



# EXPERIMENTAL EMISSION ANALYSIS ON FOUR STROKE 2 CYLINDER DIESEL ENGINE USING FUEL ADDITIVE BLEND

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## ABSTRACT

Diesel engines are most responsible for environment pollution causes several health problems for human being. Five main pollutant of diesel emission includes Carbon monoxide(CO), Hydrocarbon(HC), Nitrogen oxides(NOx), Carbon dioxide(CO2) and particulate matter. Several researchers attempted to reduce diesel emission pollutants by pre-combustion and after exhaust treatment. In this study author tried to explain effect of emission pollutant and method to control diesel emission content by blending additives with diesel.

**KEYWORDS:** Emission, additives, blend, diesel properties.

## 1. Introduction

Since diesel and petrol engine invented, better and better technology developed for fuel efficiency. All the time performance measured by the researcher is focused on the engine power, fuel economy and emission with ordinary fuel. Here trial is being taken using fuel with additives to characterize engine emission. Emission generally concerned with the complete combustion of fuel, so if engine can be run with better fuel then it can make possible. Fuel comes from the pump or refinery gives performance of diesel and petrol engine is not enough for present era.

Fuel additive which could be classified into gasoline/petrol and diesel additive is a chemical substance that assists the cleanliness of engine part, i.e. carburetor, intake valve and fuel injector, prevent incomplete combustion, temper fuel gelling and nozzle choking, as well as protect engine parts from corrosion which leads to better engine performance and acceleration, improve fuel economy and reduce emissions of greenhouse gas.

There are two fuel additives tried for experiment

- (1) DT#1TM: it is a Chemical Organic which taken from Petroleum Conservation Research Association, New Delhi and also approved by Automotive Research Association of India. Property of this additive is shown in table 2.2.
- (2) FUEL STICK: it is a proprietary product. Fuel stick is available in solid form. It contains no highly flammable, caustic, acidic or reactive ingredients. It is manufactured from 92% renewable organic material and is fully bio degradable. It should not be considered to be hazardous when used and handled under normal condition.

## 2. Sampling

**Table 2.1 Sample Identification**

SAMPLE	QUANTITY OF ADDITIVE IN DIESEL
A0	100 % Diesel (Ordinary Diesel)
A2	100 % Diesel + 0.2 % Additive(DT#1TM)
A4	100 % Diesel + 0.4 % Additives(DT#1TM)
B2	1 Litre Diesel + 2 Grams Additives(FUEL STICK)
B4	1 Litre Diesel + 4 Grams Additives(FUEL STICK)

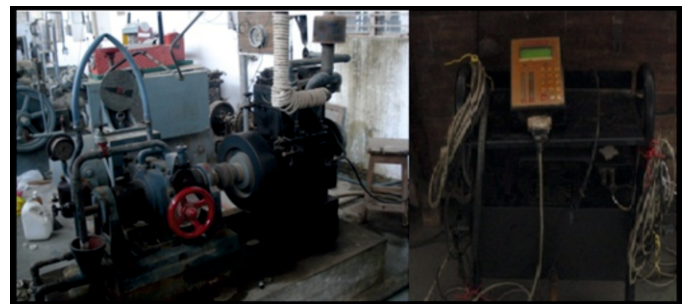
**Table 2.2 Specification of Additive DT#1TM and Fuel Stick**

PROPERTY	ADDITIVES	
	DT#1TM	FUEL STICK
Chemical character	Organic	Organic
Colour	Dark brownish clear liquid	Orange
Odour	Aromatic petroleum	Slight camphor
Specific gravity	0.91	0.925 @ 520C
Viscosity	2.59 cSt, at 400C	-
Acidity	Nil mg koh/g	-
Ash content	.0002% by wt	-
Water	Nil	Nil
Sediment	0.001 Mg/Lts	-

**Table 2.3 Measured Fuel Properties**

PROPERTY	UNIT	DIESEL+ ADDITIVE				
		A0	A2	A4	B2	B4
Density	Kg/m <sup>3</sup>	853	847	832	849	846
Kinematic viscosity at 40°C	mm <sup>2</sup> /sec	2.59	2.6	2.63	2.6	2.6
Cetane no.		55	56	56	56	56
Flash point	°C	64	63	61	62	61
Fire point	°C	75	74	71	73	70
Boiling point	°C	94	93	93	92	92
Pour point	°C	4	4	4	4	4

## 3 Experimental Setup And Test Procedure



**Fig 3.1 Experimental setup.**

Here two cylinder 4 stroke compression ignition engine is coupled with hydraulic dynamometer. Fuel tank connected with calibrated glass burette. Load applied to the engine through handle connected with dial gauge. Here engine is constant RPM, water cooled.

**Table 3.1 Engine Specification**

Engine name	Kirlosker
Engine no.	19.8004/9074
Cylinder number	2
RPM	1500
BHP	10
KW	7.4
Fuel injection system	Common rail
Valve no.	2/cylinder
Bore X stroke	80mm X 101mm
Displacement	1004 cc

## 4 Test Procedure

- Emission from the engine running on diesel blended with fuel additives were evaluated and compared with diesel fuel.

