ISDC 2020 International Sustainable Development Conference

Theme: Our Common Future

Time | 2020/11/27-28

Venue | NPUST Pingtung Taiwan

ZERO-WASTE AGRICULTURAL SYSTEM FOR THE SUGARCANE INDUSTRY

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I. INTRODUCTION

The output of sugarcane bagasse was estimated at 56 million tons in 2020, mostly used for traditional purposes. Its potential as a fuel for energy-efficient processes has captured increasing attention in recent years, especially with gasification - a thermochemical conversion process that transforms a carbonaceous material into a CO and H2-riched gas called syngas. Syngas offers a wide variety of applications such as heat, electricity, or biofuel production.

However, the main problems of biomass gasification are the rigidity in raw material selection and the important amount of solid waste generated. Increasing the use of solid waste after the process is required to ensure the sustainable development of this technology. Therefore, this study aims to characterize the solid waste from bagasse gasification and propose effective applications.

II. MATERIALS AND METHODS

Bagasse feedstock

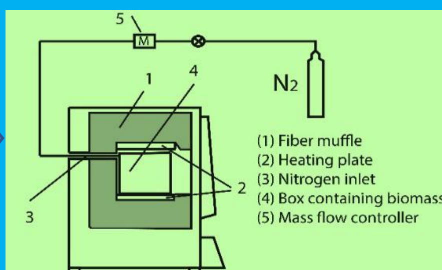

Figure 1. The char production system (1) Fiber muffle, (2) Heating plate, (3) Nitrogen inlet, (4) Box containing biomass, (5) Mass flow controller

Char production

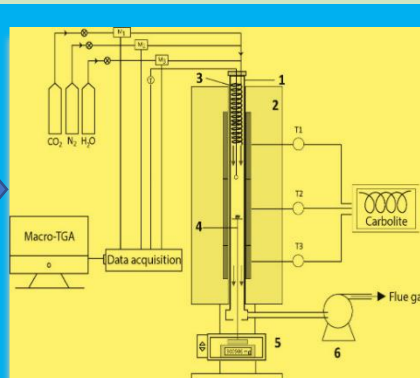

Figure 2 : The Macro-TGA system (1) Ceramic tube, (2) Electric furnace, (3) Pre-heater (4) Sample holder, (5) Weighing scale (6) Gas

Gasification experiments

Characterization of residue

III. RESULTS AND DISCUSSION

3.1. Characteristics of bagasse

3.2. Conversion profile of bagasse char

3.3. Characteristics of residues

3.3.1. SEM – EDS

3.3.2. Surface chemistry

3.3.3. N2 adsorption-desorption

Table 1. Proximate and ultimate analysis of bagasse

Proximate analysis	
Higher heating value ($MJkg^{-1}$)	17.8 ± 0.1
Ash content (% wt, db.)	0.70 ± 0.05
Fixed carbon (% wt, db.)	16.32 ± 0.06
Volatile matter (% wt, db.)	82.98 ± 0.03
Ultimate analysis	
C (% wt, daf.)	46.01 ± 0.02
H (% wt, daf.)	6.38 ± 0.03
N (% wt, daf.)	0.12 ± 0.01
O (% wt, daf.)	47.44 ± 0.04
S (% wt, daf.)	0.05 ± 0.01

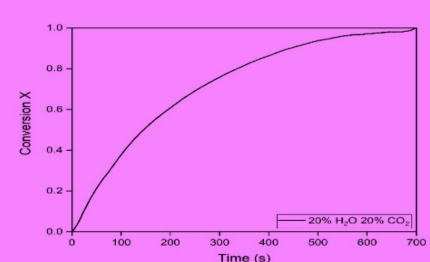

Figure 3. Conversion profile of bagasse char

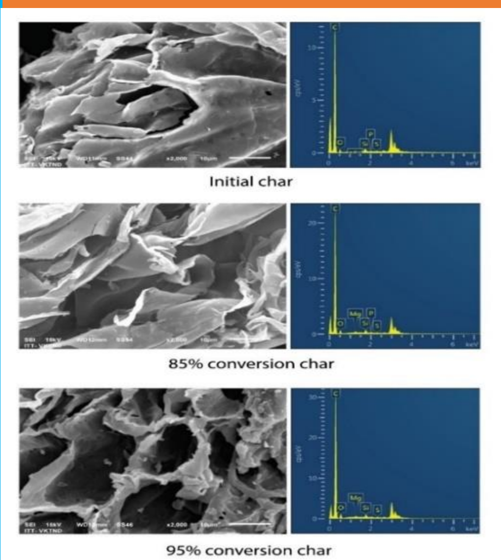

Figure 4. SEM – EDS of bagasse charsure 4. SEM – EDS of bagasse chars

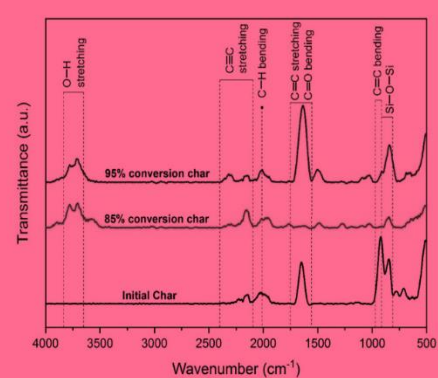

Figure 5. FT-IR results of bagasse chars

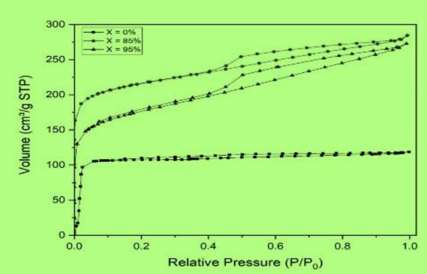

Figure 6. Adsorption – desorption isotherms of bagasse chars

Table 2. Specific surface areas and volume of bagasse chars

Conversion degree	S_{Total} (m^2g^{-1})	V_{Total} (cm^3g^{-1})	V_{Macro} (cm^3g^{-1})	V_{Micro} (cm^3g^{-1})	Mean pore diameter (nm)
X = 0	300	0.242	0.083	0.175	2.04
X = 0.85	819	0.438	0.167	0.357	2.14
X = 0.95	643	0.422	0.226	0.294	2.62

IV. CONCLUSIONS AND SUGGESTION

A deep investigation of the characteristics of the residue after bagasse gasification was presented in this study. Gasification kinetics of bagasse char was shown to be comparable to those of wood char, and higher compared to some other biomass types, highlighting the potential of bagasse gasification. The total specific area and total pore volume of chars at high conversion degrees significantly increased and in the range of commercial activated carbons.