Evolution of CO_2 released during pyrolysis of lignocellulosic biomass and its components.

INTRODUCTION

Biomass is a renewable source of energy if it is produced in a protected environment, allowing its constant production. The renewable characters present an interest to reduce CO_2 emissions. Indeed, when biomass is burnt, it releases CO_2 but this one was previously captured in the atmosphere by photosynthesis. Thus, carbon balance is theoretically neutral during one cycle of production-consumption (Figure 2). The thermogravimetry-FTIR coupling is proposed to study the CO_2 release from lignocellulosic biomass.

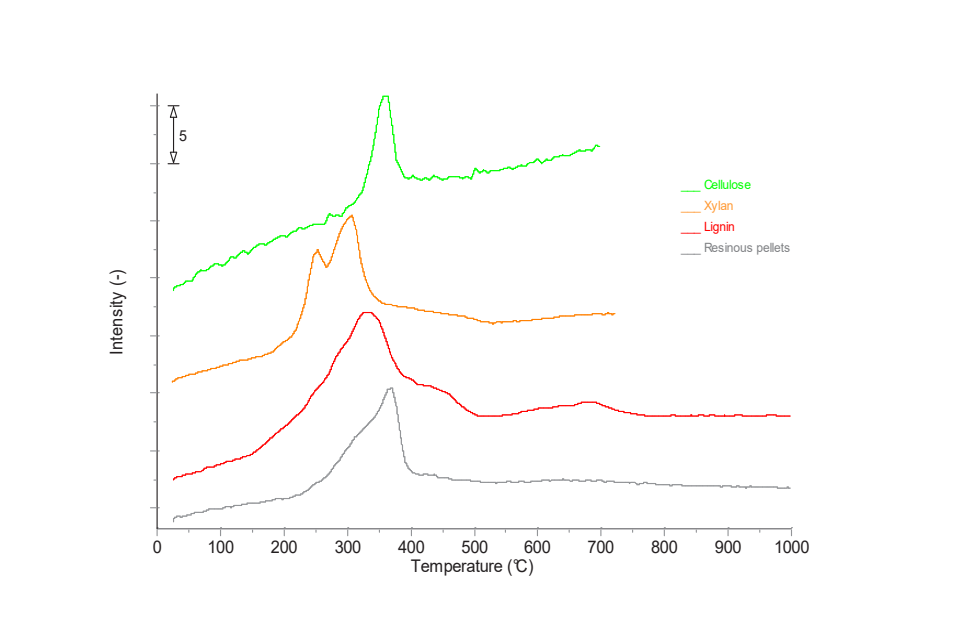

Figure 1 – FTIR profiles of CO_2 product evolving from the three components pyrolysis and a sample of resinous.

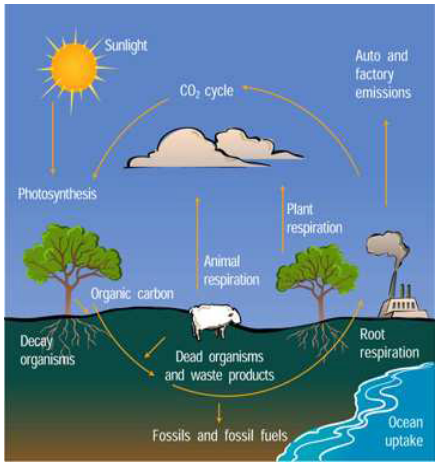

Figure 2 – Carbon cycle.
(Source: National Center for Atmospheric Research)

EXPERIMENT

The three main components (cellulose, hemicellulose and lignin) and resinous pellets are tested on THEMYS TGA connected to a Nicolet 380 FTIR Spectrometer. Samples were introduced in a platinum container and heated from 25°C to 1000°C at 10°C/min under helium atmosphere. The gases released in the TGA were directed immediately towards the FTIR spectrometer. The transfer line was heated to an internal temperature of 200°C. Each FTIR spectrum was obtained with a resolution of 4 cm^{-1} and the FTIR scanning range was from 4000 to 400 cm^{-1}.

RESULTS AND CONCLUSION

According to the literature [1], the releasing of CO2 is mainly caused by the cracking and reforming of functional group of carbonyl (C=O) and carboxyl (COOH). The CO_2 emission profile (Figure 1) of cellulose displays one peak at 360°C. Xylan gets two releasing peaks of CO_2 (253°C and 307°C) with the second much higher than the first one. The releasing of CO2 from lignin is spread over the scale of temperature and gets three peaks (330°C, 430°C and 680°C). However, the CO_2 emission profile of resinous presents one peak starting at 222°C and ending at 400°C.
In conclusion, during lignocellulosic biomass pyrolysis , almost all the CO_2 is released before 500°C. The gases that are emitted after this temperature are due to lignin.

[1] H. Yang and al, Characteristics of hemicellulose, cellulose and lignin pyrolysis, Fuel, Vol.86, pp. 1781-1788, 2007.

INSTRUMENT

THEMYS TGA/STA-EGA

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

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.

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