ANALYSIS OF EMISSION CHARACTERISTIC OF NM-DIESEL BLEND ON VCR DIESEL ENGINE

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ABSTRACT

The consumption of fuel is increasing resulting in pollution of environment with smoke and NOx due to the development in automobile and power sector. These emission contents smoke and NOx can be reduced by adding additives with diesel fuel. As these additives are very costly and hence becomes unviable. These additives decrease the performance of combustion.

Oxygenated compounds are most widely used among additives. The reason for this is the participation of their oxygen in reactions leading to better combustion and hence lowering the emission contents the molecular structure of the oxygen contents of additives directly influence on smoke reduction and the oxygen concentration of the fuel flame also effects the emission specially Nitro paraffin compound additives have high oxygen contents is then molecular structure. So we considered as oxygenated additives.

We have used nitro methane (NM) (2%) as an additives with diesel while analyzing the emission characteristic on VCR Engine.

KEY WORDS

Emission characteristics, VCR engine, NM-Diesel blend, smoke meter, gas analyzer.

1. INTRODUCTION

In this paper we are going to analyze the emission characteristic of a VCR C.I. engine using NM-diesel blend of fuel. With increase in demand for diesel fuel and more concern for environmental emission has led to considerable research for better fuel formation in order to reduce the emission contents. The development of engine design has also help in reducing emission level considerably. The other way to reduce emission is by blending the diesel with different additives has to proved very successful and hence become a point of research in this field from last two decades.

1.1 Health Effects of Diesel Engine Emission

Diesel engine emission can effect health an can cause cancer and other pulmonary and cardiovascular diseases. Diesel engine emission is also a major contributor to particulate matter in

the environment. The fine particles below 10 µm effect respiratory morbidity and mortality. They also effect chest. It has been established that the exposure to diesel fumes in sufficient concentrations may lead to eye and nasal irritation but we have no evidence of any permanent effect. These emission inhalation leads to the development of cough and sputum and in case of higher exposure may lead to acute symptoms, primarily affecting the conjunctivae and upper respiratory tract i.e. nearly always reversible with in few days. These emission affects body respiratory system and the cardiovascular system and at the same time effects human health due to poor air quality.

1.2 Additives

We have so many additives available blended with diesel and used in CI engine. Those additives with oxygenated compounds are most widely used in Diesel, as the participation of their oxygen in reactions leads to a better combustion thus lowering emission. Their molecular structure and oxygen content have direct influence on soot reduction. In order to decrease soot formation, 11-21% volume of oxygenate chemicals should be blended with diesel fuel.

When additives are added they alter the physical and chemical properties such as density, viscosity, volatility and cetane index significantly. Nitro paraffin is one additive which have high oxygen content in then molecular structure.

By addition of additives, we can improve the performance via the increase of thermal energy output and combustion product alteration.

1.3 The Merits of Additives

Following are the merits of additives:-

- Engine Performance:- It has been found out that some of additives improves thermal efficiency upto 19% without affecting the torque.
- Emissions Reduction:- Diesel additives can decreases pollutants and greenhouse gas emissions upto 55% or more.

1.4 The Demerits of Additives

Following are the demerits of additives:-

- Fuel Cost:- The high cost of additives increases the cost of fuel.
- Preparation of blend:- Preparation of diesel additives blend are difficult in some cases.

1.5 Nitromethane

Nitromethane is an organic compound with the chemical formula CH_3NO_2. It is the simplest organic nitro compound. It is generally used as a solvent in many industrial applications e.g. in extractions as a reaction medium and as a cleaning solvent. It is a less viscous and high polar liquid. Its application as an intermediate in-organic synthesis, in the manufacturing of pharmaceutical, pesticides, explosive and fiber coating has been found useful.

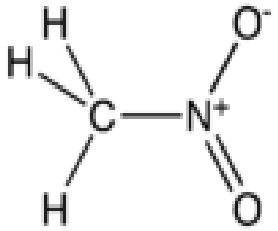

Fig. 1: Structure of Nitromethane

1.6 Properties of Diesel and Additives:

Following properties are essential to check before using the additives in internal combustion engines. Table 1 gives the comparison of physical and combustion properties of diesel and Nitromethane.

Table 1: Comparison of Physical and Combustion Properties of diesel and NM [18] [21].

