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

by

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Thesis submitted in fulfillment of the requirements

for the degree of

Doctor in Philosophy

September 2016

ACKNOWLEDGEMENT

Alhamdulillah, all praises to Allah SWT, the Al-Mighty, for blessing me with strengths and motivation to complete my PhD studies towards the end. I would like to thank my parents, Anuar Bin Awang and Noriam Binti Abdul Samat for their eternal support, love, and encouragement throughout my studies. They have made me more confident to face the disturbances especially during the project progression.

Special thanks and deepest appreciable, Prof. Dr Ahmad Zuhairi Bin Abdullah as my supervisor for this PhD studies. He was very supportive and willingly shared his time and knowledge with me without any hesitation. With his guidance and help, I have learned a lot regarding the real practices in Chemical Engineering. I would also like to thank him again for giving me adequate freedom and flexibility while working on this project. I have greatly benefited from a number of useful discussions with both of them, particularly with regard to the research and current issues.

I would like to express my gratitude to the Dean of School of Chemical Engineering, Professor Dr. Azlina Harun @Kamaruddin for her support and help towards my postgraduate affairs. I would also like to extend my heartfelt appreciation to Ministry of High Education for providing me MyPhd scholarship to assist my studies financially. I would to further my special thanks to all administrative staff and technicians from School of Chemical Engineering for their sincere help while I was conducting my test in the lab.

Finally, I would like to take this opportunity to convey my gratitude and appreciation to my dearest friends, Azimah, Hizami, Khozema, Fattah, Ismail and other colleagues for their guidance and kindness help they have given to me. Thank you very much.

Mohd.Razealy Bin Anuar

September 2016

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LIST OF ABBREVIATIONS

a.u.	Arbitrary unit
Al	Aluminum
Al^{3+}	Aluminum ion
AlO	Aluminum oxide
A^{n-}	Anion
ANOVA	Analysis of variance
ASTM	American Society for Testing and Materials
BET	Brunauer Emmett Teller
C	Carbon
CCD	Central composite design
CO_2	Carbon dioxide
CO_3^{2-}	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
M^{2+}	Divalent metal ion
M^{3+}	Trivalent metal ion
MeOH	Methanol
Mg	Magnesium
Mg^{2+}	Magnesium ion
$MgAl_2O_4$	Spinel
MgAlO	Metal oxides
MgO	Magnesium oxide (periclase)
MPOB	Malaysian palm oil board
N_2	Nitrogen
Na	Sodium
NH_3-TPD	Ammonia temperature programmed desorption
Ni	Nickel
Ni^{2+}	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	
E_a	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
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	^oC/K
t	Reaction time	h
V	Total volume	dm^3
V_P	Pore volume	
W_{FAME}	Weight of FAME sample	g
W_{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	
ε	Error	
θ	Theta	
λ_i	The linear effect coefficient	
λ_{ii}	The linear effect coefficient	
λij	The cross-product coefficient	
λ_o	Constant coefficient	
$\rho_{FAME.st}$	Mass concentration of FAME standard	g/l
v_{sample}	Volume of product sample	l