

## Reduction of Emission in a Dual Fuel C.I. Engine Using Biodiesel Mixed with DMC Additive

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### Abstract

People are experiencing price rises, economic instability, and suffering as a result of rising fuel prices and oil imports. In a "green" movement, alternative fuels are being embraced as a better energy source, primarily in the transportation industry. Alternative fuel vehicles produce fewer emissions, which is good because emissions cause smog, air pollution, and global warming. This is why the movement is becoming more and more popular. Because of its shortcomings, neat biodiesel is not suitable for use in engines. A detailed investigation reveals that poor quality biodiesel fuel is the cause of most of problems. Some of the problems especially, cold weather are not attributable to poor fuel quality, but rather to the intrinsic characteristics of biodiesel fuel. Different kinds of additives are mixed into the fuel to solve these issues and enable the engine to function more efficiently. In comparison to diesel and biodiesel, very little is used in the way of additives. Additives are used to modify the qualities of biodiesel as much as feasible. This work deals with the engine emissions of a dual fuel compression ignition engine using Argemone Mexicana bio-diesel blended with Dimethyl Carbonate (DMC) as an additive. Argemone Mexicana biodiesel was prepared by trans-esterification process followed by esterification. Initially experiments were conducted taking diesel, B25 (25% biodiesel), B45 (45% biodiesel) and B65 (65% biodiesel) at various engine loads. After that 5ml DMC was added in 1liter B25, B45 and B65 fuel sample for the experiment purpose. An exhaust gas analyzer was used to measure the emissions of engine. During experiments an exhaust gas analyzer was connected to measure CO, HC and NO<sub>x</sub> emissions.

**Keywords:** Global warming, additive, green movement, tran-esterification process, exhaust gas analyzer.

### 1. INTRODUCTION

The world's academics are searching for alternative fuels made of renewable resources due to growing environmental concerns and the depletion of traditional supplies. These fuels must to be reasonably priced, easily obtainable, and sufficiently environmentally friendly. Among the promising alternative fuels is biodiesel. Biodiesel is made up of fatty acids that are extracted from a variety of oils, including animal fat and oils like soybean, palm, cottonseed, neem, and mahua [1]. Through the process of transesterification, various oils of bioproducts are converted into biodiesel. This process is often used to reduce the high viscosity (stickiness) of triglycerides. Greater cetane numbers and greater oxygen contents are two of biodiesel's notable qualities; nevertheless, it also has several serious drawbacks, including increased emissions (like NO<sub>x</sub>) and decreased efficiency. This can be caused by either incompletely processed biodiesel fuel or biodiesel

fuel that has partially oxidized. To overcome these problems different types of additives are blended in the fuel for running the engine effectively. Additives are used very little amount compared with diesel and biodiesel. To change the properties of biodiesel as possible, additives are used. Additives blend with diesel fuel can provide a variety of benefits. Incorporating a fuel additive into your tank can aid with lubricity, cold-weather performance, and even make your fuel more stable. Additives can improve and protect, as well as smooth and correctly fuel, all at a low cost. In addition to blending biodiesel with diesel to boost engine performance and reduce exhaust emissions, additives can be used to enhance the properties of fuel [2]. When choosing a biodiesel ingredient, consider its calorific value, solubility, viscosity, density, flash point, and fire point. A number of technical problems that previously restricted biodiesel's acceptance as an alternative fuel under all conditions are also resolved by the

inclusion of additives [3].

This research work deals with the engine performances and emissions of a direct injection compression ignition engine using Argemone Mexicana bio-diesel blended with Dimethyl Carbonate (DMC) as an additive. Argemone Mexicana biodiesel was prepared by transesterification process followed by esterification. Initially experiments were conducted taking diesel, B25 (25% biodiesel), B45 (45% biodiesel) and B65 (65% biodiesel) at various engine loads. After that 5ml DMC was added in 1liter B25, B45 and B65 fuel sample for the experiment purpose. During experiments an exhaust gas analyzer was connected to measure CO, HC and NOx emissions.