	Diesel	**Nitromethane**
Molecular Formula	$C_{10}H_{20}$-$C_{15}H_{28}$	CH_3NO_2
Molecular Weight	170	61.04
Hydrogen Content (wt%)	12-15	4.8
Carbon Content (wt%)	86-88	19.5
Oxygen Content (wt%)	0	52.4
Density(Kg/m^3) (20°C)	837	1138
Specific Gravity	.836	1.137
Latent heat of vaporization (KJ/Kg)	255	564
Cetane Number	50	NA
Viscosity (40°C)cSt	4.8	4.8
Lower heating value (MJ/Kg)	42	11.2
Flash Point (°C)	62-84	34
Boiling Point (°C)	181-362	101-102

Nitromethane used as an additive with diesel fuel for C.I. engine as it has :-

- Auto ignition temperature high.
- High Oxygen Contents.
- Very little Hydrogen and carbon contents.

2. Test Engine Selection and Development of Experimental Setup

The parameters of the test Engine for research work are as below

- Single Cylinder with bore 80mm and Stroke 110mm.
- Four stroke direct injection.
- Naturally aspirated VCR multi fuel engine.
- Power output 5 HP.

- Manufacture by TTE Banglore.

The engine is loading by eddy current dynamometer. The VCR engine is start by hand cranking/self start.

Fig.2: Experimental Set up of VCR engine

3. Exhaust Emission Measurement

The exhaust gas compositions have been measured using i3sys gas exhaust analyzer (EPM1601) and AVL smoke meter (437C):

3.1 I3sys Gas Exhaust Analyzer

Gas analyzer is used to measure concentrations of Carbon Monoxide, Hydrocarbons and Carbon Dioxide based on Non-Dispersive Infra Red principle and Oxygen, Oxides of Nitrogen and Sulphur are measured by Electro Chemical principle. The principal of the gas analyzer is based on the amount of infrared energy absorbed by a compound in a cell is proportional to the concentration of the compound. The analyzer is equipped with advanced microprocessor technology with printer and RS 232 serial port for a personal computer interface.

Fig. 3: View of I3sys Gas Exhaust Analyzer

3.2 AVL Smoke Meter

Smoke meter is used to measure smoke density and smoke opacity based on the light absorption coefficient principle. The smoke meter is equipped with advanced microprocessor technology with printer and RS 232 serial port for a personal computer interface.

Fig. 4: View of AVL Smoke meter

4. EMISSION PARAMETERS

The main emissions are carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_x) and smoke opacity during combustion process from C.I. engine. The results were compared between diesel at compression ratio 17.5 and Nitromethane- diesel blend at compression ratio 17.5 and 16.5.

4.1 Carbon Monoxide

The graph shown in fig.5 is drawn between brake power (kW) and carbon monoxide emission (ppm). The Carbon for Nitromethane-diesel blends higher than pure diesel operation for both compression ratios. The result revels that we decrease the compression ratio from 17.5 to 16.5. CO emission increases, it may because of less intermolecular reactivity at low compression ratio.

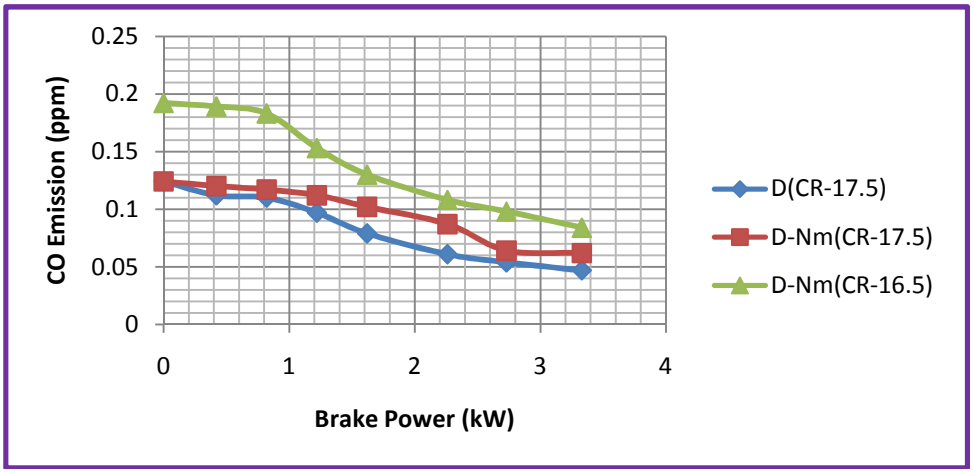

Fig.5: Change in CO emission with BP

4.2 Unburnt Hydrocarbons

The graph shown in fig.6 is drawn between brake power (kW) and hydrocarbons (ppm). The HC emission of diesel at compression ratio 17.5 is less as compare to Nitromethane-diesel blend at compression ratio 16.5 and slightly less as compare to Nitromethane-diesel blend at compression ratio 17.5.

