous pellets were heated from 25°C to 1000°C at 10°C/min with a helium flow of 50mL/min in order to maintain an inert atmosphere.

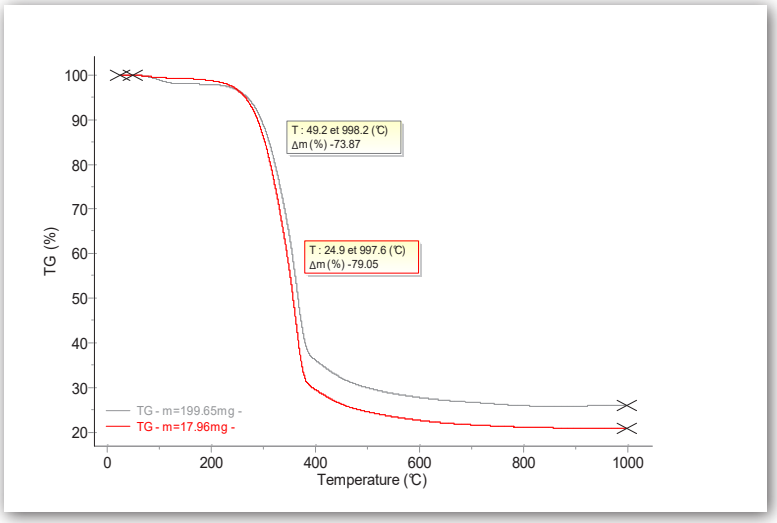

Figure 1 –Weight loss curve (%) vs. temperature for different initial masses of resinous.

RESULTS AND CONCLUSION

On Figure 1 the red and grey curves are the weight loss corresponding respectively to an initial mass of 17.96 mg and 199.65 mg. The first one looses 79.05 % of its initial mass while the second one looses 73.87%. These results demonstrate that increasing the initial mass of sample in the reactor implies an increase of the charcoal yield (remaining mass).

2.Influence of the heating rate

EXPERIMENT

Pellets were ground, sieved and the resulting 0.125-0.250 mm size fraction was used for the pyrolysis test. For each experiment a mass of 20 mg was introduced in a platinum crucible. Resinous pellets were heated from 25°C to 800°C at 1, 10 and 50°C/min with a helium flow of 50mL/min.

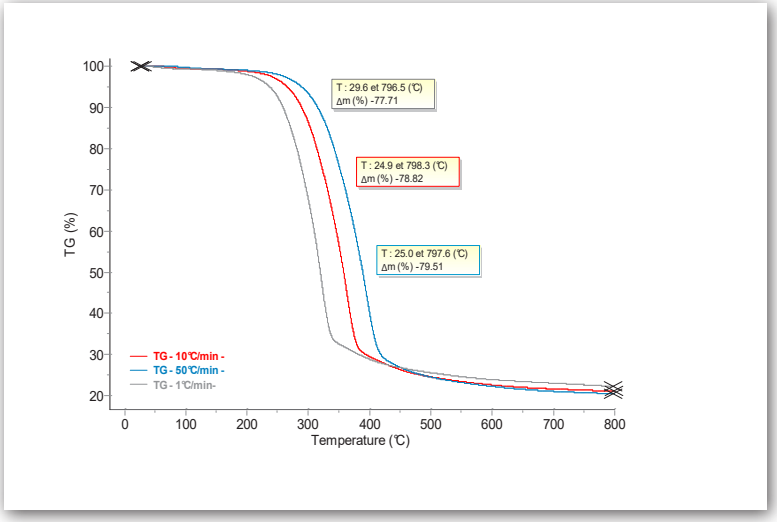

Figure 2 –Weight loss curve (%) vs. temperature for different heating rates.

RESULTS AND CONCLUSION

On Figure 2, the grey, red and blue curves are the weight loss corresponding respectively to a heating rate of 1°C/min, 10°C/min and 50°C/min. The total weight loss differs by one percent, between each heating rate. These results demonstrate that, the higher is the heating rate, the lower is the the charcoal yield.

3. Influence of the sample size

EXPERIMENT

Pellets were ground, sieved and the resulting 0.125-0.250 mm and >0.500 mm size fractionswere used for the pyrolysis. For each experiment a mass of 20 mg is introduced in a platinum crucible. Resinous pellets are heated from 25°C to 1000°C at 10°C/min with a helium flow of 50mL/min.

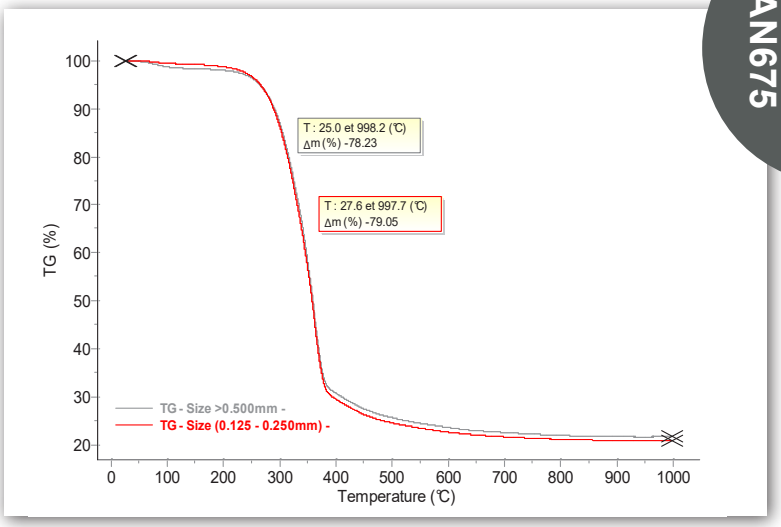

Figure 3 –Weight loss curve (%) vs. temperature for different grain sizes.

RESULTS AND CONCLUSION

On Figure 3, the grey and red curves are respectively the weight loss corresponding to 0.125-0.250 mm and >0.5 mm size fractions. The first one looses 79.05 % of its initial mass while the second one looses 78.23%. Therefore, the charcoal yield increases with the sample size.

GENERAL CONCLUSION

In order to obtain a high yield of gas and bio-oil, in other words a low charcoal yield, the pyrolysis must be carried out with a high heating rate, a low sample mass and a low sample size.

INSTRUMENT

THEMYS TGA

HIGH ACCURACY & VERSATILITY
hang-down symmetrical beam balance, specifically designed for TGA applications

ULTRA-HIGH TEMPERATURE CAPABILITY
to 2400°C with a single furnace.

MODULAR ADAPTIONS ALLOWING
TGA only, DTA only, TG-DTA, and TMA up to 2400°C, DSC only and TG-DSC up to 1600°C all in one instrument.

EXTERNAL COUPLING CAPABILITY
designed for evolved gas analyzers (FTIR, MS, GCMS, MSFTIR, or FTIR-GCMS)