- The properties of diesel fuel are given in Table 3.1. Above 4% additives, fuel cost will be increased; therefore, only experimental results obtained up to this percentage of additives will be presented.
- The fuel additives blends were prepared just before starting the experiment to ensure that the fuel mixture was homogenous and to avoid the reaction.
- A series of experiments were carried out using diesel, and the various diesel additives blends.
- All the blends were tested under constant engine speed conditions. The engine was started using diesel fuel and it was operated until it reached the steady state condition.
- After the engine reached the stabilized working condition, emission parameters such as CO, CO<sub>2</sub>, HC, NO<sub>x</sub> and the exhaust gas temperature from an online and accurately calibrated exhaust gas analyzer were recorded. All experiments have been carried out at full throttle setting.
- Before obtaining data from the engine operated with a new blended fuel, the engine was operated using the new fuel for sufficient time to clean out the remaining fuel from the previous blend.
- Fuel properties were determined at the laboratories of Petroleum Industry in Vapi.

In this report, the quantity AX represents a blend consisting of X% additives by volume, e.g., A2 indicates a blend consisting of 0.2% additives in 100% diesel. Five test fuels were used in this study: 0% additives A0; 0.2% additives A2; 0.4% additives A4. The quantity BX represents a blend consisting of X grams additives by weight, e.g., B2 indicates a blend consisting of 2 grams additives in 1 litre diesel; B4 means 4 grams additives in 1 litre diesel.

**5 Exhaust Gas Sampling And Analysis**

The exhaust gas is sampled about 1500 mm downstream from the engine exhaust outlet, and it would be analyzed with an automotive exhaust gas analyzer (INDUS 5 PEA 205) as shown in Fig. it will measure five emission like HC, NO<sub>x</sub>, CO, CO<sub>2</sub>, THC etc. analyzer is placed after the engine outlet and it indicates paper output having value by printing output.

**5.1 NO<sub>x</sub> Emission**

Under the high pressure and temperature conditions in an engine, nitrogen and oxygen atoms in the air react to form various nitrogen oxides, collectively known as NO<sub>x</sub>. Nitrogen oxides, like hydrocarbons, are precursors to the formation of ozone.

The critical time period of NO<sub>x</sub> formation is when burned gas temperatures are at a maximum, i.e. between the start of combustion and shortly after the occurrence of peak cylinder pressure. After peak pressure, burned gas temperatures decrease as cylinder gases expand. Expansion leads to decrease in temperature and mixing of high temperature gas with air or cooler burned gas stops the formation of NO<sub>x</sub>.

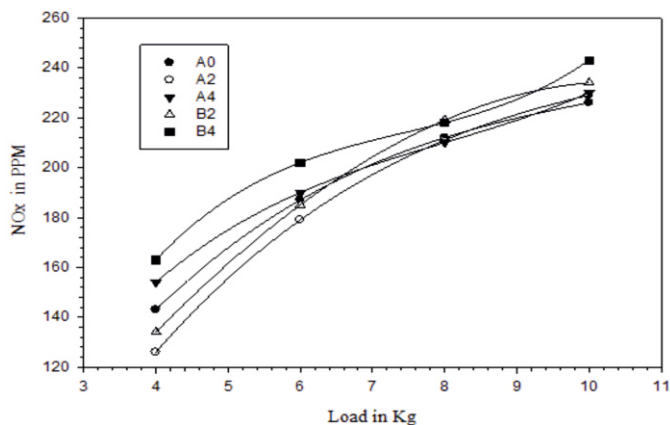


Fig 5.2 Concentration of NOx

Fig shows the NO<sub>x</sub> emission concentration for neat diesel and various percentages of additives blends in diesel fuel. As load is increased NO<sub>x</sub> concentration is increased but as percentage of fuel additives blend, increased, NO<sub>x</sub> concentration for that load is decreased. Here, A2 gives best result for lower load and A4 gives best result for higher load. Higher variation was observed 11.88% for A2 from A0 at 4 Kg load.

**5.3. CO Emissions**

Carbon monoxide (CO) is a product of incomplete combustion and occurs when carbon in the fuel is partially oxidized rather than fully oxidized to carbon dioxide (CO<sub>2</sub>). Carbon monoxide (CO) emissions from IC Engines are a concern because of its toxicological effects on humans.

