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Optimizing Performance of CI Engine fueled with Undi Oil Biodiesel

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ABSTRACT

An increasing demand of fossil fuels has being a critical problem for us. The natural resources of fossil fuel are dwindling day by day. Biodiesel that may called natural fuel may be a good source or substitute for fossil fuel in future. An experiment is conducted to obtain the operating and emission characteristics of Undi Oil Biodiesel on Diesel Engine run on various Blends of biodiesel, Load Conditions and Injection Pressure. From the comparison of results, it is inferred that the engine performance is improved with significant reduction in emissions for the chosen oils without any engine modification. The effective injection pressure can be fixed based on the experimental results obtained in the engine since the findings of the present research work infer that the biodiesel obtained from Undi oil is a promising alternative fuel for direct-injection four-stroke VCR diesel engine.

Keywords: Biodiesel, Undi oil, Transesterification, Various Injection Pressure, Biodiesel Blends, Engine Loads Performance & Emission Characteristics.

I. INTRODUCTION

In recent years, oil prices have been rising rapidly again and there is a major concern for the long term availability of fossil fuels. This and the growing concern for our environment have created a much larger market for renewable resources. Vegetable oils are one of the important sources of renewable energy, and can be transesterified to biodiesel, which is an alternative fuel for diesel engines.

The difference between bio-diesel and petroleum diesel lies in the name itself. Petroleum diesel is 100% petroleum based and considered as a fossil fuel. On the other hand bio-diesel is created from live feedstock such as vegetable oil, peanut oil, coconut oil, even algae oil. Bio-diesel can be used as a direct fuel considered B100, or in its unrefined form of vegetable oil. Many of these vegetable oils are similar in properties to those of petroleum diesel, the main difference is that vegetable oils and bio-diesels have a lower oxidative stability state, a higher viscosity coefficient, and a higher volatility point. These properties make bio-diesel blends a suitable candidate for an immediate alternative energy fuel.

Biodiesel is a non-toxic, biodegradable, and renewable diesel fuel and can be used neat or blends with petroleum diesel fuels. Biodiesel has many advantages compared to diesel fuels. It has higher cetane number than diesel fuel, and contains no aromatics, almost no sulfur and 10-12% oxygen by weight. Biodiesel-fueled engines produce less CO, HC and particulate emissions than petroleum diesel-fueled engines. Biodiesel improves the lubricity, which results in longer engine component life.

Bio-diesel production is a very modern and technological area for researchers due to the relevance that it is winning everyday because of the increase in the petroleum prices and the environmental advantages biodiesel offers over diesel. Accordingly, many researchers around the world have dealt with these issues and in many cases devised unique solutions.

1.1 Problem Statement

There is a problem statement as, to optimize the Injection Timing by analyzing engine performance and exhaust emission for blend C25 at compression 16.5 : 1 and injection pressure 220bar.

1.2 Objectives

There are two main objectives in this research,

- To investigate the performance and emission characteristic of a diesel engine operating with Undi Oil biodiesel blend U25 under varying conditions of injection timing and Engine Load.
- To optimizing the performance of CI engine.

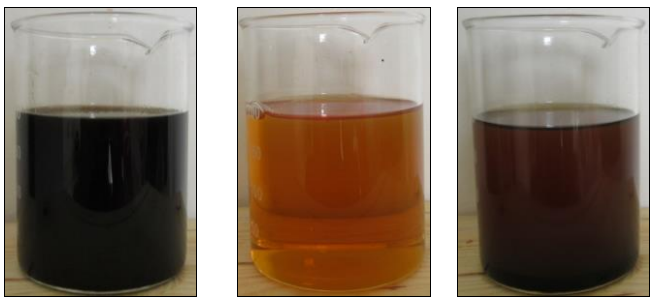
II. METHODS AND MATERIAL

The production of biodiesel from Undi Oil checked for suitability as alternative fuel for diesel use in CI engine was done in author's previous work, title "Honne Oil Biodiesel – Alternative Fuel for CI Engine" pulished in IJSRSET/ Volume 1/ Issue 2/ March April 2015 [433-435].

