ACID-BASE BIFUNCTIONALIZED HYDROTALCITE CATALYST FOR BIODIESEL PRODUCTION FROM WASTE COOKING OIL USING ULTRASOUND-ASSISTED REACTOR SYSTEM

by

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iii

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENT	ii
TABLE OF CONTENTS	iv
LIST OF TABLES	X
LIST OF FIGURES	xiii
LIST OF SCHEMES	xviii
LIST OF PLATES	xix
LIST OF ABBREVIATIONS	XX
LIST OF SYMBOLS	xxiii
ABSTRAK	XXV
ABSTRACT	xxvii
CHAPTER ONE: INTRODUCTION	
1.1 Depletion of fossil fuel	1
1.2 Biodiesel	2
1.3 Implementation of biodiesel in Malaysia	4
1.4 Challenges in biodiesel industry	5
1.5 Catalytic esterification and transesterification	7
1.6 Ultrasonication reaction	9
1.7 Problem statement	10
1.8 Objectives	12
1.9 Scope of study	12
1.10 Thesis organization	14

CHAPTER TWO: LITERATURE REVIEW

2.1	Biodi	esel economics	16
	2.1.1	Biodiesel feedstock	16
	2.1.2	Biodiesel production	18
	2.1.3	Biodiesel process intensification	19
2.2	Biodie	sel from waste cooking oil	23
2.3	Biodie	sel production through transesterification and esterification	27
	2.3.1	Transesterification mechanism	28
	2.3.2	Esterification mechanism	29
2.4	Ultras	sound-assisted reaction	30
	2.4.1	Introduction to ultrasound	30
	2.4.2	The principle and mechanism of ultrasound system	32
	2.4.3	Homogeneously catalyzed ultrasound-assisted system	34
	2.4.4	Heterogeneously catalyzed ultrasound-assisted system	36
		2.4.4 (a) Heterogeneously acid catalyzed ultrasound-assisted system	36
		2.4.4 (b) Heterogeneously base catalyzed ultrasound-assisted system	39
	2.4.5	Simultaneous esterification and transesterification reaction of	
		biodiesel production using heterogeneous catalyst	43
	2.4.6	Influence of reaction parameters	45
2.5	Hydro	otalcite	48
	2.5.1	Structure of Hydrotalcite	49
	2.5.2	Synthesis of Hydrotalcite	52
	2.5.3	Combustion method	52
		2.5.3 (a) Calcination temperature	53

	2.5.3 (b) Fuel type	54
	2.5.4 Acid-base bifunctionalized of Hydrotalcite	55
	2.5.4 (a) Second divalent cation incorporation in HT structure	57
	2.5.4 (b) Metal composition effect	61
	2.5.5 HT catalyst in biodiesel production	62
2.6	Statistical data analysis	65
	2.6.1 Design of experiment	65
	2.6.2 Response surface method	66
2.7	Biodiesel quality	68
2.8	Kinetics study	70
2.9	Concluding remarks	71
СН	APTER THREE: MATERIALS AND METHODS	
3.1	Introduction	75
3.2	Materials and chemicals	75
3.3	Overall experiment flowchart	
3.4	Equipment	
3.5	Catalyst preparation	81
	3.5.1 Effect of calcination temperature	81
	3.5.2 Effect of fuel	82
	3.5.3 Effect of second divalent metal introduction and composition	82
3.6	Characterization of catalyst	84
	3.6.1 Nitrogen adsorption-desorption isotherms	84
	3.6.2 X-Ray diffraction (XRD)	84
	3.6.3 Scanning electron microscopy (SEM) and energy dispersive	84

	3.6.4	Thermal gravimetric analyzer (TGA)	85
	3.6.5	Fourier transform infrared spectrophotometer (FTIR)	85
	3.6.6	Temperature programmed desorption (TPD)	86
3.7	Ultras	sound-assisted biodiesel production	86
	3.7.1	Ultrasound-assisted transesterification reaction	86
	3.7.2	Ultrasound-assisted simultaneous transesterification and esterification reaction	87
	3.7.3	Reusability	87
3.8	Produ	ct analysis	88
3.9	Non-u	ultrasound-assisted transesterification reaction	90
3.10) Desi	gn of experiment.	90
3.11	Biod	liesel quality evaluation	92
3.12	2 Kine	etic studies	93
CH.	APTE	R FOUR: RESULTS AND DISCUSSION	
4.1	Overv	view	94
4.2	Waste	e cooking oil analysis	94
4.3		nces of calcinations temperature on characteristics and catalytic ty of HT	96
	4.3.1	Introduction	96
	4.3.2	Effect of calcination temperature on surface characteristics of HT	96
	4.3.3	Effect of calcination temperature on crystallinity of HT	99
	4.3.4	Effect of calcination temperature on morphology and chemical composition of HT	101
	4.3.5	Effect of calcination temperature on thermal decomposition of	
		HT	104

