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# Role of Additives and their Influence on Performance of Engine for Petroleum Diesel Fuel, Oxygenated-Diesel Blend: A Review

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***Abstract*— Increasing demand of fuel in everyday life and its hazards cause serious problem for this planet. Intensive attention is required to see this problem. In this review paper there is a comparative study to find out the alternative for diesel fuel and efforts to increase its performance. In this paper blending of oxygenated additive at different percentage with sole diesel and effects on various performance parameters are studied. Blending of Oxygenated additives, improve brake specific fuel consumption (BSFC), combustion performance and reduce emission from diesel engine. Properties of the blended fuel and standard exhaust emission of compression ignition (CI) engine have been studied comparatively for sole diesel, NM-Diesel and NE-Diesel fuel blends from different experimental investigation on engine performance and exhaust gas emissions at various engine operating conditions using an engine dynamometer setup.**

***Keywords*— *Oxygenated Fuel , NM-Diesel, VCR Diesel Engine, Engine emissions, Engine performance.***

## INTRODUCTION

The world has been witnessing extraordinary volatility in energy prices in the past five years. Reason behind this are rising petroleum prices, Reduction of petroleum reserves, Environmental hazards from exhaust emission and due to global warming. So Demand is continuously increasing for the development of non-petroleum fuels for engines. Due to depletion of fossil fuels at a very fast rate day by day create an uncertainty between demand and supply.

Amid this high degree of uncertainty on both the demand and supply side of the energy equation, observers are keen to gain an understanding of how to supply demand balance will evolve given the current global economic downstream. And these are carried out with the development of new methods to balance the energy crisis.

## FUEL ADDITIVES

Fuel additives have been one of the most prolific innovations of liquid engineering as well as material science giving Natural fuel sources and additional properties which help us drive that little extra out of them. A diesel fuel additive helps by liberating the chemical energy of the fuel on boilers or the flame zone of an automotive engine and breaking down carbon deposits on engine parts. This way, the formation of soot and particulate emissions are reduced and less fuel is wasted. Boiler performance is also improved and requires less maintenance because of its smoother operation. Fuel additives are compounds formulated to enhance the quality and efficiency of the fuels used in motor vehicles; researchers have developed a range of additives which give these fuels an added property which serves a pressing need from consumers by improving the performance of engine

This diesel fuel additive also promises to lubricate and clean the fuel system, increase miles per gallon by burning off excess exhaust emissions, and prolong the life of injectors and pumps. This gasoline and diesel fuel additive is made out of a blend of oils and additives free from any solvents. Formulated to mainly increase fuel mileage and power, it also helps lessen emissions by encouraging a better combustion process. Its unique blend also utilizes a high detergent action which pushes the engines to work at maximum efficiency. Additives have been developed to increase combustion rates, as anti-oxidants, to effect burn rates, to enable fuels to work under extreme temperatures, reduce harmful emissions and more. Over the years various hybrid compounds and blends have been tested to create better fuels for industries commercial use and end consumers alike.

## CLASSIFICATION OF FUEL ADDITIVES

The types of additives include oxygenates, ethers, antioxidants (stabilizers), antiknock agents, fuel dyes, metal deactivators, corrosion inhibitors and some that can't be categorized.

### *A. Oxygenates*

These contain oxygen as a part of their chemical structure. They are used to reduce the carbon monoxide emissions creating when burning fuel. Oxygenates can be based on either alcohol or ethersDiisopropyl Ether (DIPE) , Ethyl Tert-Butyl Ether (ETBE)Ethanol, Methanol, N-Butanol , Tert-Butyl Alcohol (TBA) , Tertiary-Amyl Methyl Ether (TAME) ,Other Oxygenates

*B. Ethers*

Methyl tetra-butyl ether, ethyl tertiary butyl ether, diisopropylether, tertiary amyl methyl ether, tertiary hexyl methyl ether.

*A. Antioxidants*

Antioxidants are the molecule that inhibits the oxidation of other molecule and used as fuel additives when creating fuel blends. Oxidation reaction produce free radicals leading to chain reactions and antioxidants terminate the chain reaction by disrupting radical intermediates. Some antioxidants are used as a stabilizer in fuel to prevent oxidation.