TABLE I
PHYSICO-CHEMICAL PROPERTIES

Parameter	*Test Standard*	*Diesel*	*UOME*	*Undi Oil*
Density at 15ºC (gm/cc)	IS 1448 (P16) 2007	0.835	0.8653	0.9363
Kinematic Viscosity at 40ºC (cst)	IS 1448 (P25) 2007	3.5	1.744	51.58
Calorific Value (MJ/Kg)	IS 1448 (P6) 2007	43.00	35.37	40.27
Flash Point (ºC)	IS 1448 (P69) 2013	44	8.5	220

Material used is a biodiesel blend U25, where the datum line data is obtained by using neat Diesel U00.



Row Undi Oil | Diesel (U00) | U25 (25%UOME + 75%Diesel)

Figure 1 : Fuel Samples Used

2.1 Optimizing CR and Blend

The objective of the first work is to study through experiments, the performance and emission characteristics of Undi Oil (UOME) blends in direct injection (DI) VCR diesel engine at various blend, engine load and compression ratio, to find the most suitable compression ratio and blend type at all load condition.

TABLE II
METHODOLOGY OPTIMIZING CR & BLEND

Blend Type	*Blend*	*IOP in bars*	*Injection Timing in degree bTDC*	*C R*	*Load in KW*
U00	100% Diesel	210	27	14.5 : 1	0.75
U25	25% UOME +75% Diesel			15.5 : 1	1.50
U50	50% UOME +50% Diesel			16.5 : 1	2.25
U75	75% UOME + 25 Diesel			17.5 : 1	3.0

From author's previous work titled "Performance Test of CI Engine fueled with Undi Oil Biodiesel under Variation in Blend Proportion, Compression Ratio & Engine Load" published in IJSETR, Volume 3, Issue 8, August 2014, [2197-2205], it was concluded that the best suited blend was U25 and the Compression Ratio was the 16.5 irrespective of all load conditions.

2.2 Optimizing IOP and Blend

The objective of the second work was to study, the performance and emission characteristics of Undi Oil (UOME) blends in CI engine at various blend, engine load and injection pressure ratio, to find the most suitable injection pressure and blend type at all load condition.

TABLE III
METHODOLOGY OPTIMIZING IOP & BLEND

Blend Type	*Blend*	*IOP in bars*	*Injection Timing in degree bTDC*	*C R*	*Load in KW*
U00	100% Diesel	190	27	16.5 : 1	0.75
U25	25% UOME +75% Diesel	200			1.50
U50	50% UOME +50% Diesel	210			2.25
U75	75% UOME + 25 Diesel	220			3.0

From author's previous work titled " Performance Test of CI Engine fueled with Undi Oil Biodiesel under Variation in Injection Pressure, Blend Proportion & Engine Load" published in JECET, June-August 2015, Sec. C, Volume 4, No.3, [427-436], it was concluded that the best suited blend was U25 and the Injection Operating Pressure was the 200bars at all load conditions.

2.3 Optimizing Injection Timing

The present work is to optimize the injection timing, through the study of engine performance and exhaust emission under the variation of injection timing and load conditions.