	4.3.6	Effect of calcinations temperature on Fourier-transformed spectra of HT	105
	4.3.7	Effect of calcination temperature on catalytic activity of HT	107
4.4	Comp	arison with mechanical stirring effect	110
4.5	Influe	nces of fuel type used in the combustion method on	
	charac	eteristics and catalytic activity of HT	112
	4.5.1	Introduction	112
	4.5.2	Effect of fuel type on surface characteristics of HT	113
	4.5.3	Effect of fuel type on crystallinity of HT	116
	4.5.4	Effect of fuel type on morphology and chemical composition of HT	118
	4.5.5	Effect of fuel type on thermal decomposition of HT	120
	4.5.6	Effect of fuel type on Fourier transform spectra of HT	123
	4.5.7	Effect of fuel type on catalytic activity of HT	124
4.6	Influe	ences of metal introduction in developing acid-base	
	bifunc	etionalized HT catalyst	127
	4.6.1	Introduction	127
	4.6.2	Effect of metal introduction on surface characteristics of HT	127
	4.6.3	Effect of metal introduction on crystallinity of HT	133
	4.6.4	Effect of metal introduction on morphology and chemical composition of HT	136
	4.6.5	Effect of metal introduction on thermal decomposition of HT	139
	4.6.6	Effect of metal introduction on Fourier-transformed spectra of HT	143
	4.6.7	Effect of metal introduction on acid strength of HT	146
	4.6.8	Effect of metal introduction on catalytic activity of HT	150
Δ 7		bility and leaching study	155
-T. /	111111111111111111111111111111111111111	DILLY OLD DAVILLE MUNIX	1.7

4.8	Ultras	sound-assisted biodiesel process optimization	160	
	4.8.1	Experimental design with response surface methods (RSM)	160	
	4.8.2	Analysis of variance (ANOVA)	162	
	4.8.3	The interaction effects of the reaction parameters	165	
	4.8.4	Process optimization	171	
4.9	Biodi	esel quality evaluation	173	
4.10) Kine	etic study	178	
СН	APTE:	R FIVE: CONCLUSIONS AND RECOMMENDATIONS		
5.1	Concl	lusions	185	
5.2	Reco	mmendations	189	
REI	REFFERENCES 19			
API	APPENDICES			
LIS	LIST OF PUBLICATIONS			

LIST OF TABLES

		Page
Table 1.1	Composition of methyl ester in different feedstock (Lam et al., 2010)	3
Table 2.1	Examples of biodiesel feedstock (Atabani et al., 2012)	17
Table 2.2	Biodiesel processing methods (Atabani et al., 2012; Sharma et al., 2008)	19
Table 2.3	Approaches for biodiesel processing intensification.	21
Table 2.4	Unwanted reactions and undesired products during frying process	25
Table 2.5	Performance of ultrasound-assisted systems in homogeneous of biodiesel production	35
Table 2.6	Performance of Ultrasound-assisted systems in heterogeneous acid catalyzed biodiesel production	37
Table 2.7	Ultrasound-assisted performance in heterogeneous basic catalyzation of biodiesel production	40
Table 2.8	Simultaneous transesterification and esterification reactions for biodiesel production.	43
Table 2.9	Application of HT incorporated with Ni, Cu and Zn in various applications	59
Table 2.10	Application of HT in biodiesel production	63

Table 2.11	Biodiesel specifications	69
Table 3.1	List of materials and chemicals	76
Table 3.2	List of equipment used in catalyst preparation, simultaneous transesterification and esterification reactions and product analysis.	79
Table 3.3	Coded and actual reaction variables used in the experimental design	91
Table 4.1	Comparison between properties of fresh and waste cooking palm oils	95
Table 4.2	Surface characteristics of HT catalysts with different calcination temperatures	97
Table 4.3	Chemical composition of HT catalysts with different calcination temperatures based on EDX results	103
Table 4.4	Surface characteristics of HT catalysts with different fuel types	113
Table 4.5	Chemical composition of HT catalysts with different fuels used based on EDX results	120
Table 4.6	Surface characteristics of HT introduced with Cu, Zn and Ni.	129
Table 4.7	Chemical compositions of HT introduced with Cu, Zn and Ni based on EDX analysis	139
Table 4.8	Acid sites concentration of HT introduced with Cu, Zn and Ni	146