Examples of some antioxidants used are:

• Butylated hydroxytoluene
• 2, 4-Dimethyl-6-tert-butylphenol
• Di-tert-butylphenol- Phenylene diamine
• Ethylene diamine

*B. Antiknock agents*

An antiknock agent is a gasoline additive used to reduce engine knocking and increase the fuel's octane rating by raising the temperature and pressure at which auto-ignition occurs.

*C. Metal deactivators*

Metal deactivators or metal deactivating agents (MDA) are fuel additives and oil additives used to stabilize fluids by deactivating(usually by sequestering) metal ions, mostly introduced by the action of naturally occurring acids in the fuel and acids generated in lubricants by oxidative processes with the metallic parts of the systems. An example of a metal deactivator that is often used for gasoline is N, N'-disalicylidene-1, 2- propanediamine.

*D. Corrosion Inhibitors*

A corrosion inhibitor is a substance when added in a small concentration to an environment reduces the corrosion rate of a metal exposed to that environment. Inhibitors often play an important role in the oil extraction. Corrosion inhibitors are additives that prevent chemical attack on a metal surface. This group of additives repels water and neutralizers the acidic reaction by-product of corrosion formed at the lubricant surface. Some of the corrosion inhibitors are hexamine, phenylenediamine, and dimethyl ethanolamine, and their derivatives sometimes sulphite and ascorbic acid are also used.

*A. Others*

There are several other fuel additives that don't fall into the same categories as the above. Some of these are:-

• Acetone – this is a vaporization additive. It is used, together with methanol, to improve vaporization when the engine starts up.
• Nitromethane – is used to up the engine power – commonly referred to as 'nitro'.
• Ferrous picrate is used to improve combustion and increase mileage.
• Ferox- this is a catalyst additive used to increase fuel efficiency, clean the engine, extend the life of the engine, Lower emissions.

## RESEARCH STUDIES

It was shown that the use of biodiesel and Additive-Diesel blend is rapidly increasing around the world. Reason behind this is that the petroleum reserves are depleting rapidly and blended fuel mixture give the better performance which is investigated by researchers.

A. An experimental study by R. Rama Udaya Marthanda et.al. Had been carried on 4-stroke C.I Engine with different blends of Ethyl Alcohol & disel with n-butanol as an additive A-An experimental study by R. Rama Udaya Marthanda et.al. Had been carried on 4-stroke C.I Engine with different blends of Ethyl Alcohol & disel with n-butanol as an additive.

B. A test rig for an experimental study by A Y F Bokhary, Majed Alhazmy, Nafis Ahmad and Abdulrahman Albahkali was developed to run a single cylinder, 4-stroke, 470 cc, and CT 300 variable compression ratio spark ignition engine. The engine was coupled to an electrical dynamometer, which is equipped with an instrument cabinet (column mounted) fitted with a torque gauge, electric tachometer and switches for the load remote control.

C. Experimental results was find out by Nasarullah. M and Raja Gopal. K on Kirloskar, AV-1 Four- stroke, single cylinder, Compression Ignition engine, with variable compression ratio fuelled with diesel, It had 80mm×110mm bore × stroke and compression ratio 16.5:1, variable from 13.5 to 20 with a rated power of 3.7kW at 15000 rpm torque output of 340 N m at 1500 rpm. Methyl ester of jatropha oil (MEJO) and MEJO with ignition improver and Ethanol is used as fuel.

D. An experimental investigation was carried out by V.Pirozfar, A.Z.Moghadam, S.sepehri, M.R. Omidkhah, A.Ameri. The performance of the new fuel formulations were studied on a MB-OM 457 LA diesel engine in Idle and cut-off speed position and Commercial diesel fuel and analysis-grade anhydrous ethanol (99.7% purity) were used in this test. In this experiment investigation the blend of 5% ethanol and 95%diesel is called E5.