TABLE IV
METHODOLOGY OPTIMIZING INJECTION TIMING

Blend Type	*Blend*	*IOP in bars*	*Injection Timing in degree bTDC*	*C R*	*Load in KW*
U00	100% Diesel	200	25	16.5 : 1	0.75
			27		1.50
U25	25% UOME +75% Diesel		29		2.25
			31		3.0

III. RESULTS AND DISCUSSION

3.1 Experimental Engine Setup

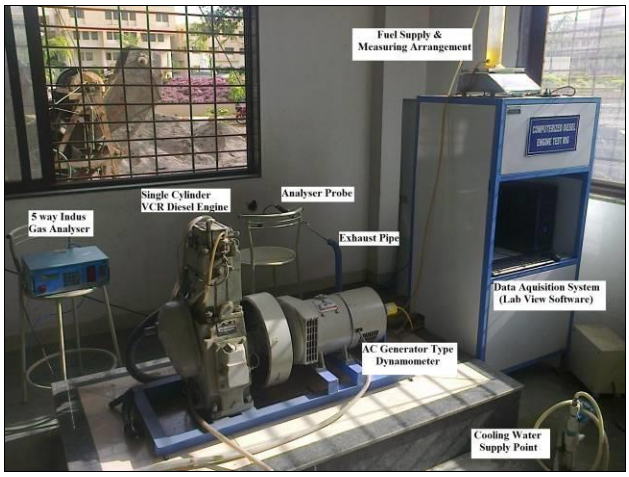


Figure 2 :Experimental Engine Setup

3.2 Engine Specifications

TABLE V
EXPERIMENTAL ENGINE SPECIFICATIONS

Sr. No.	Description	Specification
1	Make	Rocket Engineering Model VRC-1
2	Type of Engine	Vertical Single Cylinder Water Cooled
3	Bore	80 mm
4	Stroke	110 mm
5	Swept Volume	553 mm^3
6	RPM	1500
7	Brake Hours Power	5 HP
8	Compression Ratio	15.5 : 1 to 18.5 : 1
9	Fuel	High Speed Diesel
10	Coefficient of Discharge	0.65
11	Water Flow Transmitter	0 to 10 lit./min.
12	Air Flow Transmitter	0 to 250 wc
13	Piezo Sensor	0 to 5000 psi with low noise cable
14	Software	LabView

3.3 Experimental Methodology

Experiment is carried out with the diesel fuel and biodiesel blend U25 (25% UOME + 75% Diesel) where engine performance data with diesel is considered as the reference for experimentation.

The total experimental work is carried out by varying injection timing from 27 °bTDC to 31 °bTDC in the increment of 2 deg. and engine load from 0.75 KW to 3

KW in the increment of 0.75 KW, where as IOP 200 bar, Compression Ratio 16.5 are kept constant.

4. Results

4.1 Variation of Exhaust Gas Temperature

The result indicates that the variation in exhaust gas temperature (EGT) for diesel is highest at 27 °bTDC and that of blend U25 at 29 °bTDC, irrespective of load conditions. This shows that combustion of respective fuel reaches the maximum temperature at that injection timing.

From the graphs it is found that for biodiesel blends U25 the injection timing best suited is 29 °bTDC .