Table 4.9	Chemical compositions of MgAl SAC 650 and MgNiAl 10 % before and after reaction based on EDX analysis	158
Table 4.10	Central composite design matrix of four individual variables and the respective responses	161
Table 4.11	Analysis of variance (ANOVA) for the quadratic model established for the ultrasound-assisted biodiesel production using MgNiAl 10 % catalyst	163
Table 4.12	Predicted and experimental results based on three optimal solutions	172
Table 4.13	Quality of raw and washed biodiesel produced using MgNiAl 10 % versus international standard of ASTM D6751	174
Table 4.14	Summary of activation energy (Ea) for transesterification reaction using MgAl SAC 650 and simultaneous transesterification and esterification reactions using MgNiAl 10 % as catalyst	183

LIST OF FIGURES

		Page
Figure 1.1	The spot crude oil price from 2012 to 2016 (Pope, 2016)	1
Figure 1.2	Transesterification reaction step (Borges and Diaz, 2012)	7
Figure 1.3	Esterification reaction of FFA	9
Figure 2.1	Principle of ultrasound acoustic cavitation bubbles	33
Figure 2.2	Schematic view of the structure of HT. The sixfold coordinated cations form an octahedral that share edges to constitute infinite layers. The compensating anions in the interlayer are represented by small spheres (Debecker et al., 2009; Solamão et al., 2011)	50
Figure 2.3	Geometry of CCD design including circumscribed, faced and inscribed design (a) rotatable (b) face-centred and (c) inscribed	67
Figure 3.1	The overall experimental works involved in this study	78
Figure 3.2	Schematic diagram of the ultrasound-assisted reactor setup	80
Figure 3.3	Flowchart of HT synthesis using combustion method	83
Figure 4.1	Nitrogen adsorption-desorption isotherms of HT catalysts prepared using different calcination temperatures	99
Figure 4.2	XRD patterns of (a) MgAl SAC 550 (b) MgAl SAC 650 (c) MgAl SAC 750 (d) MgAl SAC 850 and (*) HT peak	100

Figure 4.3	SEM images of (a) MgAl SAC 550 (b) MgAl SAC 650 (c) MgAl SAC 750 and (d) MgAl SAC 850	102
Figure 4.4	TGA-DTG profiles of HT catalysts with different calcination temperatures	105
Figure 4.5	FTIR spectra of (a) MgAl SAC 550 (b) MgAl SAC 650 (c) MgAl SAC 750 (d) MgAl SAC 850 (i) 3450- 3500 cm ⁻¹ (ii) 1640 -1660 cm ⁻¹ (iii) 1375-1400 cm ⁻¹ (iv) 1015-1210 cm ⁻¹ and (v) 870-900 cm ⁻¹	106
Figure 4.6	Catalytic activity of HT with different calcination temperatures in the transesterification reaction of waste cooking oil under ultrasound-assisted condition (reaction time 60 min, methanol to oil ratio 15:1, catalyst amount 0.08 g catalyst/g oil and ultrasound amplitude 55 %)	109
Figure 4.7	Transesterification reaction of waste cooking oil using MgAl SAC 650 catalyst conducted under ultrasound-assisted and mechanical stirring conditions.	111
Figure 4.8	Nitrogen adsorption-desorption isotherms of HT catalysts prepared using different sugars	115
Figure 4.9	XRD patterns of (a) MgAl SAC 650 (b) MgAl GLU 650 (c) MgAl FRU 650 and (*) HT peak	117
Figure 4.10	SEM images of a) MgAl SAC 650 (b) MgAl GLU 650 and (c) MgAl FRU 650	119
Figure 4.11	TGA-DTG profiles of HT catalysts with different fuels used in the preparation	122

