AUTOTHERMAL BIOCHAR PRODUCTION AND CHARACTERIZATION AT PILOT SCALE

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The present work reports on the results from the validation campaign of an autothermal pilot carbonization unit (CarbON) and on the characterization of the produced biochar and pyrolysis vapors. The proposed pilot plant leverages the simplicity and effectiveness of autothermal operations together with open top, downdraft design, to bring to the small scale the performance of larger installations. In autothermal operation, heat for the process is internally provided by combusting part of the feedstock and evolved volatiles inside the reactor, the so called “oxidative pyrolysis”. Beyond bringing significant simplification in the process layout, autothermal operation also allows for process intensification in biomass pyrolysis. The unit was operated with mixed wood chip (hardwood) with a moisture content of 13.2 wt% (wb), and run continuously over one shift (8 h). In the reported tests, charcoal mass yield in excess of 22 wt% (db) has been achieved, with a fixed carbon content higher than 85 wt% (db). The attained fixed carbon yield (fCy) was 19 wt%, the char carbon yield (CCy) 39 wt% and the net energy conversion efficiency to char (ε) equal to 42 % (db). Volume concentration of permanent gases in the pyrolysis vapors and condensable species were also measured before incineration and critically compared against literature data. Ddry pyrolysis vapors resulted to be composed of: CO2 18 vol%; CO 16 vol%; H2 11 vol%; N2 46 vol%; CH4+ 5-8 vol% (including C2H4, C2H6 and higher); the condensable fraction of pyrolysis vapors had been collected according to UNI CNE/TS 15439, and the liquid analyzed by KF titration and GC-MS. Condensation products resulted to be mainly composed of water (78.25 wt%), a broad mixture of organics with boiling point between 20 and 340 °C (10.27 wt%), and heavier bottom. GC-detectable compounds made up the 47 wt% of the total organic content, a better figure compared to previously published results [1] for a similar process. Biochar chemical and physical properties were compared against national and international standards (EBC, IBI) and results compared with literature. Measured and calculated performance data shows that the pilot unit can produce high quality charcoal, meeting and exceeding the product specifications set by European standard EN 1860-2 for BBQ lump charcoal, and that it is also suitable for metallurgy, activated-carbon manufacturing, and use as biochar. The experimental campaign herein reported provides valuable to validate the results of the technology and to support the upscaling of the proposed process to a larger, demo scale unit. This contribution relates to the conference themes “Biochar production processes: from torrefaction to slow and fast pyrolysis” and “Biochar reactor technologies”.

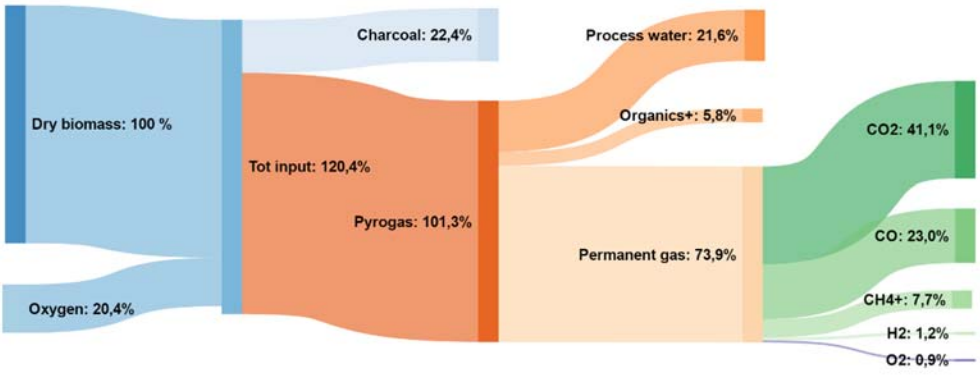

Figure 1 – Calculated process mass balance

References

[1] E. Daouk, Etudes Expérimentale et Numérique de la Pyrolyse Oxydante de la Bioimasse en Lit Fixe, Université Nantes Angers Le Mans, 2015.