EXPERIMENTAL ANALYSIS OF PERFORMANCE, COMBUSTION AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER DIESEL ENGINE USING BIOFUEL (DIESEL-TURPENTINE BLEND) WITH HYDROGEN INDUCTION

A PROJECT REPORT

Submitted by

NIROSHINI K **2019502032**

AKILAN S **2019502509**

DHINESH BABU R **2019502517**

HARIVIGNESH N S **2019502523**

In partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

AUTOMOBILE ENGINEERING

DEPARTMENT OF AUTOMOBILE TECHNOLOGY

MADRAS INSTITUTE OF TECHNOLOGY ANNA UNIVERSITY

MAY 2023

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report "**EXPERIMENTAL ANALYSIS OF PERFORMANCE,COMBUSTION AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER DIESEL ENGINE USING BIOFUEL (DIESEL-TURPENTINE BLEND) WITH HYDROGEN INDUCTION**" is the bonafide work of

NIROSHINI K	**2019502032**
AKILAN S	**2019502509**
DHINESH BABU R	**2019502517**
HARI VIGNESH N S	**2019502523**

Who carried out the project work under my supervision. Certified further that to the best of my knowledge, the work reported herein does not form part of any other thesis or laboratory report on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate

SIGNATURE

Dr.A.Sangeet Sahaya Jeyangel

SUPERVISOR

Teaching Fellow

Department of Automobile Engineering

Madras Institute of Technology

SIGNATURE

Dr. K. Annamalai

HEAD OF THE DEPARTMENT

Professor

Department of Automobile Engineering

Madras Institute of Technology

ACKNOWLEDGEMENT

We would like to express our sincere thanks and deep sense of gratitude to our supervisor**, Dr.A.SANGEET SAHAYA JEYANGEL** for his valuable guidance, suggestions and constant encouragement.

We sincerely thank our Project Coordinator, **Dr.S.ARULSELVAN** ,Assitant Professor ,**Mr.S.MARIAPPA** Teaching Fellow ,Department of Automobile Engineering and Review panel members for their valuable suggestions.

We are highly indebted to our reputable Head of the Department, **Dr.K.ANNAMALAI,** Department of Automobile Engineering, MIT, Anna University and to our respectable Dean, **Dr.J.PRAKASH,** MIT, Anna university for providing us with sufficient facilities that contributed to the success in this endeavor.

Home is the backbone of every success and our humble salutation to our beloved parents who inspired, motivated and supported us throughout the course of the project

We also extend our sincere thanks to all the faculty members of the Automobile Engineering Department, Class, Committee, Chairman and friends who have rendered their valuable who carried out the project work under my supervision. Certified further that to the best of my knowledge, the work reported herein does not form part of any other thesis or laboratory report on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate help in completing this project successfully.

ABSTRACT

Main aim of the project is to study the influence of hydrogen induction on the performance, combustion and emission characteristics of a compression ignition engine fueled with Turpentine oil biofuel. The work was categorized into two phases. For the phase 1, The Turpentine oil was mixed with diesel in various proportions. Mainly the B20, B30, B40 and B50 blends were taken into account. The test was conducted on a 5.2 kW four stroke, single cylinder diesel engine with compression ratio of 17.5:1. The results obtained are compared with neat diesel fuel at all the loads. The biofuel blends show a significant reduction in the BTE when compared to the diesel fuel. The incylinder pressure and the amount of heat released was also found to be lesser than diesel. The reduction in the CO and NOx emissions was found. But still the smoke and HC emissions were found to be higher than the diesel. The BTE for B20, B30, B40, B50 blends were founded as 31.92%, 31.71%, 31.38%, 30.89%. The HC and CO emissions were 81,83,65,68 ppm and for 0.15%.0.27%,0.21%,0.26% for B20, B30, B40, B50 respectively. It was found that the B20 and B30 blends were promising to have higher BTE and lower emissions so for the phase 2, B20 and B30 blends was taken for further testing with hydrogen induction. The BTE was found to be increased for the blends B20 and B30 while using hydrogen. The BTE for B20 was 33% and B30 was 32% respectively. The hydrogen energy share was 7%. The SFC was also found to be decreased with hydrogen induction. The cylinder pressure and the net heat release rate was found to be increased. The emissions of CO, HC, and smoke was decreased. Only the NOx emissions were increased with hydrogen induction. The NOx at full loads were 2513 ppm and 2678 ppm for B20 and B30 blends.