Figure 4.12	FTIR spectra of (a) MgAl SAC 650 (b) MgAl GLU 650 (c) MgAl FRU 650 (i) 3450- 3500 cm ⁻¹ (ii) 1640 -1660 cm ⁻¹ (iii) 1375-1400 cm ⁻¹ (iv) 1015-1210 cm ⁻¹ and (v) 870-900 cm ⁻¹	123
Figure 4.13	Catalytic activity of HT with different fuel types in the transesterification reaction of waste cooking oil under ultrasound-assisted condition (reaction time 60 min, methanol to oil ratio 15:1, catalyst amount 0.08 g catalyst/g oil and ultrasound amplitude 55 %)	125
Figure 4.14	Nitrogen adsorption-desorption isotherms of HT catalysts introduced with Ni, Cu and Zn	131
Figure 4.15	Nitrogen adsorption-desorption isotherms of HT catalysts introduced with different Ni compositions	132
Figure 4.16	XRD patterns of (a) MgZnAl 10 % (b) MgCuAl 10 % (c) MgNiAl 10 % (d) MgNiAl 5 % (e) MgNiAl 15 % and (*) HT peak	134
Figure 4.17	SEM images of (a) MgCuAl 10 % (b) MgZnAl 10 % (c) MgNiAl 10 % (d) MgNiAl 5 % and (e) MgNiAl 15 %	137
Figure 4.18	TGA-DTG profiles of HT introduced with Cu, Zn and Ni	140
Figure 4.19	FTIR spectra of (a) MgCuAl 10 % (b) MgZnAl 10 % (c) MgNiAl 10 % (d) MgNiAl 5 % (e) MgNiAl 15 % (i) 3450-3500 cm ⁻¹ (ii) 1640 -1660 cm ⁻¹ (iii) 1375-1400 cm ⁻¹ (iv) 1015-1210 cm ⁻¹ (v) 830-890 cm ⁻¹ and (vi) 575-630 cm ⁻¹	144
Figure 4.20	NH ₃ -TPD profiles of (a) HT introduced with Cu, Zn and Ni (b) HT introduced with different Ni compositions	149

Figure 4.21	the simultaneous esterification and transesterification reactions of waste cooking oil using an ultrasound-assisted reactor system (reaction time 60 min, methanol to oil ratio 15:1, catalyst amount 0.08 g catalyst/g oil and ultrasonic amplitude 55 %)	151
Figure 4.22	Effect of FFA addition on the FAME yield	152
Figure 4.23	Catalytic activity of MgNiAl with different Ni compositions in the simultaneous esterification and transesterification reactions of waste cooking oil under ultrasound-assisted conditions (reaction time 60 min, methanol to oil ratio 15:1, catalyst amount 0.08 g catalyst/g oil and ultrasound amplitude 55 %)	155
Figure 4.24	Catalytic activity of MgAl SAC 650 in successive reaction cycles (reaction time 60 min, methanol to oil ratio 15:1, catalyst amount 0.08 g catalyst/g oil and ultrasound amplitude 55 %)	156
Figure 4.25	Catalytic activity of MgNiAl 10 % in successive reaction cycle (reaction time 60 min, methanol to oil ratio 15:1, catalyst amount 0.08 g catalyst/g oil and ultrasound amplitude 55%)	157
Figure 4.26	Parity plots of predicted vs actual values of the FAME yield in ultrasound-assisted biodiesel production	165
Figure 4.27	Response surface 3D plot indicating the interaction between reaction time and methanol to oil ratio on FAME yield	166
Figure 4.28	Response surface 3D plot indicating the interaction between	167

reaction time and ultrasound amplitude on FAME yield

Figure 4.29	Response surface 3D plot indicating the interaction between reaction time and catalyst amount on FAME yield	168
Figure 4.30	Response surface 3D plot indicating the interaction between methanol to oil ratio and ultrasound amplitude on FAME yield	169
Figure 4.31	Response surface 3D plot indicating the interaction between methanol to oil ratio and catalyst amount on FAME yield	170
Figure 4.32	Response surface 3D plot indicating the interaction between ultrasound amplitude and catalyst amount on FAME yield	171
Figure 4.33	Triglyceride concentration as a function of reaction time at different reaction temperatures in the transesterification reaction using MgAl SAC 650 as catalyst	179
Figure 4.34	Triglyceride concentration as a function of reaction time at different reaction temperatures in simultaneous transesterification and esterification reactions using MgNiAl 10 % as catalyst	179
Figure 4.35	Arrhenius plot of rate constants versus reciprocal of reaction temperatures	182