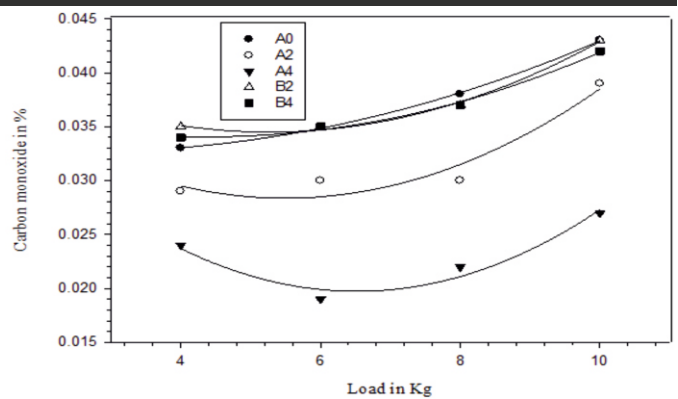


Fig 5.3 Concentration of CO

Fig shows the CO emission concentration for neat diesel and various percentages of additives blends in diesel fuel. As percentage of additive increased in diesel fuel CO % is decreased for different additive blend for particular load compare to neat diesel. Here highest variation of CO emission is for A4 from A0 and that is 45.71% at 6 Kg. Other variation is shown in fig. A4 gives best result for all load compare to neat diesel.

**5.4. HC Emissions**

There are two major reasons of HC formation and emissions from diesel engines under normal operating conditions.

Over leaning of the fuel injected during the ignition delay period is a significant source of hydrocarbon emission, especially under conditions when the ignition delay is long. The second source is the excess fuel that enters the cylinder under over fuelling conditions.

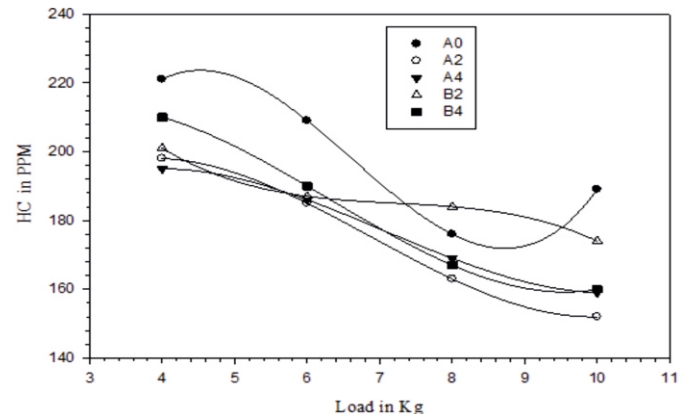


Fig 5.4 Concentration of HC

Fig shows the HC emission concentration for neat diesel and various percentages of additives blends in diesel fuel. As percentage of additive increased in diesel fuel HC PPM is decreased for different additive blend compare neat diesel. Here highest variation for A2 from A0 at 10 Kg load is 19.57%. Here for 4 Kg and 6 Kg, A4 gives best where for 8 Kg and 10 Kg A2 gives best result.

**5.5 Carbon Dioxide**

In recent years, the U.S. Environmental Protection Agency (EPA) has started to view carbon dioxide, a product of “perfect” combustion, as a pollution concern. Carbon dioxide does not directly impair human health, but it is a “greenhouse gas” that traps the earth’s heat and contributes to the potential for global warming.

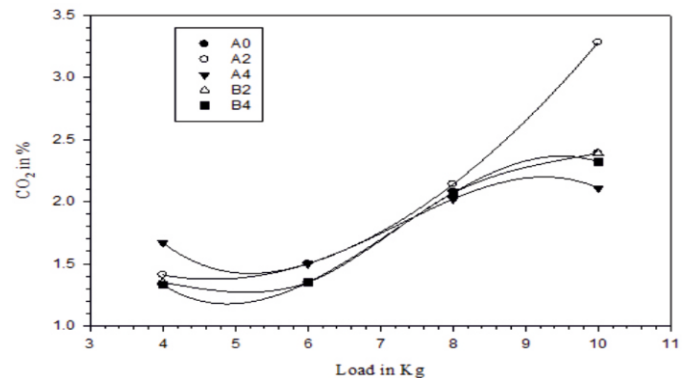


Fig 5.5 Concentration of CO2

Fig shows the Co<sub>2</sub> emission concentration for neat diesel and various percentages of additives blends in diesel fuel. It is observed that concentration of Co<sub>2</sub> is uncertain. For A4 it is best suited at all loads and additive blend. Highest variation for A2 from A0 is 37.23%.

#### 5.6 Particulate Matter

Particulate matter (PM) is a complex mixture of solid and liquid particles that are suspended in air. These particles typically consist of a mixture of inorganic and organic chemicals, including carbon, sulphates, nitrates, metals, acids, and semi-volatile compounds.

People with heart or lung diseases, children and older adults are the most likely to be affected by particle pollution exposure. However, even if you are healthy, you may experience temporary symptoms from exposure to elevated levels of particle pollution.

#### Conclusion

1. Properties of the 0.2% and 0.4% blends of additives are nearer to the diesel fuel.
2. Reducing harmful particulate matter including CO, HC, and NO, etc. 10%-20%. It is propitious to protect the environment.

3. Effectively inhibit or eliminate carbon deposits in combustion chamber including the spark plug, fuel spray nozzle, gas inlet valve, gas exhaust valve etc.
4. No engine modification is required.

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