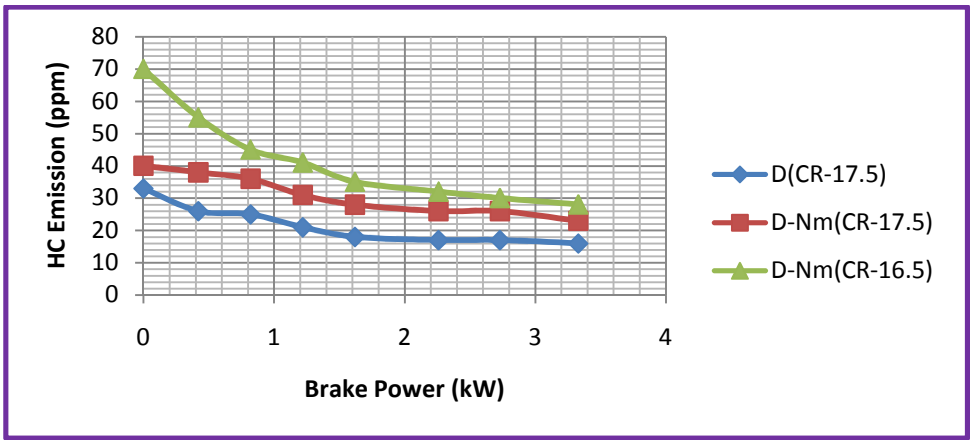

Fig. 6: Change in HC emission with BP

4.3 Oxides of Nitrogen (NO_x)

The graph shown in fig.7 is drawn between brake power (kW) and oxides of nitrogen (ppm). The NOx emission of diesel at compression ratio 17.5 is slightly high as compare to Nitromethane-diesel blend at compression ratio 17.5 and is high enough as compare to Nitromethane-diesel blend at compression ratio 16.5.

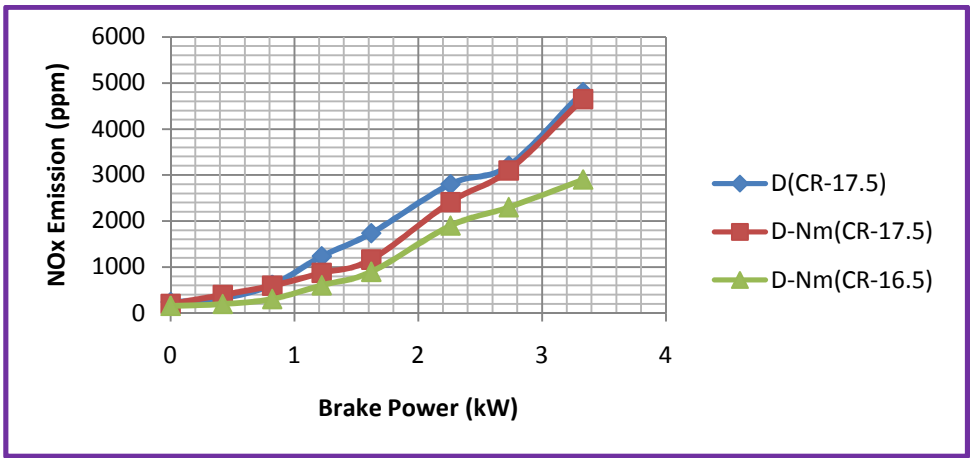

Fig. 7 Change in NOx emission with BP

4.4 Opacity (N)

The opacity graph shown in fig.8 is drawn between brake power (kW) and opacity (%). The opacity emission of NM-diesel blend at compression ratio 16.5 is enough high as compare to diesel at compression ratio 17.5 and enouh high as relative to NM-diesel blend at compression ratio 17.5.