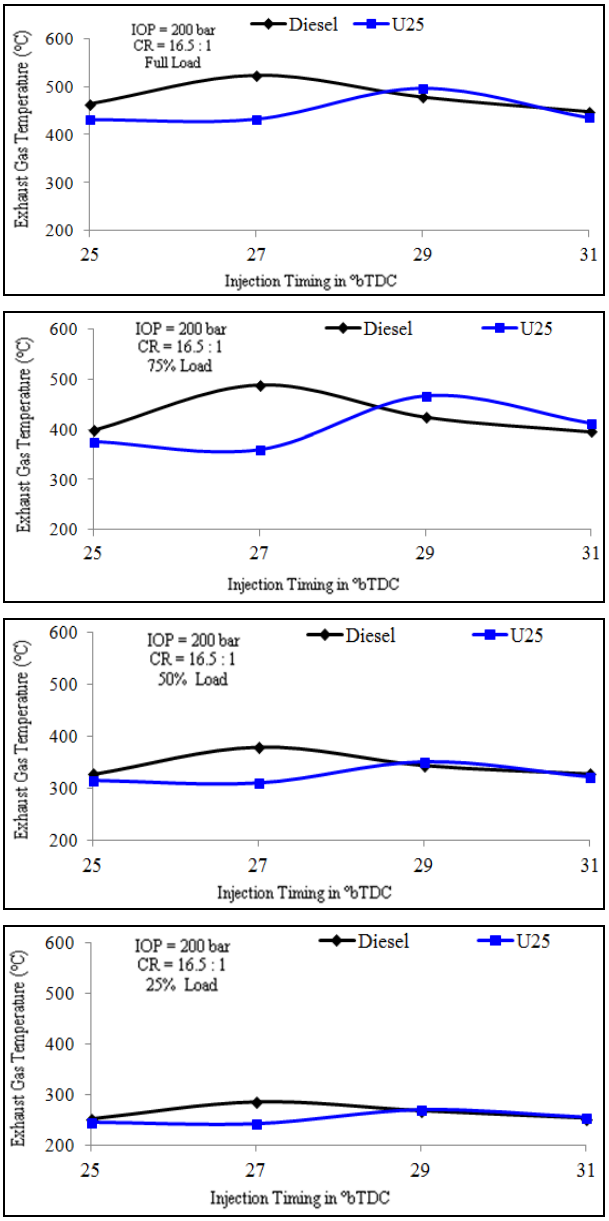


Figure 3: Variation of Exhaust Gas Temperature

4.1.2 Variation of Brake Thermal Efficiency

Brake thermal efficiency as compared to diesel over the entire range of injection timing is lower for blend U25 as compared to diesel, for all load conditions, which is as per expected as the lower heating value of biodiesel leads to decrease in brake thermal efficiency.

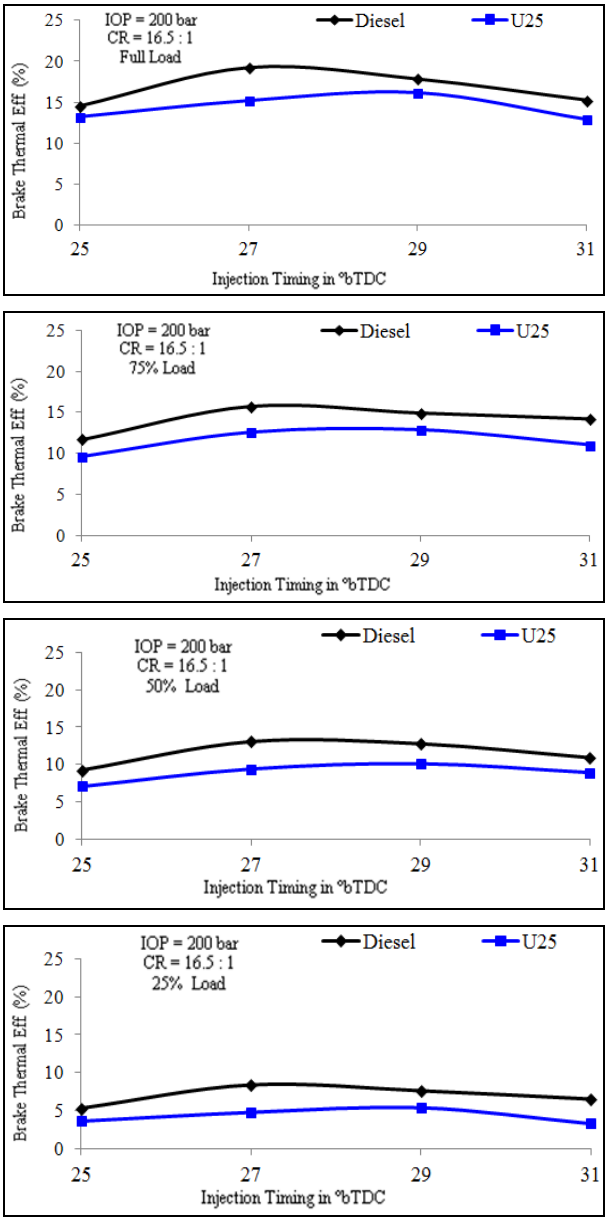


Figure 4 Variation of Brake Thermal Efficiency

4.1.3 Variation of Brake Specific Fuel Consumption

The figure shows that, BSFC for biodiesel blend U25 is higher than that of diesel. This is due to lower heating value of biodiesel, lower the power generation for the same fuel consumption rate as compared to diesel.

