CATALYTIC CO-PYROLYSIS OF SUGARCANE BAGASSE AND WASTE PLASTICS USING ZEOLITE AND HYDROXYAPATITE BASED CATALYST FOR HIGH QUALITY PYROLYSIS OIL IN A FIXED-BED REACTOR

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by

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LIST OF SYMBOLS

Symbol	Description	Unit
A	Pre-exponential factor	min^{-1}
E	Activation energy	kJ/mol
g(α)	Mechanism function	-
α	Conversion of the combustible sample	-
·OH	Hydroxyl radical	-
R	Universal gas constant	J/mol·K
R^2	Correlation coefficient	-
T	Absolute temperature	K
w_o	Initial mass of sample	mg
w_f	Final mass of sample	mg
w	Mass of sample at time t,	mg
ΔW	Weight loss	wt%

LIST OF ABBREVIATIONS

BET	Brunauer-Emmett-Teller
BJH	Barret-Joyner-Halenda
BOFS	Basic oxygen furnace slag
CE	Cellulose
CS	Corn stalk
CDM	Clean Development Mechanism (CDM)
CR	Coats-Redfern
DAEM	Distributed activation energy model
DTG	Derivative thermogravimetric
EAFS	Electric arc furnace slag
EDX	Energy dispersive X-ray
FAU-EAFS	Faujasite-electric arc furnace slag zeolite
FWO	Flynn-Wall-Ozawa
GC–MS	Gas chromatography–mass spectrometry
GC-TCD	Gas chromatography-thermal conductive detector
HAP-ZE	Hydroxyapatite-zeolite
HHVs	High heating values
H/C_{eff}	Hydrogen-to-carbon effective ratio
HDPE	High-density polyethylene
IUPAC	International Union of Pure and Applied Chemistry
KAS	Kissinger-Akahira-Sunose
LDPE	Low-density polyethylene
LLDPE	Linear low-density polyethylene

MSW	Municipal solid waste
m/z	Mass to charge ratio
NH_3-TPD	Ammonia temperature-programmed desorption
NIST	National Institute of Standards and Technology
PAHs	Polyaromatic hydrocarbons
PAW	Paulownia wood
PC	Polycarbonate
PE	Polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PS	Polystyrene
PST	Peach stones
PSW	Plastic solid waste
PVC	Polyvinylchloride
Py-GC/MS	Pyrolysis-gas chromatography/mass spectrometry
RS	Rice straw
SCB	Sugarcane bagasse
SEM	Scanning electron microscopy
TGA	Thermogravimetric analysis
TG	Thermogravimetric
TG-MS	Thermogravimetric -mass spectrometry
WP	Waste newspaper
WS	Walnut shells
XRD	X-ray diffraction
XRF	X-ray fluorescence

YP	Yellow poplar

CO-PIROLISIS BERMANGKIN KE ATAS HAMPAS TEBU DAN SISA PLASTIK MENGGUNAKAN PEMANGKIN BERASASKAN ZEOLIT DAN HIDROKSIAPATIT UNTUK MENGHASILKAN MINYAK PIROLISIS BERMUTU TINGGI DI DALAM REAKTOR LAPISAN-TETAP

ABSTRAK

Kesusutan sumber asli, permintaan petroleum yang besar dan kebimbangan alam sekitar telah mencetus motivasi kajian pada bahan api boleh diperbaharui dari biomas. Kajian ini bertujuan menyelidik co-pirolisis dan co-pirolisis bermangkin ke atas hampas tebu (SCB) dan polietilena berkepadatan tinggi (HDPE) atau polietilena teraftalat (PET) di dalam reaktor lapisan tetap pemanasan perlahan menggunakan pemangkin zeolit (FAU-EAFS) dan hidroksiapatit-zeolit (HAP-ZE) yang disediakan dari arka elektrik sanga relau. Dalam proses co-pirolisis, kesan suhu tindak balas (400-700 ℃) dan nisbah biomas kepada plastik (100:0-0:100) ke atas hasil keluaran, komposisi kimia dan juga kesan bersinergi telah dikaji. 63.69 wt% hasil cecair optimum dicapai pada 600 °C dan nisbah SCB kepada HDPE 60:40 di dalam co-pirolisis SCB dan HDPE manakala 60.94 wt% hasil cecair dicapai pada 600 °C dan nisbah SCB kepada PET 40:60. Dalam bahagian co-pirolisis bermangkin, kesan suhu tindak balas (400-700 ℃), nisbah pemangkin kepada bahan mentah (1:10-1:2) dan nisbah plastik kepada biomas (0:100-100:0) ke atas hasil keluaran dan komposisi kimia telah dikaji. 68.56 wt% and 71.01 wt% maksimum minyak-pirolisis diperolehi dalam co-pirolisis bermangkin SCB dan HDPE menggunakan pemangkin FAU-EAFS dan HAP-ZE. Co-pirolisis bermangkin SCB dan PET menggunakan pemangkin FAU-EAFS dan HAP-ZE, menghasilkan 42.95 wt% and 45.64 wt%, maksimum minyak-pirolisis. Co-pirolisis

bermangkin SCB dan HDPE menggalakkan pengeluaran hidrokarbon dan alkohol manakala co-pirolisis bermangkin SCB dan PET meningkatkan pengeluaran aromatik dan asid. Berbanding HAP-ZE, FAU-EAFS menunjukkan prestasi yang lebih baik dalam pengeluaran hidrokarbon dan aromatik semasa co-pirolisis bermangkin SCB dan HDPE atau PET kerana keasidan yang kuat dan saiz liang yang lebih besar yang meningkatkan tindak balas peretakan dan penyahoksigen dan kecekapan resapan wap pirolisis ke dalam liang pemangkin. Kelakuan pirolisis haba, co-pirolisis dan co-pirolisis bermangkin bagi SCB dan HDPE telah ditentukan menggunakan analisis termogravimetri manakala parameter kinetik telah dikira menggunakan kaedah Coats-Redfern. Di kawasan kedua di mana uraian selulosa dan hemiselulosa menjadi dominan, kolerasi paling sesuai untuk HDPE diperihalkan oleh mekanisme tindak balas kimia tertib pertama, manakala sampel tindak balas lain dikawal oleh model resapan. Manakala, di kawasan ketiga di mana tindak balas di antara SCB dan HDPE berlaku, kesemua sampel tindak balas mengikut mekanisme tindak balas tertib. Penambahan pemangkin FAU-EAFS dan HAP-ZE menghasilkan tenaga pengaktifan yang lebih rendah di kawasan kedua di dalam co-pirolisis bermangkin SCB dan HDPE.