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Characteristic analysis of phytoremediation plants and the possible use in resource recycling

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Background and Objectives

Phytoremediation is practical application in contaminated soil treatment. Furthermore, the possible use of phytoremediation plants need to be considered for sustainable development. In this work, we applied the phytoremediation plants, paper mulberry to be used as solid recovered fuel (SRF). Proximate analysis and elemental analysis of phytoremediation plants are conducted to collect basic composition data. Furthermore, characteristics analysis (carbon monoxide content, carbon dioxide content, methane content, hydrogen content, hydrocarbon content) of flammable gas converted from SRF in high temperature pyrolysis/gasification processes are also conducted in present work. The heating value of flammable gas has also been calculated. Besides that, a rated power 120KW engine is applied, the power generation efficiency is evaluated, also the emissions from 120KW generator were analyzed in present. The solid products were examined to determine their generation amounts, properties, and possible pollution control methods.

Materials and Methods

In this research, paper mulberry was collected from an illegal damping site in central Taiwan as shown in Fig. 1. After that, paper mulberry trees were crushed to 0.8 cm~1.2 cm put pellet's diameter and were exanimated with proximate analysis and elemental(Fig.2). A high temperature pyrolysis process was applied convert wood waste to energy(Fig.3). Characteristic analysis of flammable gas from paper mulberry wood waste was taken via GC-TCD/FID, FTIR and portable flammable gas analyzer.

Fig. 1 Paper mulberry

Fig. 2 Wood chips.

Fig. 3 Pyrolysis equip.

Results and Discussions

Results from approximate analysis showed that the water content of the paper mulberry woods was 24.5%～25.3%, ash content 0.5%～0.6%, and volatile matter 74.2% %～74. 9%. The elemental analysis results were revealed in Table 1.

After a high temperature pyrolysis process, converting wood waste to energy, the characteristic analysis of flammable gas showed the H_2 concentration was 22.88±2.51%, the CO concentration was 11.62±0.00%, the CH_4 concentration was 7.08±0.04%, the C_mH_n concentration was 1.43±0.26%, the CO_2 concentration was 12.15±0.00%, the O_2 concentration was 10.93±0.00%.

Table 1 Elemental analysis of the paper mulberry woods.

	Items	Unit	Sample 1	Sample 2	SRF regulation (Taiwan)
Proximate analysis	Moisture content	%	25.3	24.5	--
	ash	%	0.5	0.6	--
	Combustible matter	%	74.2	74.9	
Ultimate analysis (as dry base)	C	%	42.61	43.57	--
	H	%	5.86	5.90	--
	O	%	49.00	48.12	--
	N	%	1.72	1.33	--
	S	%	<0.01	<0.01	--
	Cl	%	0.16	0.29	≦3
Calorific analysis (as arrival)	LHV	kcal/kg	2,938	2,911	≧2,392
Metallic analysis (as dry base)	Pb	mg/kg	164.6	42.0	≦150
	Cd	mg/kg	<5	<5	≦5
	Hg	mg/Mcal	<0.1702	<0.1718	≦0.6279

The lower heating value (LHV) of flammable gas was calculated as, (Kantarelis et al(2009))

LHV= (30[CO]+25.7[H2]+85.4[CH4]+151.3·[CmHn]) *4.2/1000 MJ/Nm^3

= 7.38 MJ/Nm^3= 1,758 kcal/ Nm^3

Besides that, the residues ash of pyrolysis treatment (Fig.4) presented a good copper ions adsorption and methanol blue solution adsorption performances. Contacting with an initial concentration of 200mg/l and 300 ng/l of copper sulfate solution in solid to liquid ration of 1:20, the pyrolysis residues showed a 99.80%～99.94% and 99.88%～99.95% copper removal efficiency, respectively(shown in Fig.5). It also posed good adsorption capacity (in solid to liquid ration of 1:20) when used in methanol blue solution (initial concentration of 10 mg/l, 50mg/l, 100mg/l) removal (Fig.6).

Fig. 4 Pyrolysis residues.

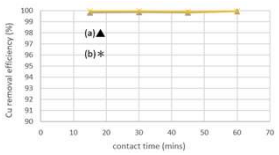

Fig. 5 Cu removal efficiency of pyrolysis residues contacting with (a)200mg/l, (b) 300mg/l $CuSO_4$ solution

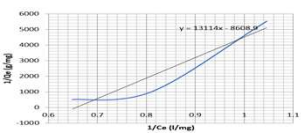

Fig. 6 Langmuir isotherm of methanol blue solution applied with pyrolysis residues.

Conclusions

1. The paper mulberry woods could be used as phytoremediation plants in illegal damping site, and were suitable to be an energy resources-solid recovered fuel (SRF). Characteristic analysis showed Cl content, LHV meet the SRF regulation in Taiwan. The Pb content might be a little bit high, and it need to pay more attention.
2. The flammable gas from pyrolysis process showed LHV is 7.38 MJ/Nm^3 (1,758 kcal/ Nm^3).
3. The pyrolysis residues posed good copper removal and methanol blue solution removal performances.