Evaluation of heating rate on the pyrolysis of residual biomass for biochar production

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Introduction

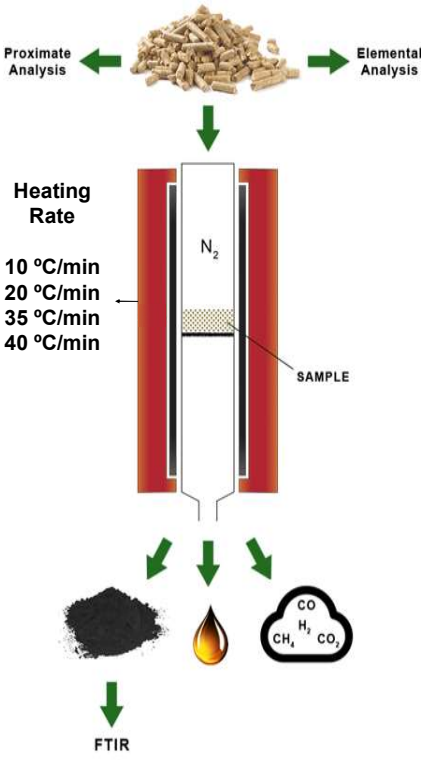
Biochar is a carbon-rich solid product of biomass thermal conversion, which contains several properties for a wide range of applications that promote the attention of industries and researchers. The porous structure of char particles enables its application as soil fertilizer, adsorbent, catalyst, among others [1].

In this context, biomass is a critical resource, as it can be used for biochar production at the same time produce renewable energy, being able to mitigate climate change phenomena.

There are many advantages to using biomass as an energy source, namely its carbon neutrality and being a non-polluting source. In this context, the main technologies for fuel and/or energy production from biomass are pyrolysis, gasification, or combustion [2].

Among technologies for biomass conversion, pyrolysis is widely used, consisting of a thermal decomposition process in absence of oxygen, to convert biomass into biochar, bio-oil and gases, generating no waste during the process [3].

Experimental



Results

Table I. Characterization of pellets biomass.

Parameter	Value (wt%)
Moisture	7.130
Volatile compounds	73.651
Ashes	0.350
Fixed Carbon (FC)	18.877
C	46.526
H	5.576
N	0.119
S	0.000
O	47.779

Figure 1. Effect of heating rate on the yield of biomass pyrolysis products.

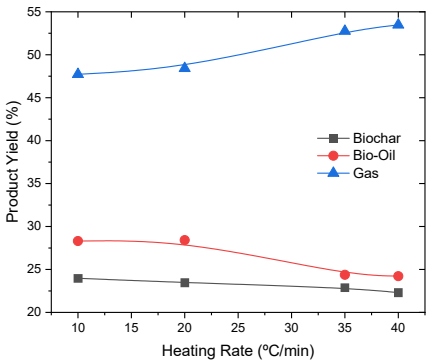
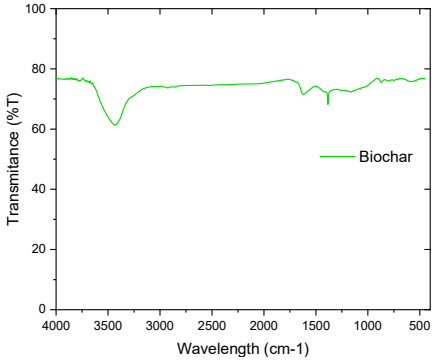


Figure 2. Biochar FTIR characterization.



- Pellets have a low value for ashes, being a suitable feedstock for the pyrolysis
- According to the ultimate analysis, the average chemical formula of this biomass would be $C_1H_{1.43}N_{0.002}O_{0.76}$.
- The increment of the heating rate caused a reduction of the biochar and bio-oil yield. The higher heating rates can provide more energy for the fractionation of the heavy carbonaceous biomass molecules into smaller ones, being a possible cause for this fact, generating more gaseous particles at cost of biochar and bio-oil yield.
- The maximum Biochar yield obtained was 24 wt%, at the milder heating rate tested.
- In the FTIR characterization of the biochar, some bands were identified, as the 3280 cm^{-1} (O-H stretching vibrations), 1730 cm^{-1} (carboxyl C=O stretching mode), and the 1380 to1400 cm^{-1} band (C-C stretching vibrations in the aromatic ring).

Conclusions

- ✓ The pyrolysis proved to be a viable option to obtain renewable energy sources and valorize a worldwide produced waste.
- ✓ Biochar was successfully obtained by the pyrolysis of the biomass, with the highest yield of 24 wt%.
- ✓ Higher heating rates proved to favor the production of the gas fraction, lowering the biochar yield. For biochar production, slow pyrolysis (with lower heating rates) is a more viable strategy.

References

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