Analysing Acidified Biomass Cracking through Thermal Degradation for Sustainable Development

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Keywords: Waste to Energy; Biomass; Carbon Capture; Renewables; Sustainable Development
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Introduction

The bio refinery concept must incorporate a biomass-based energy system in order to improve the energy sector. The International Energy Agency (IEA) states that the two most urgent issues facing the world community are the depletion of the environment and the absence of renewable energy in the energy mix. (Qureshi et al., 2024). Pakistan's energy mix is reliant in major part on imported conventional fuel. Imported petroleum not only degrades the environment but also raises the possibility of geopolitical instability Qureshi et al., 2024). Additionally, due to inadequate waste management techniques, Pakistan's solid waste is increasing dramatically every day. To establish environmental friendly practices, an integrated fuel producing method that relies on regional energy sources and waste-to-energy measures must be implemented (Soltanian et al., 2020). In this study, wheat straw sample composition is acidified in 5% hydrochloric acid to examine various degradation profiles in bio-energy systems used in the bio refinery industry. Due to the presence of high lignocellulosic content, wheat straw has good burning properties. (Mirmohamadsadeghi et al., 2017). Given this context, it conversion of demineralized form during co-combustion, to assess its viability as ecofriendly alternative to conventional energy source, it is necessary to evaluate their potential for sustainability. (Siddiqi et al., 2020).

Materials and Method

In Fig. 1, two-phase thermochemical burning method, encompassing pyrolysis and combustion, was employed on acidified wheat straw under varying heating rates from 20 - 40 ^{o}C min^{-1} and flow rates ranging from 20 – 40 mL*min^{-1}, respectively, under nitrogen environment from 0 ^{o}C to 500 ^{o}C and air from 500 ^{o}C to 900 ^{o}C respectively in thermos-gravimetric analyzer (TGA).

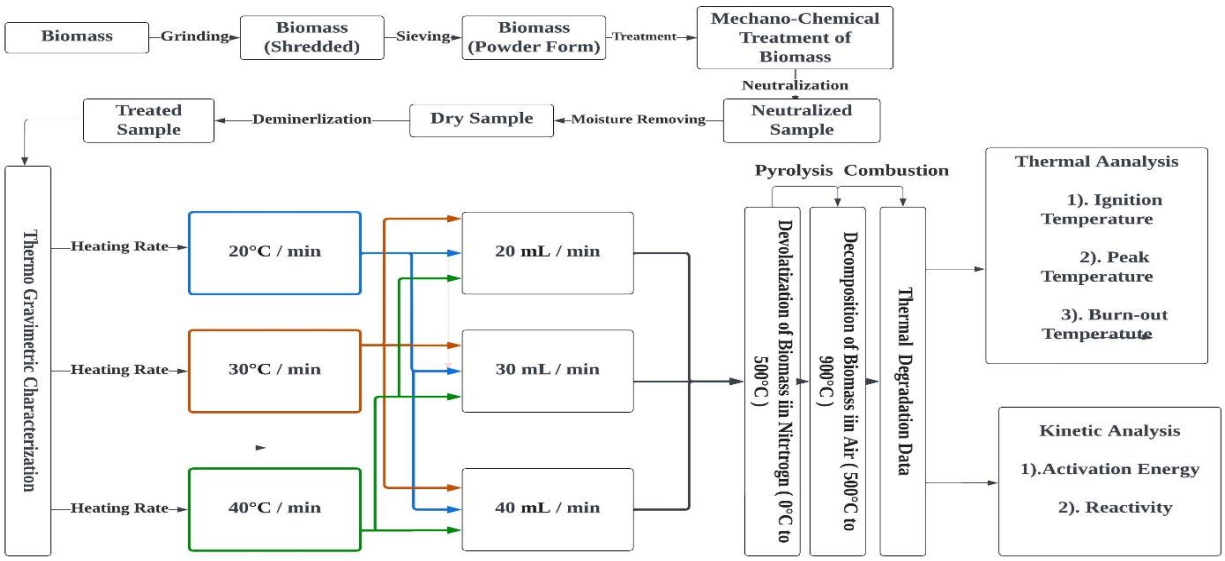

Figure 1: TG investigation of wheat straw on the basis of heating rate

In addition thermal and kinetic analysis will be conducted in order to find burning fuel properties e.g. degradation temperatures, activation energy and reactivity.

Results and Discussion

Fig. 2 shows the variation in TG and DTG curve of biomass due to heating rate. It is quite evident from graphical data that the placement of the maximum temperature points on the TG pattern and the pace of deterioration are both impacted by a rise in heating rate. The gradient of the TG curves somewhat increases as the flow rate rises. This is due to the possibility that a larger flow rate may result in more turbulence and mixing, which will increase the frequency of the object's fluid surface contact at different angles. Increasing the effective surface area as a result. According to the DTG graphs, burning becomes smoother and more consistent as heating rate increases, because less air reaction occurs. On the other hand, a rise in flow rate causes multi-ways cracking to become unresolved multi-cracking. "Multistage cracking" in biomass refers to the gradual breakdown of complicated organic substances into smaller species at different temperature points.

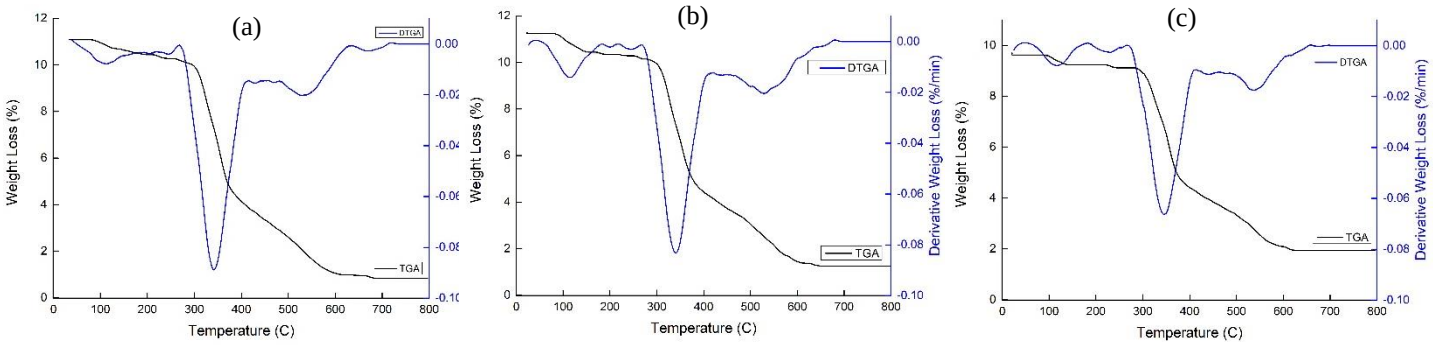

Figure.2: TG and DTG Profile Wheat Straw Samples on the basis of Heating Rate 20 ^{0}C heating rate profile (b) 30 ^{0}C heating rate profile (c) 40 ^{0}C heating rate profile

Conclusion

The results indicated that demineralization has enhanced the organic characteristics of the wheat straw, leading to improved trends in complete combustion and higher energy output. Moreover, different combinations of heating rate and flow rates appear to exert a notable influence on detioration patterns, resulting in less energy require for biomass activation and high reactivity values under specific conditions.

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