LIST OF SCHEMES

		Page
Scheme 2.1	Deprotonation of alcohol molecule producing alkoxide ion	28
Scheme 2.2	Nucleophilic attack of carbonyl carbon in a triglyceride molecule	28
Scheme 2.3	Deprotonation of alcohol molecule by tetrahedral intermediate	29
Scheme 2.4	Rearrangement of tetrahedral intermediate to form alkyl ester	29
Scheme 2.5	Esterification reaction mechanism of FFA (Foreman, 2012)	30

LIST OF PLATES

		Page
Plate B.1	Ultrasound-assisted reactor system (a) ultrasonic processor (b) ultrasonic probe (c) mixture of reactants before exposed to ultrasonic agitation and (d) mixture of reactants after exposed to ultrasonic agitation	210
Plate B.2	Separated obtained product mixture (a) FAME layer (b) glycerol layer and (c) reusable catalyst	211
Plate B.3	(a) Fresh cooking oil (b) waste cooking oil (c) raw FAME product and (d) washed FAME product	211

LIST OF ABBREVIATIONS

a.u. Arbitrary unit

Al Aluminum

Al³⁺ Aluminum ion

AlO Aluminum oxide

Aⁿ⁻ Anion

ANOVA Analysis of variance

ASTM American Society for Testing and Materials

BET Brunauer Emmett Teller

C Carbon

CCD Central composite design

CO₂ Carbon dioxide

CO₃²- Carbonate ion

Cu Copper

CuO Copper oxide

DF Dilution factor

DOE Design of experiment

EDX Energy dispersive X-ray

EN European standard

FAME Fatty acid methyl ester

FFA Free fatty acid

FID Flame ionization detector

FRU Fructose

FTIR Fourier Transformed Infrared Spectrometry

GC Gas chromatography

GLU Glucose

H⁺ Hydrogen ion

HFU High frequency ultrasound

HT Hydrotalcite

KBr Potassium bromide

LDH Layered double hydroxide

LFU Low frequency ultrasound

M²⁺ Divalent metal ion

M³⁺ Trivalent metal ion

MeOH Methanol

Mg Magnesium

Mg²⁺ Magnesium ion

MgAl₂O₄ Spinel

MgAlO Metal oxides

MgO Magnesium oxide (periclase)

MPOB Malaysian palm oil board

N₂ Nitrogen

Na Sodium

NH₃-TPD Ammonia temperature programmed desorption

Ni Nickel

Ni²⁺ Nickel ion

NiO Nickel oxide

OH- Hydroxyl ion

rpm Rotation per minute

RSM Response surface methodology

SAC Saccharose

SEM Scanning electron microscope

TGA-DTG Thermal gravimetric analyzer-derivative thermal gravimetric

WTP Willingness to pay

XRD X-ray diffraction

Zn Zinc

ZnO Zinc oxide

LIST OF SYMBOLS

Symbol	Descriptions	Unit
A	Arrhenius factor (pre-exponential factor)	
C_{TG}	Concentration of triglycerides in oil phase	
C_{TGo}	Highest initial concentration of triglycerides	
CV	Coefficient of variance	
Ea	Activation energy	kJ/mol
F	Fisher F-test	
k	Reaction rate constant	dm ³ /mol.h
M/O	Methanol to oil ratio	
n	Number of mol	mol
N_A	Initial amount of reactant	mol
P/P _o	Relative pressure	
R	Gas constant	J/mol.K
\mathbb{R}^2	Coefficient of determination	
R_{sample}	Relative area ratio of FAME sample	
$R_{standard}$	Relative area ratio of FAME standard	
r_{TG}	Consumption rate of triglycerides	mol/dm ³ .h
T	Temperature	°C/K
t	Reaction time	h
V	Total volume	dm^3
V_P	Pore volume	
W FAME	Weight of FAME sample	g
$W_{\rm oil}$	Weight of oil used	g

X_i, X_j	Variables corresponding to factors	
Y	Response determined by model	
α	Distance from the center in central composite	
	design	
3	Error	
θ	Theta	
λ_{i}	The linear effect coefficient	
λ_{ii}	The linear effect coefficient	
λij	The cross-product coefficient	
λ_{o}	Constant coefficient	
ρ fame.st	Mass concentration of FAME standard	g/l
V _{sample}	Volume of product sample	1