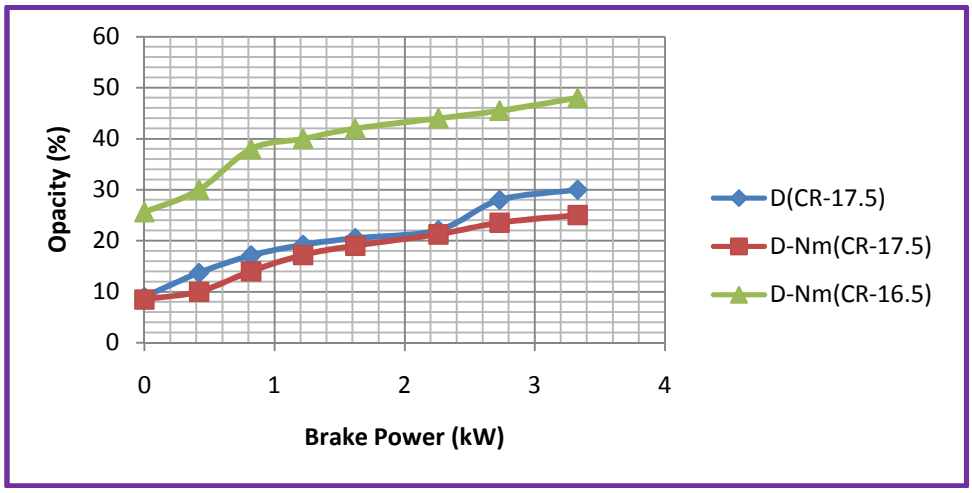

Fig. 8: Change in Opacity emission with BP

4.5 Smoke density (K)

The graph shown in fig.9 is drawn between brake power (kW) and smoke density (m^{-1}). The smoke density emission of NM-diesel blend at compression ratio 16.5 is high as compare to diesel fuel at compression ratio 17.5 and high as relative to NM-diesel blend at compression ratio 16.5.

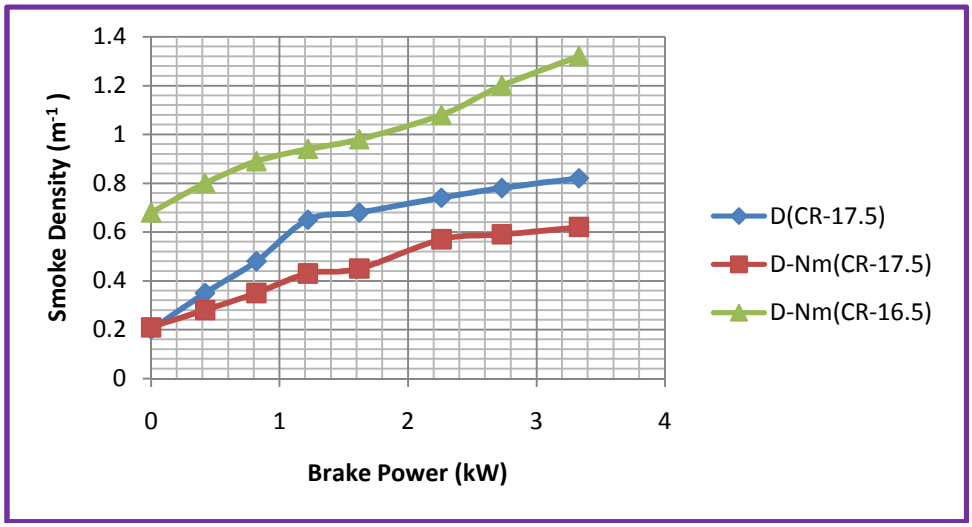

Fig. 9: Change in Smoke density emission with BP

The increased smoke at lower compression ratio is because of less efficient combustion at low pressure and temperature.

5. CONCLUSIONS

The following conclusion has been drawn from the experiments and analysis of C.I. Engine combustion with pure diesel at compression ratio 17.5 and NM-Diesel blend at compression ratio 17.5 and 16.5.

- The CO emission of NM-Diesel blend at compression ratio 17.5 is more as compare to diesel, at same compression ratio. As we reduce compression ratio up to 16.5 emission of CO will be increased. The increases of CO are prolonged at low loads.

- The HC emission shows the same trends as CO.

- NOx emission of NM-Diesel blend at compression ratio 17.5 is lower as compare to diesel at same compression ratio. As compression ratio reduced to 16.5 the NOx emission reduced at a great extend for all loads.

- The smoke of NM-Diesel blend at compression ratio 17.5 is less as compare to diesel at same compression ratio. At lower compression ratio the smoke level has been increased.

Only NOx has been reduced by lowering the compression ratio, otherwise CO, HC and smoke has been increased due to reduced compression ratio. Thus it is concluded that lowering the compression ratio from normal (i.e. 17.5) to 16.5 is not in favour for emission of C.I. Engine with NM-Diesel blend.

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