From the graph, the lowest BSFC for diesel is observed at For the full load condition, the highest BSFC obtained at 27 °bTDC, where as for blend U25 at 29 °bTDC. Which is as expected from the graphs of EGT and Brake thermal efficiency.

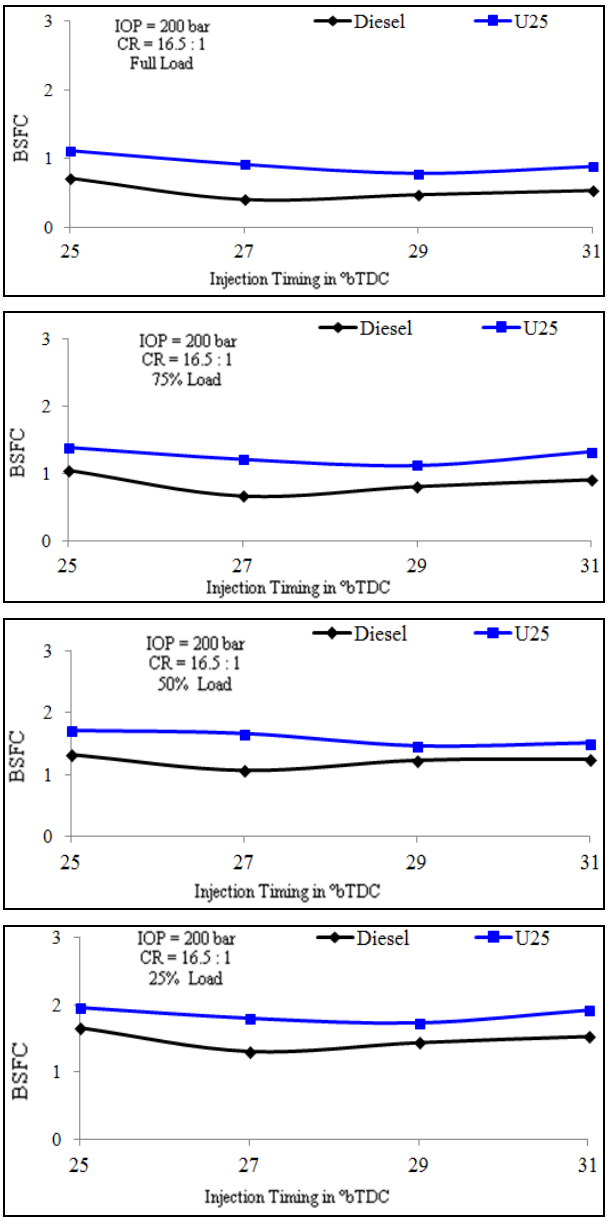


Figure 5: Variation of BSFC

4.1.5 Variation of Carbon Dioxide (CO2)

Carbon Dioxide emission is higher for diesel as compared to blend U25, but among all injection timing for U25 the highest CO2 emission is at 29 °bTDC , which indicates that the complete combustion is higher compared to other injection timing.

This validates the highest brake thermal efficiency and EGT for blend U25. For diesel highest CO2 emission is observed at 27 °bTDC.