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	**iv**
	LIST OF FIGURES	**viii**
	LIST OF TABLES	**ix**
1	**INTRODUCTION**	**1**
	1.1 OVERVIEW	1
	1.2 RELATED STUDY	1
	1.2.1 Fuels	1
	1.2.2 Conventional fuels	2
	1.2.3 Advantages of conventional fuels	2
	1.2.4 Disadvantages of conventional fuels	3
	1.2.5 Nonconventional fuels	3
	1.2.6 Advantages of nonconventional fuels	3
	1.2.7 Disadvantages of nonconventional fuels	4
2	**LITERATURE SURVEY**	**5**
	2.1 LITERATURE SUMMARY	5
3	**ALTERNATIVE FUELS**	**10**
	3.1 TURPENTINE OIL	10
	3.2 COMPOSITION	11
	3.3 OIL YIELD	11
	3.4 PRODUCTION OF TURPENTINE OIL	11
4	**METHODOLOGY**	**13**
	4.1 EXTRACTION OF TURPENTINE OIL	14
	4.1.1 Collection of pine saps	14
	4.1.2 Extraction of raw oil	14

4.1.3 Preparation of diesel turpentine blends 15
4.2 HYDROGEN INDUCTION 15
4.2.1 Dual fuel operation 16
4.2.2 Hydrogen storage tank 16
4.2.3 Pressure regulator 17
4.2.4 Flame trap 18
4.2.5 Flow meter 18
4.2.6 Induction at intake manifold 19

5 PROPERTIES 21
5.1 PROPERTIES OF TURPENTINE OIL BLENDS 21
5.1.1 Kinematic viscosity 21
5.1.2 Flash point 21
5.1.3 Density 22
5.1.4 Calorific value 22
5.2 INSTRUMENTS USED TO MEASURE PROPERTIES 22
5.2.1 Redwood viscometer 22
5.2.3 Digital density meters 23
5.2.4 Open cup apparatus 23

6 SPECIFICATIONS 25
6.1 ENGINE DESCRIPTION 25
6.2 FEATURES 25
6.3 ENGINE LAYOUT 26
6.4 UTILITIES REQUIRED 27
6.5 ENGINE SPECIFICATIONS 27
6.6 SOFTWARE 28
6.7 EXHAUST GAS ANALYSER 29
6.8 SMOKE METER 30

7	**PERFORMANCE, COMBUSTION AND EMISSION CHARACTERISTICS**	**31**
	7.1 PERFORMANCE PARAMETERS	31
	7.1.1 Brake thermal efficiency	31
	7.1.2 Specific fuel consumption	32
	7.2 COMBUSTION PARAMETERS	33
	7.2.1 In-cylinder pressure	33
	7.2.2 Heat release rate	34
	7.3 EMISSION PARAMETERS	35
	7.3.1 Hydrocarbon emission	35
	7.3.2 Carbon monoxide emission	36
	7.3.3 Smoke opacity	37
	7.3.4 Oxides of nitrogen	38
8	**CONCULSION**	**39**
9	**REFERENCE**	**41**

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
4.1	Pine saps	14
4.2	Pine tree	14
4.3	Diesel-turpentine blends	15
4.4	Hydrogen tank	16
4.5	Pressure regulator	17
4.6	Flame trap	18
4.7	Flow meter	19
4.8	Hydrogen induction setup	20
5.1	Redwood viscometer	22
5.2	Digital density meter	23
5.3	Cleveland open cup apparatus	24
6.1	Engine layout	26
6.2	Avl gas analyser	30
6.3	Avl smoke meter	30
7.1	BTE Vs LOAD	31
7.2	SFC Vs LOAD	32
7.3	CRANK ANGLE Vs PRESSURE	33
7.4	CRANK ANGLE Vs HRR	34
7.5	LOAD Vs HC	35
7.6	LOAD Vs CO	36
7.7	LOAD Vs SMOKE	37
7.8	LOAD Vs NOx	38

LIST OF TABLE

TABLE NO	TITLE	PAGE NO
3.1	Turpentine oil production in India	12
5.1	Properties of fuel	24
6.1	Engine specifications	27