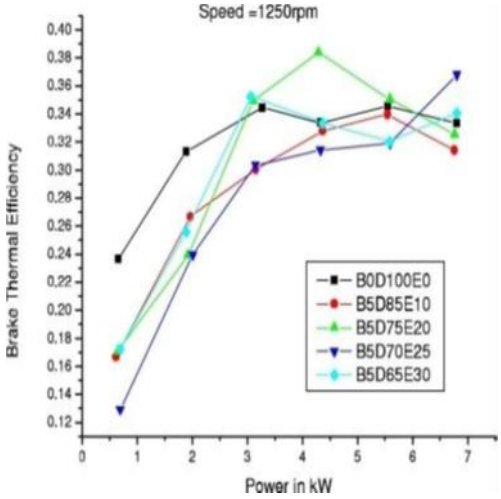
E. An experimental study was carried out by Mojtaba Saei Moghaddam, Abdolsamad Zarringhalam Moghaddam. The experimental study was carried out on ECE R-96 8-modes cycle the engine used in this study was a commercial DI, water cooled four cylinders, in-line, turbocharged, aspirated diesel engine (MT4.244). It had 3.99-L displacement, 100-mm × 127-mm bore × stroke and 17.5 compression ratio with a peak power output of 61.5 kW at 2200 rpm and a peak torque output of 340 N m at 1500 rpm. The Nitromethane (NM) and Nitroethane (NE) were blended with diesel fuel 10% in volume to produce three different fuels as sole diesel, NM + diesel, and NE + diesel is used as fuel for investigation.

## RESULTS AND DISCUSSION

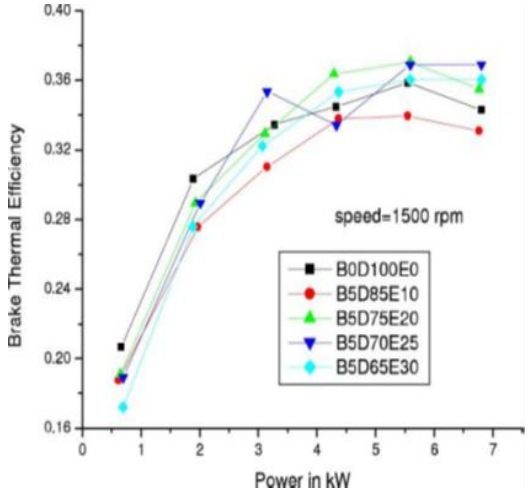
*A. ENGINE EFFICIENCY*

In order to understand the effect of the blended fuel on engine efficiency, the brake specific fuel consumption (BSFC) and thermal efficiency of the engine were measured at different load and at different engine speed.

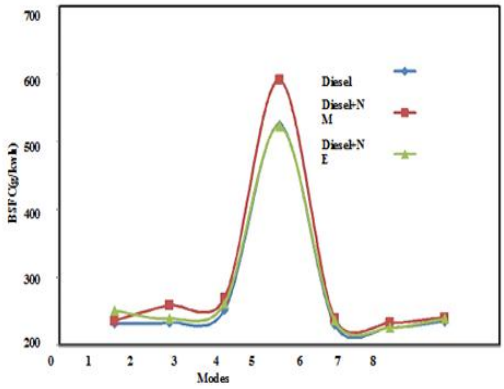
According to result of R. Rama Udaya Marthanda et.al, when the engine runs at 1250 rpm on different engine loads, for the blends of B5D65E30, the BSFC is increased by 4% for the blends of B5D85E10 BSFC is decreased by 1.2% for maximum engine load and the blends of B5D75E20 BSFC is average by 2.5% up and down. Figures show the results of the break thermal efficiency (BTE) of the engine. Fig shows the break thermal efficiency (BTE) at 1250 rpm.




This fig shows break thermal efficiency (BTE) at 1500 rpm.




V.Pirozfar, A.Z.Moghadam, S.sepehri, M.R. Omidkhah, A.Ameri shows by his experiment that the nitro Ethan restores the cetane number of the diesel fuel better than 2-Methoxy ethyl ether (MXEE) and nitro Methane. Blending ethanol to the Tehran1 diesel fuel shows a profound effect on soot reduction (25% soot reduction with 10% ethanol). The soot formation can be reduced by more than 50%, 30% and 27% with the diesel formulations.




Experimenal investigation by Chandan Kumar, Manish Bafna, Ashish Nayyar, Ved Parkash Nitin Goyal shows that When brake power is increases, the brake thermal efficiency of the nitromethane-diesel blend at compression ratio 17.5 is decreases as compare to diesel at compression ratio 17.5 and compression ratio 16.5. Brake thermal efficiency of diesel at compression ratio 17.5 is decreases at higher load.