## 2. PREPARATION OF BIODIESEL BLENDS

The crude oils from Argemone mexicana that are found in rural areas are not edible. Therefore, Argemone Mexicana crude oil was bought in Bhubaneswar, Odisha, India, from a rural local provider. Argemone seed oil was converted into biodiesel via the transesterification and esterification processes [4,16]. The free fatty acid (FFA) value of the Argemone mexicana crude oil was discovered to be 19.5, which was extremely high. The esterification procedure was used to lower the FFA value. a magnetic stirrer at 60 °C for an hour. Following that, 0.1% aqueous sodium hydroxide (NaOH) solution was added, and the mixture was allowed to settle for one day in a beaker. Following that, the oil was prepared for the esterification process, which involved heating it to 65°C for three hours and adding 20 ml of sulfuric acid and 200 ml of methanol. The transesterification procedure, which involved mixing 200 milliliters of methanol and 8 grams of potassium hydroxide (KOH) with the heated oil, was used to remove the alcohol. By doing water washing, the final Argemone Mexicana biodiesel was ready to use in compression ignition engine. The properties of Argemone Mexicana biodiesel are different than the other biodiesel. When the biodiesel blending with the diesel again the properties were changed those were checked by different measuring apparatus. Before using these fuel samples in the engine, the properties must be checked. Viscosity, calorific values, density, flash point and fire point are the critical fuel properties,

on which the combustion of the fuel depends [5,6]. Therefore properties checks are necessary for the biodiesel and biodiesel blended fuel after production. The important physical and chemical properties of fuel samples were measured by different apparatus using standard set procedure as per ASTM. The properties were compared with diesel. The values were found within the limit, which can be used in DICl Engine. In Table1. The properties of fuel samples are shown.

**Table-1 Properties of biodiesel blends**

Properties of fuel blend/unit	Neat Diesel	Argemone Mexicana biodiesel	DMC	B25	B45	B65
Flash point ( °C)	55	168	66	87	115	132
Kinematic viscosity at 40°C	2.51	5.05	0.61	4.2	4.34	4.63
Density (Kg/m <sup>3</sup> )	824	869	1065	845	852	861
Calorific value (KJ/kg)	42600	41450	1578	42503	42240	41910
Cetane number	47	52	35	53	57	59
Oxygen content (Wt. %)	0	10	54.27	6	7	8

### Fuel samples for experimental work

D100 - Diesel 100%

B25 - Biodiesel 25% + Diesel 75%

B45 - Biodiesel 45% + Diesel 55%

B65 - Biodiesel 65% + Diesel 35%

B25 + 5 ml DMC - Biodiesel 25% + Diesel 75% + 5ml DMC

B45 + 5 ml DMC - Biodiesel 45% + Diesel 55% + 5ml DMC

B65 + 5 ml DMC - Biodiesel 65% + Diesel 35% + 5ml DMC

## 3. EXPERIMENTAL PROCEDURE

Electric supply was switched on first and ensured that Piezo powering unit (PPU) and Dynamometer loading unit (DLU). The engine model was selected and checked the configuration values with the displayed values of the engine test rig presented in Figure.1. The engine was allowed to run at idling conditions for 4-5 minutes. Scan start on the monitor was clicked on [7,8,17]. These readings were checked with the engine displayed panel. The load was gradually increased by rotating DLU knob and reading was taken manually as well as in computer. The above steps were repeated for 25% load to 100% loads. The compression ratio was

taking constant 17.5. The values of speed, load, break power, torque, pressure, efficiencies etc. were recorded in the computer. After finished all the experiments by taking all fuel samples in the engine, the loads were reduced gradually. An exhaust gas analyzer was connected with the exhaust pipe of the engine to measure the emissions like CO<sub>2</sub>, CO, HC, NO<sub>x</sub> [10].

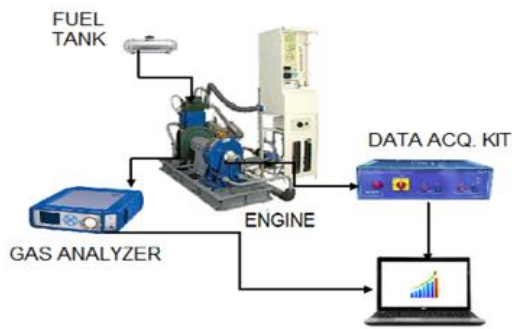


Figure.1 Experimental Test rig [19]

#### 4. RESULTS AND DISCUSSION

The emissions like HC, CO, NO<sub>x</sub> were measured and details were listed below. Figure 2 represents the AVL gas analyzer. For 100% load case using the fuel B65+5ml DMC, the emission of CO was found less comparing with the other fuel [11,12]. Variations of CO emissions with respect to loads using 5ml DMC Figure 3.



