Production of biochar from biomass

Iqmat Iyiola[1], Deepak Pudasainee[1], Md Khan[1], Rajender Gupta[1]

[1]Department Chemical and Materials Engineering, University of Alberta

Abstract

Biochar is a kind of charcoal that's produced from biomass using pyrolysis technology. As climate change continues to be a growing concern, biochar has been sought for its environmental applications. It is both cost effective and environmentally sound in terms of being a soil additive and renewable fuel. When used as a soil amendment, biochar has been shown to improve water holding capacity and absorb more nutrients. Biochar also sequesters carbon dioxide when applied to soil, and can also be used as a replacement for activated carbon that is prepared from coal. The objectives of this research was to produce biochar from biomass and study biochar's properties. A thermogravimetric analysis (TGA) was used to measure the weight loss behavior of the wood sample (biomass) as the temperature increased. The biomass was heated to 500 °C in a nitrogen atmosphere and then cooled in nitrogen to prevent combustion of biochar. The overall yield of biochar was 15%. Elemental analysis of biomass shows the composition of the sample to be mostly carbon and oxygen with fewer amounts of hydrogen and nitrogen. Surface area of the prepared biochar was 305 m2/g, which is approximately 100 times the surface area of raw biomass. Biochar's higher porosity will allow for greater absorption of nutrients when applied to soil.

Key words:
biomass, biochar, TGA, proximate analysis, elemental analysis, chemical engineering

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Department of Chemical & Materials Engineering, University of Alberta

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Introduction

- Biomass is a renewable source of energy that comes from animal and plant materials. [1]
- Biochar is a kind of charcoal that is produced from biomass using pyrolysis technology.
- There are multiple environmental and agronomic benefits when biochar is used as a soil amendment. [2]
- Reports on the impact of biochar on soil indicate that biochar quality is important for crop yields.
- The objective of this research is to produce biochar from biomass and to study its properties.

Methods

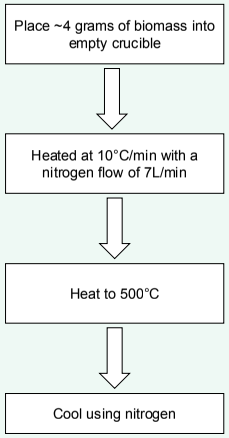

Figure 2: Char preparation method in TGA

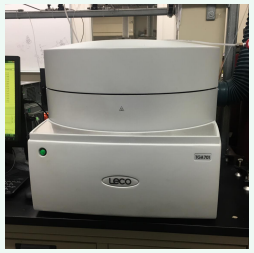

Figure 1: TGA Leco

Thermogravimetric Analysis (TGA) was used to measure the weight loss behaviour of the biomass as temperature increases.

Figure 3: Wood is shredded to 1-2mm samples and then charred in the TGA

Results

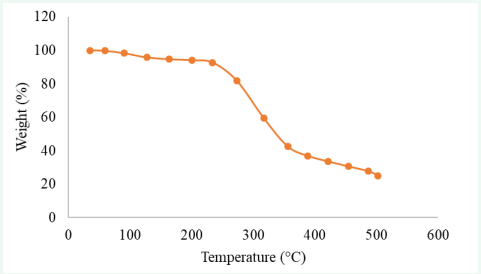

Figure 4: TGA curve to show weight loss at different temperatures

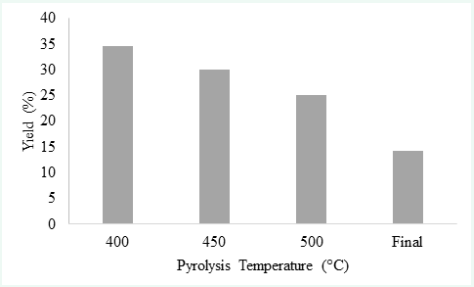

Figure 5: Char yield at different temperatures. Particle size of the biomass used was 425micron to 2mm

Table 1: Proximate Analysis (weight percentage)

Sample	Moisture	Volatile	Ash	Fixed Carbon
Wood	6.5	76	1.5	16

Table 2: Elemental Analysis (weight percentage)

Sample	Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen*
Wood	46	6.2	0.2	0	47.6

*Calculated from difference

Table 3: Surface Area & Pore Volume

Sample	Surface Area m^2/g	Total pore volume cc/g
Wood Char 500	305	2.00E-01

Figure 6: Biomass after shredding (425micron to 2mm)

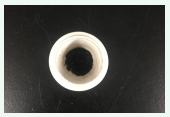

Figure 7: Biochar obtained at 500°C

Conclusions

- Biochar was prepared in laboratory using TGA.
- The biomass weight loss was approximately 80%. Final biochar yield was about 15%.
- Proximate analysis of biomass shows that the sample contains 6.5% moisture, 76% volatile, 16% fixed carbon, and 1.5% ash.
- Elemental analysis of biomass shows the composition of the sample to be mostly carbon and oxygen with less amounts of hydrogen and nitrogen.
- Surface area of the prepared biochar was 305 m^2/g, which is approximately 100 times the surface area of raw biomass.

Applications

- Biochar has been shown to improve water holding capacity as it effectively absorbs both nutrients.
- Biochar can be used as a replacement for the activated carbon that is prepared from coal (non-renewable resource)

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