

CSO Biodiesel Production through Hybrid Reactor and Performance Testing at Variable Compression Ratio

A major project submitted in partial fulfilment of the requirement for the award of a degree in

MASTERS OF TECHNOLOGY IN THERMAL ENGINEERING

Submitted by
SHASHANK MOHAN 2K11/THE/18

Under the guidance
of
Dr. AMIT PAL



Department of Mechanical Engineering
DELHI TECHNOLOGICAL UNIVERSITY
JUNE-2013

CERTIFICATE

This is to certify that the major project report entitled “**An Experimental Analysis on Biodiesel production from Cottonseed Oil and Its Performance Testing on a VCR Engine**” submitted by Sh. Shashank Mohan (R. No. 2K11/THE/18) for the partial fulfilment for the award of the Degree of Masters of Technology in Thermal Engineering of Delhi Technological University. It is an authentic record of student’s own work carried out by him under our guidance and supervision.

This is also certified that this dissertation has not been submitted to any other Institute/University for the award of any degree or diploma.

Dr. Amit Pal

Assistant Professor

ABSTRACT

The increasing industrialization and motorization of the world has led to a steep rise for the demand of petroleum products. Petroleum based fuels are obtained from limited reserves. These finite reserves are highly concentrated in certain regions of the world. Therefore, those countries not having these resources are facing a foreign exchange crisis, mainly due to the import of crude oil. Hence, it is necessary to look for alternative fuels, which can be produced from materials available within the country. This project deals with development of a biodiesel production test rig based on combined hydrodynamic cavitation and mechanical stirring method and comparison of performance of various blends of Cotton Seed oil with diesel (B20, B40 and B60) also has been made against pure diesel at variable compression ratios. The performances of these biodiesel blends have been tested by evaluating the performance parameters like torque, brake power, brake thermal efficiency and brake specific fuel consumption, brake specific energy consumption, exhaust gas temperature, air fuel ratio and emission characteristics like smoke opacity. Performance testing has been performed on 4-stroke, single cylinder, water cooled Kirloskar C.I. engine. Performance parameters has been obtained from the computer (software is "Engine soft") which is incorporated with the engine panel box. Smoke opacity has been checked by the A.V.L smoke meter. The results obtained show that various blends of Cotton seed oil with diesel (B20, B40 and B60) can be acceptably used as an alternative fuel when C.I engine is operating at high compression ratios.

ACKNOWLEDGEMENT

It is distinct pleasure to express our deep sense of gratitude and indebtedness to my learned supervisor Dr. S.Maji, Prof. and Dr. Amit Pal, Assistant Prof. in the Department of Mechanical Engineering, Delhi Technological University, Delhi, for their invaluable guidance, encouragement and patient review. Their continuous inspiration only has made me complete this major project.

I would like to thank Sh. Lalit Kumar, Sh. Harjeet Singh & Sh. Vijay of I. C. Engine laboratory and bio diesel laboratory for extending their kind support and sharing their valuable time for the completion of the major project.

I am thankful to my family, my all teachers, classmates and friends for their unconditional support and motivation during this project. It is a great opportunity for me to extend my heartiest felt gratitude to everybody who helped me throughout the course of this major project in anyway.

SHASHANK MOHAN

(2K11/THE/18)

LIST OF ABBREVIATIONS

A/F	Air fuel ratio
BIS	Bureau of Indian Standards
BMEP	Brake mean effective pressure
BP	Brake power
BSFC	Brake specific fuel consumption
BSEC	Brake specific energy consumption
BTHE	Brake thermal efficiency
BTHEff	Brake thermal efficiency
CSO	Cotton seed oil
CSO B20	20% Cotton seed oil & 80% Diesel
CSO B40	40% Cotton seed oil & 60% Diesel
CSO B60	60% Cotton seed oil & 40% Diesel
C SOME	Cotton seed oil methyl ester
EGR	Exhaust gas recirculation
EXT	Exhaust temperature
FMEP	Frictional mean effective pressure
FP	Frictional power
IMEP	Indicated mean effective pressure
IP	Indicated power
IThe	Indicated thermal efficiency
MechE	Mechanical efficiency
MoEF	Ministry of Forests and Environment
NOVOD	National Oilseed and Vegetable Oil Development Board
PPM	Parts per million
Voleff	Volumetric efficiency

LIST OF FIGURES

- Figure 1.1 World Energy Consumption
- Figure 1.2 World primary energy consumption in Terajoules (yearly)
- Figure 1.3 Differences between Production and Consumption Of Oil in India
- Figure 1.4 Increase in CO₂ Concentration
- Figure 1.5 Cotton Seeds
- Figure 3.1 Photograph of Mechanical stirrer
- Figure 3.2 Photograph of washing process of biodiesel
- Figure 3.3 Ultrasonic Generator
- Figure 3.4 Ultrasonic Processor Horn mounted on stand with Jack type table.
- Figure 3.5 Ultrasonic horn type processor
- Figure 3.6 Hydrodynamic cavitation experimental set up (2-10 kg))
- Figure 3.7 Block diagram for Hybrid Reactor
- Figure 3.8 Hybrid Reactor (15-100Kg capacity)
- Figure 3.9 Biodiesel conversion yield at 0.5% NaOH by weight of oil.
- Figure 3.10 Biodiesel conversion yield at 0.75% NaOH by weight of oil.
- Figure 3.11 Biodiesel conversion yield at 1% NaOH by weight of oil.
- Figure 5.1 Schematic Layout of Single Cylinder Engine Setup
- Figure 5.2 Actual Engine Setup
- Figure 5.3 An AVL Smoke meter
- Figure 5.4 Comparison of Opacity v/s Brake Power for diesel and CSO biodiesel at 16 compression ratio
- Figure 5.5 Comparison of Opacity v/s Brake Power for diesel and CSO biodiesel blends at 18 compression ratio
- Figure 5.6 Comparison of BTE v/s Brake Power for diesel and CSO biodiesel blends at 18 compression ratio
- Figure 5.7 Comparison of BTE v/s Brake Power for neat diesel and CSO biodiesel blends of at 16 compression ratio
- Figure 5.8 Comparison of BSFC v/s Brake Power for diesel and CSO biodiesel blends at 18 compression ratio
- Figure 5.9 Comparison of BSFC v/s Brake Power for neat diesel and CSO biodiesel blends at compression ratio 16