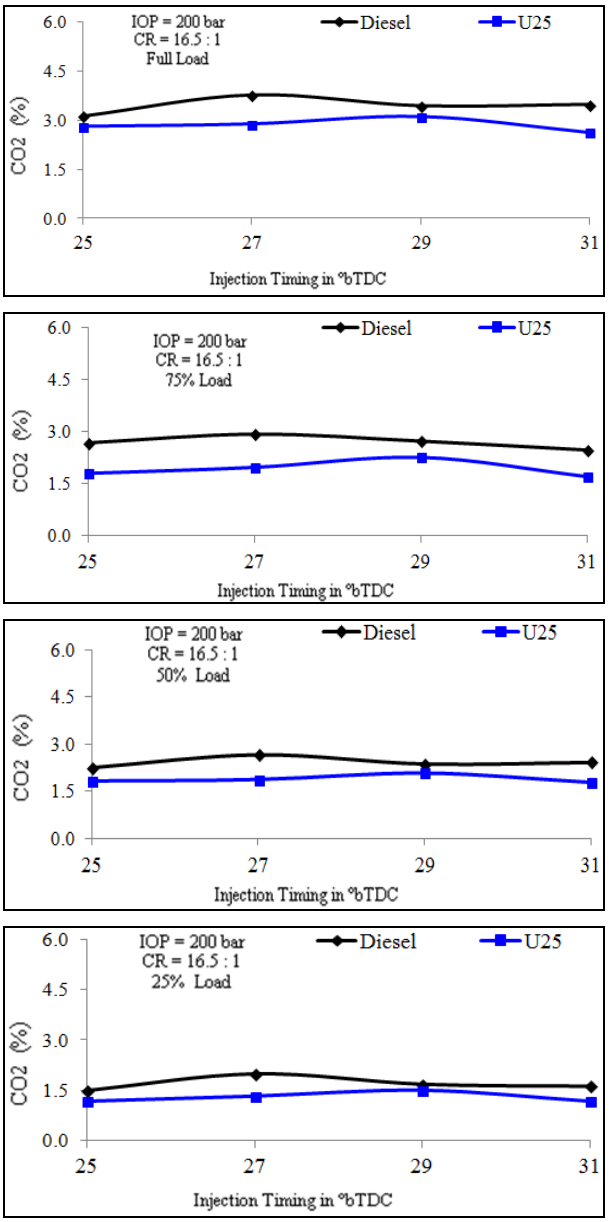


Figure 6: Variation of Carbon Dioxides

4.1.4 Variation of Carbon Monoxide (CO)

Carbon Moxide emission is lower for blend U25 as compared to diesel, irrespective of load and injection timing. Among all injection timing for U25 the Lowest CO emission is at 29 °bTDC , which is due to % of complete combustion and thus CO2 formation is higher at this injection timing.

For diesel lowest CO emission is observed at 27 °bTDC.