Figure 2. AVL Analyzer [18]

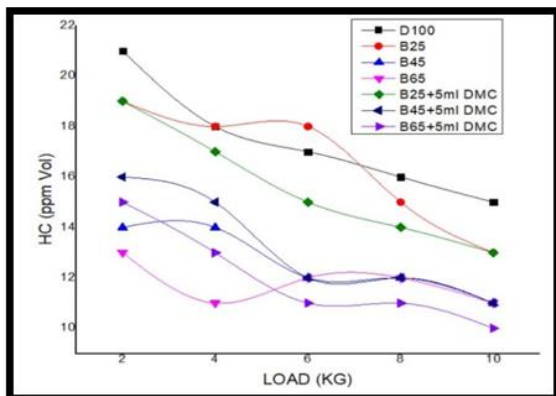


Figure 3. CO emissions with respect to loads using 5ml DMC.

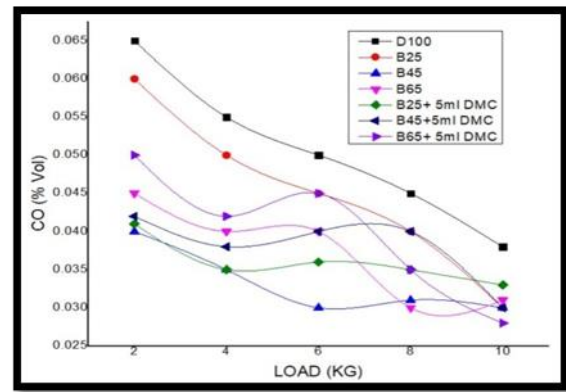


Figure 4. HC emissions with respect to loads using 5ml DMC

Using B65+5ml DMC in engine, the HC values were found less. The variations of HC emissions at different loads using 5ml DMC are shown in Figure 4. The value of exhaust NO<sub>x</sub> emissions from the fuel B65+5ml DMC was measured to be lowest at all loads. The variations of NO<sub>x</sub> emissions with loads for all fuel samples are shown in Figure 5.

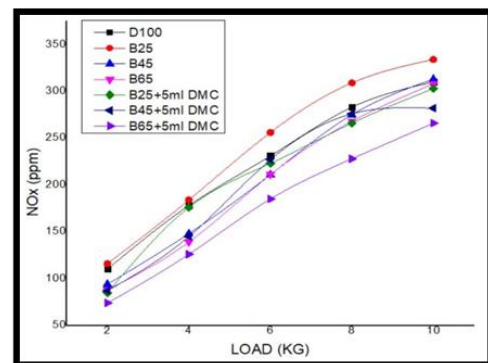


Figure 5. NOx emissions with respect to loads using 5ml DMC

#### 5. CONCLUSION

After so many literature surveys it was found that Argemone Mexicana biodiesel is a clean and good alternative fuel for compression ignition engine [15]. Oxygenated additives, which raise the biodiesel's oxygen content, are highly helpful in reducing the viscosity and density of biodiesel and diesel blended fuel. The addition of oxygenated additives to diesel and biodiesel fuel reduces all types of pollutants. So for this experiment DMC (dimethyl carbonate) used as an additive.

Argemone Mexicana biodiesel preparation from crude oil was a lengthy process. After Trans-esterification process the density of biodiesel was

reduced and within the limit. The reduced heating values of blend and biodiesel fuels are fewer than those of regular diesel because of their oxygen contents. It was determined by examining the combined fuel's chemical and physical characteristics that these blended fuels could be utilized for this experiment without requiring any changes to the CI Engine.

Using B45+5ml DMC the CO emissions were measured less as compared with other fuel samples at high load conditions. HC emissions found less by using B65+5ml DMC. Taking 5ml DMC in B65 fuel the value of exhaust NO<sub>x</sub> emissions were found lowest as compared with the other fuel samples at all load conditions. From these experiments, it was concluded that addition of DMC gave excellent results in case of emissions compared with diesel fuel.

#### ACKNOWLEDGMENT

For helping me to draft the review paper, Kalinga Institute of Industrial Technology, now recognized as University, Bhubaneswar, has my deepest gratitude. I express my gratitude to Dr. Akshaya Kumar Rout for providing advice in finishing this work. I would like to thank Mr. Bishnu Prasad Swain and Mr. Aditya Prasad Swain of GIET, Ghangapatana, Bhubaneswar for helping me to draft the paper and for giving the technical advice.

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