DESIGN OF A PILOT PLANT FOR BIODIESEL PRODUCTION FROM HIGH FREE FATTY ACID OILS

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Degree of Master of Science

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DECLARATION OF THE CANDIDATE & SUPERVISOR

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ABSTRACT

Biodiesel or fatty acid methyl ester is a fuel that can be produced from lipid sources. It is popular as a totally renewable, nontoxic and biodegradable alternative fuel for fossil based diesel due to its numerous environment benefits associated with its use. Currently, biodiesel is produced mainly using edible oils and the rest is covered by non-edible oils, animal fats and waste cooking oils (WCOs). The lab-scale studies of the research identified that, locally available feedstock materials such as Coconut, Palm, Rubber seed oil (RSO), Jatropha, Neem, Lard and WCO can be successfully used in biodiesel production. The study used alkali-catalyzed transesterification process to produce biodiesel and proven the feasibility of using it for oils with FFA content less than 2.0%. The oils with FFA content greater than 2.0% were pre-treated using acid-esterification. The optimization of oil pre-treatment conducted in lab-scale using RSO showed that 0.05 g of H_2SO_4/g of FFA, 3.0 g of methanol/g of FFA and 30 min reaction time are the optimum process conditions, and 2.0 or 2.5 g of methanol/g of FFA with 0.075 or 0.100 g of H_2SO_4/g was recommended for commercial-scales.

The study identified that the FFAs remained after pre-treatment further reduced with settling time and invented that single acid esterification step followed by extended settling can be used as a novel FFA reduction method. Study also introduced a simplified chemical dosage estimation method based on FFA content of the oil.

A 50 litre portable reactor system was designed and fabricated with multi disciplinary units based on lab-scale results for pilot-scale studies. The designed unit is capable of carrying out complete biodiesel production process from pre-treatment to drying under both manual and automatic modes. The studies also proved the potential of using the pilot-unit in biodiesel production using alkali-catalyzed transesterification.

Keywords: Biodiesel, FFA, Free fatty acid, pilot-scale

DEDICATION

I dedicate this thesis to my parents. I might not come into this plane without my parents who have dedicated their life for making me an educated and a successful person. I would like to express my love and appreciation for the encouragement and the sacrifices made by my parents.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
ASTM	American Society for Testing and Materials
AV	Acid Value
B100	100% biodiesel
B20	20% biodiesel and 80% diesel blend
BECON	Biomass Energy Conversion Centre in Nevada
CCU	Central control unit
CPI	Control panel interface
CPU	Central processing unit
DC	Direct Current
EN	European standards
FAME	Fatty acid methyl ester
FFA	Free fatty acid
IC	Intergraded circuit
ISPU	Input signal processing unit
LCD	Liquid crystal display
LED	Light-emitting diode
OFM	Oscillatory Flow Mixing
OPU	Onboard programme unit
OSI	Oxidation stability index
OSPU	Output signal processing unit
PDS	Power distribution system
PIC	Peripheral interface controller
PSU	Power supply unit
PSU	Process sensor unit
RSO	Rubber Seed Oil
SS	Stainless steel
UFO	Used fryign oil
UOM	University of Moratuwa
US	United States
WCO	Waste cooking oil
WFG	Waste fryer grease
WVO	Waste Vegetable Oil

LIST OF APPENDICES