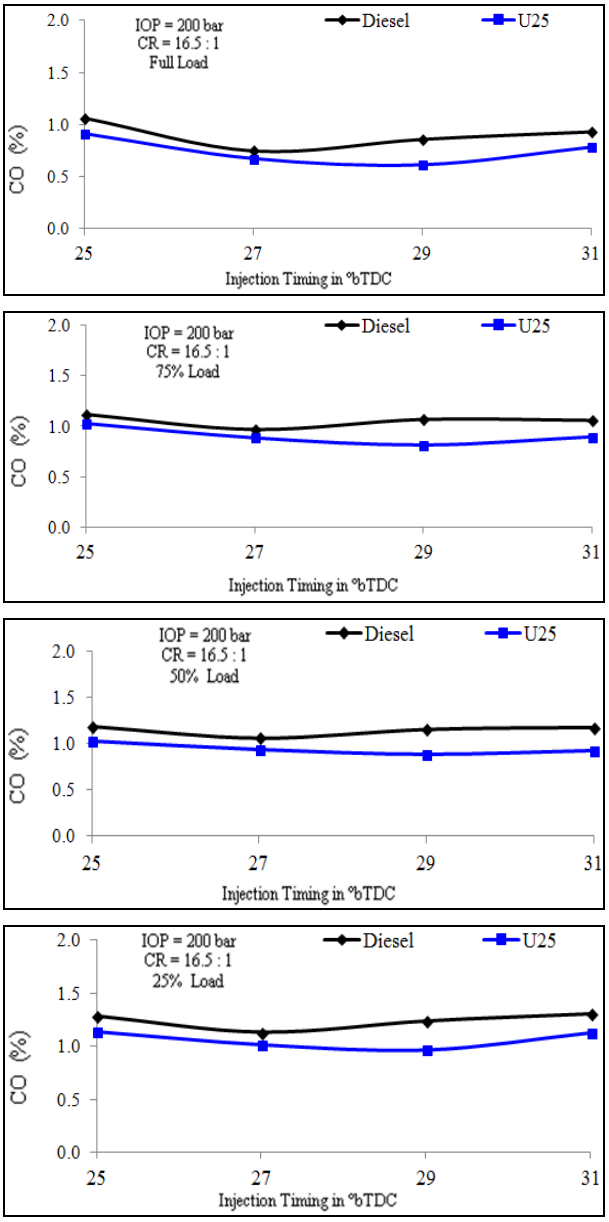
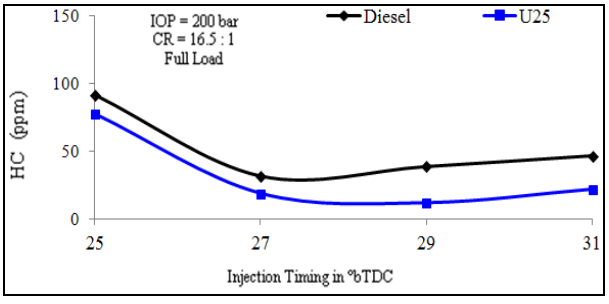


Figure 7: Variation of Carbon Monoxides

4.1.4 Variation of Hydrocarbon (HC)

Carbon Monoxide and Hydrocarbon always shows the similar trend in exhaust emission. Graphs shows hydrocarbon emission is lower for blend U25 as compared to diesel at all engine load condition and injection timing. For blend U25 the lowest HC emission is observed at 29 °bTDC , which is as expected .
For diesel lowest HC emission is observed at 27 °bTDC.



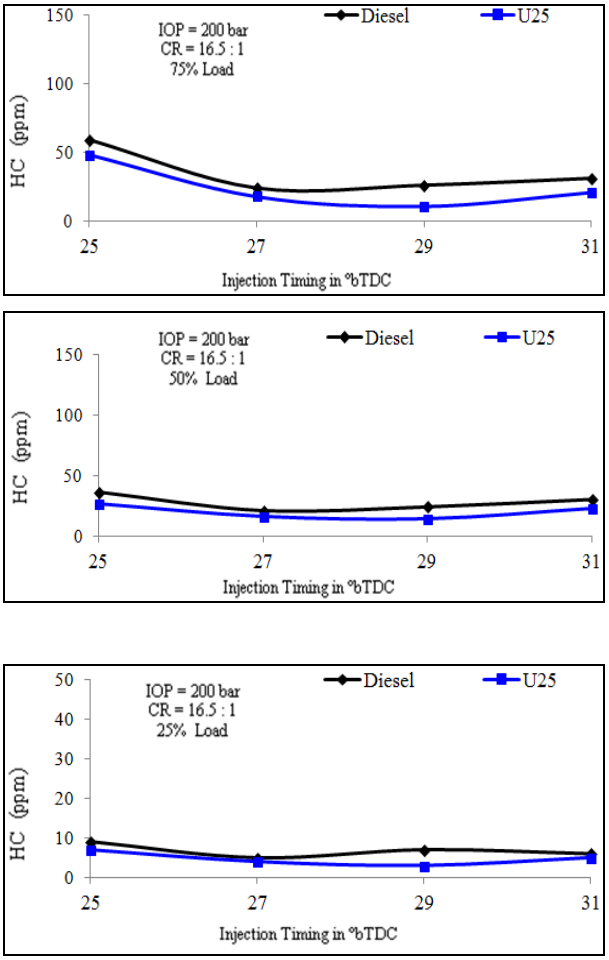
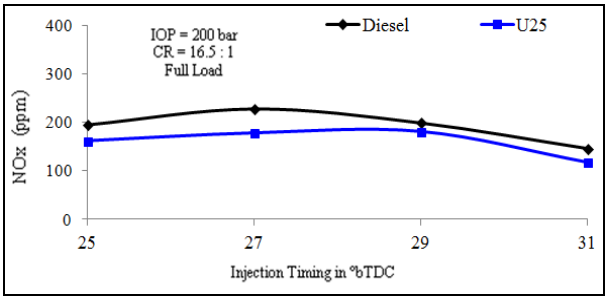