### *B. ENGINE EMISSIONS*

The exhaust emissions were compared for different Additives-Diesel fuel mixture at different operating condition. The exhaust emissions measured were carbon monoxide (CO), carbon dioxide (CO2), unburned hydrocarbons (HC), oxides of nitrogen (NOx), and the Bosch smoke number (SN).

#### *a. COMPARISON OF CO EMISSIONS*

Result of Mojtaba Saei Moghaddam, Abdolsamad Zarringhalam Moghaddam sows that The CO concentration in the exhaust gas has been reduced with NE as the additive and increased with NM as additive. According to investigation of Nasarullah. M and Raja Gopal. K. The CO emissions reduced with the increasing ethanol percentage in diesel-ethanol blends. The emissions of CO in diesel-ethanol blends were comparatively lower than the diesel fuel at high loads. The CO emissions were decreased by 19.10%, 21.34%, 22.47%, 23.59%, 33.7% and 29.21% respectively with MEJO, MEJO5ETNM2, MEJO10ETNM2, MEJO15ETNM2, MEJO20ETNM2 and MEJO25ETNM2

#### *b. COMPARISON OF CO2 EMISSIONS*

According to experimental investigation of Nasarullah. M and Raja Gopal. K.The carbon dioxide emissions increased with brake power for all fuel modes. The CO2 emissions of biodiesel-ignition improver-ethanol were higher than the, biodiesel, biodiesel-ignition improver and diesel fuel.

#### *c. COMPARISON OF UNBURNED HC EMISSIONS*

According to experimental investigation of Nasarullah. M and Raja Gopal. K. the HC emissions of biodiesel-ignition improver-ethanol blends were 44ppm, 48ppm, 47ppm, 46ppm and 45ppm respectively with MEJO20ETNM2, MEJO5ETNM2, MEJO10ETNM2, MEJO15ETNM2 and MEJO25ETNM2 at full load of the engine.

*d.* COMPARISON OF NOX EMISSIONS

Result of Mojtaba Saei Moghaddam, Abdolsamad Zarringhalam Moghaddam shows that In diesel engines smoke generation has an inverse relation-ship with NOxemission The results study show that in thepresence of additives, the soot formation is reduced, while theNOxis increased confirming the above relationNOxemission shows a 5.1% increase for NM and 6.3% increase forNE compared with Diesel.

According to experimental investigation of Nasarullah. M and Raja Gopal. K the NOx emissions are increased as the engine load increases due to increase in combustion temperature. The NOx emissions of biodiesel-ignition improver-ethanol blends were higher than MEJO, and diesel fuel at full load condition the lower NOx emissions were produced by MEJO20ETNM2 among biodiesel-ignition improver-ethanol blend.

*e. COMPARISON OF BOSCH SMOKE NUMBERS (SN)*

Result of experimental Mojtaba Saei Moghaddam, Abdolsamad Zarringhalam Moghaddam With the blended fuels,the smoke release is reduced and fluctuation with engine operation mode is less pronounced. Both additives, NM and NE, reduced the smoke emission

## CONCLUSIONS

The objective of this review paper is to compare the result of performance and emissions parameter of the work of the authors in which they are trying to carry out an experimental investigation on diesel engine field with alcohol fuels by adding certain additives such as Ethylnitrate,Butylnitrate, Diisipropylether and Dimethylether , Nitromethane (NM) and Nitroethane (NE).

In this regard the authors carried out a research on previous works and make certain conclusions on the concerned work.

- Alcohols can be used successfully in combination with diesel by adding certain additives.
- Combustion processes inside the cylinder is better with ethanol blend.
- Blending ethanol to the Tehran1 diesel fuel show a 25% soots reduction of soot.
- Additive can enhance the stability of ethanol blended diesel fuel, and partly restore their viscosity.
- Nitro Ethan restores the physicochemical properties of the diesel fuel is better than 2–Methoxy ethyl ether (MXEE) and Nitro Methane.
- In comparing with standard diesel, when 10% NE is present, the average smoke generation rate reduces by 35.7%, in allengine modes. However, with NM as additive, 16.2% reduction occurs.
- Diesel- Nitromethane blends at compression ratio 17.5 Shows increasing Brake thermal efficiency in comparison to Diesel.
- The CO2, NOx increased with increasing percentage of ethanol in biodiesel-ignition improver blend.

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