LIST OF TABLES

Table 1.1	Demand of energy, for the consumption in India
Table 1.2	Demand for diesel and biodiesel
Table 1.3	Global productions of the major vegetable oils
Table 1.4	Top 10 countries in terms of biodiesel potential
Table 1.5	Summary of proposed BIS (Bureau of Indian Standards) standards for biodiesel
Table 3.1	Oil, alcohol and catalyst during the experimentation (Magnetic stirring)
Table 3.2	Time and yield (%) of cotton seed oil (Magnetic Stirring)
Table 3.3	Time and yield (%) of cotton seed oil (Ultrasonic Cavitation)
Table 3.4	Time and yield (%) of cotton seed oil (Hydrodynamic Cavitation)
Table 3.5	CSO BD Yield observed at various reaction times for molar ratio of 6:1 and 0.5% catalyst
Table 3.6	CSO BD Yield observed at various reaction times for molar ratio of 6:1 and 0.75% catalyst
Table 3.7	CSO BD Yield observed at various reaction times for molar ratio of 6:1 and 1% catalyst
Table 4.1	Miscellaneous cost in biodiesel production
Table 4.2	Total Production Cost of Bio-Diesel
Table 5.1	Details of different blends of biodiesel

CONTENTS

CERTIFICATE

- I ABSTRACT
- II ACKNOWLEDGEMENTS
- III LIST OF TABLES
- IV LIST OF FIGURES
- V LIST OF ABBREVIATIONS IX

Chapter 1 Introduction

1.1 Introduction

- 1.1.1 Energy Crisis
- 1.1.2 World primary energy consumption
- 1.1.3 Energy Scenario: Indian Context
- 1.1.4 Environmental effects
- 1.1.5 Alternative Fuel Imputes

1.2 Biodiesel

- 1.2.1 General
- 1.2.2 Advantages of the Biodiesel over Petroleum based Diesel Fuel
- 1.2.3 Indian scenario in biodiesel
- 1.2.4 Resources of Biodiesel
- 1.2.5 Vegetable oil utilization as engine fuel
 - 1.2.5.1 Direct use and blending
 - 1.2.5.2 Micro – Emulsions
 - 1.2.5.3 Pyrolysis (Thermal Cracking)
- 1.2.6 Properties of biodiesel
- 1.2.7 Storage, Handling and Distribution
- 1.2.8 Additives for oxidative stability of biodiesel
- 1.2.9 Material compatibility

1.3 Motivation for present work

1.4 Objective of the present research work

1.5 Organization of the report

Chapter 2 *Literature review*

2.1 About Cottonseed Oil

2.1.1 Composition

2.1.2 Physical Properties

2.1.3 Uses of Cottonseed Oil

2.2 Performance and Emissions studies of Cottonseed Oil

2.3 Performance and Emissions studies of other oils

Chapter 3 *Biodiesel production*

3.1 Biodiesel production by Mechanical Stirring

3.1.1 Experimental set-up

3.1.2 Reagents and materials used for experiment

3.1.3 Experimental Procedure

3.1.4 Experimental Results

3.2 Biodiesel production by Ultrasonic Cavitation

3.2.1 Principle

3.2.2 Experimental Set-up

3.2.3 Reagents and materials used

3.2.4 Experimental Procedure

3.2.5 Experimental Results

3.3 Biodiesel production by Hydrodynamic Cavitation

3.3.1 Principle

3.3.2 Experimental Set-up

3.3.3 Reagents and materials used

3.3.4 Experimental Procedure

3.3.5 Experimental Results

3.4 Biodiesel production by Hybrid Reactor

Chapter 4 *Economic Analysis of Biodiesel production*

- 4.1 Economics of Biodiesel
- 4.2 Cost estimation of biodiesel production

Chapter 5 *Performance and emission studies*

- 5.1 Experimental Setup of single cylinder Kirloskar Engine
- 5.2 Preparation of biodiesel blends
- 5.3 Performance Evaluations
- 5.4 Results of performance and emission testing
 - 5.4.1 Variation of opacity w.r.t brake power at 16 CR
 - 5.4.2 Variation of opacity w.r.t brake power at 18 CR
 - 5.4.3 Variation of BTE w.r.t brake power at 18 CR
 - 5.4.4 Variation of BTE w.r.t brake power at 16 CR
 - 5.4.5 Variation of BSFC w.r.t brake power at 18 CR
 - 5.4.5 Variation of BSFC w.r.t brake power at 16 CR

Chapter 6 *Conclusion and future scope*

- 6.1 Conclusion
- 6.2 Scope of future work

REFERENCES