Figure 8 Variation of Hydro Carbons

4.1.4 Variation of Oxides of Nitrogen (NOx)

Oxides of Nitrogen form at the higher combustion temperature (about 1000°C and more) and as expected NOx emission is higher for diesel as compared to blend U25 due to higher heating value result in higher combustion temperature.

For blend U25 NOx emission is higher at 29 °bTDC as compared to other injection timing as at this timing blend U25 shows highest combustion temperature. Among all the lowest value is observed at 31 °bTDC . For diesel highest NOx emission is observed at 27 °bTDC.



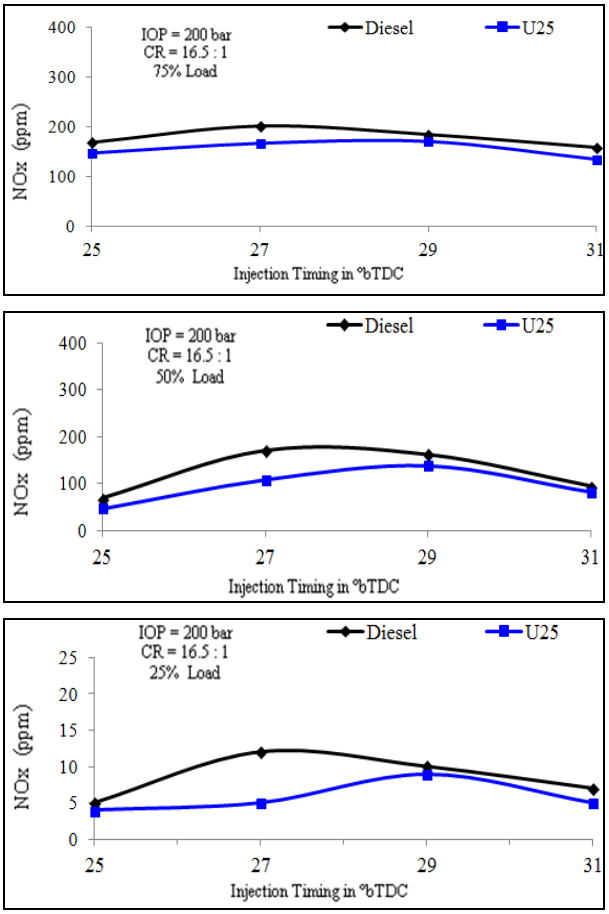


Figure 9 Variation of Oxides of Nitrogen

IV. CNCLUSIONS

Use of a undi oil biodiesel is considered as a new possible source of alternative fuel for diesel engine. No difficulty was facing at the time of starting the engine and the engine ran smoothly over the range of engine speed. Based on the experimental work, the following conclusions are drawn.

- Best suited Undi Oil Biodiesel Blend is U25, which can be used in CI engines without any modifications.
- The best suited compression ratio to use blend U25 is 16.5 : 1.
- The best suited injection pressure to use blend U25 is 200 bars.
- The optimum value of injection timing to used blend U25 is 29 °bTDC.

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VI. BIOGRAPHIES

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