Valorization of Transesterification byproduct Glycerol to Solketal using Heterogeneous Catalyst

Thesis submitted in partial fulfillment for the award of the degree

of

DOCTOR OF PHILOSOPHY

by

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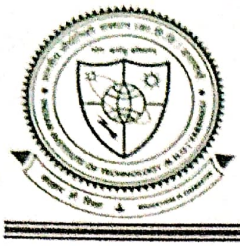

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It is further certified that the student has fulfilled all the requirements of Comprehensive Examination, Candidacy and SOTA for the award of Ph.D. Degree.

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I, **Sunita Maurya**, certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of **Prof. Yogesh Chandra Sharma** from July 2019 to June 2024, at the **Department of Chemistry**, Indian Institute of Technology (BHU), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any other's work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports dissertations, theses, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

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It is certified that the above statement made by the student is correct to the best of my knowledge. The thesis work **entitled "Valorization of Transesterification byproduct Glycerol to Solketal using Heterogeneous Catalyst"** has been done by Miss Sunita Maurya under my supervision.

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List of Abbreviations

Å	Angstrom
eV	Electron volt
FT-IR	Fourier transform infrared
GC-MS	Gas chromatography-mass spectrometry
NMR	Nuclear magnetic resonance
IEA	International Energy Agency
JCPDS	Joint Committee on Powder Diffraction Standards
Gly	Glycerol
Ace	Acetone
E-factor	Environmental factor
PMI	Process Mass Index
CE	Carbon Efficiency
TOF	Turnover Frequency
AE	Atom Economy
M	Molar
EIA	Energy Information Administration
FAME	Fatty acid methyl ester
FFA	Free fatty acid
Kg	Kilogram
KJ/mol	Kilojoule per mole
kV	Kilovolt
nm	Nanometre
mmol/g	Millimole per gram
N	Stoichiometric factor
T	Temperature
°C	Degree Celsius
K	Kelvin
λ	Lambda
mM	Micrometre
pH	Potential of hydrogen
XRD	X-ray diffraction
TGA	Thermogravimetric analysis
SEM	Scanning electron microscopy
EDX	Energy dispersive X-ray analysis
XPS	X-ray photo electron spectroscopy
BET	Brunauer-Emmett-Teller
BJH	Barrett-Joyner-Halenda
pKa	Dissociation constant of acid
nm	Nanometer
rpm	Revolution per minute

wt. %	Weight percentage
θ	Theta
ZA	ZrO_2-Al2O_3
SZA	SO_4^{-2}/ZrO_2-Al_2O_3
SC	$SO_4^{-2}/CoAl_2O_4$ (1:0)
ST	SO_4^{-2}/TiO_2 (0:2)
SCAT (3:2)	$SO_4^{-2}/CoAl_2O_4$-TiO_2 (3:2)
SCAT (2:3)	$SO_4^{-2}/CoAl_2O_4$-TiO_2 (2:3)
SCAT (4:1)	$SO_4^{-2}/CoAl_2O_4$-TiO_2 (4:1)
SCAT (1:4)	$SO_4^{-2}/CoAl_2O_4$-TiO_2 (1:4)
SZZ	$SO_4^{-2}/ZnAl_2O_4$-ZrO_2
SZT	$SO_4^{-2}/ZnAl_2O_4$-TiO_2