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# Performance and Emission Analysis of Water in Diesel Emulsion with Various Blending Ratio

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***Abstract:*** ***In order to find alternatives to fossil fuels and to solve the increasing pollution problems this study was conducted to investigate the effect of water diesel emulsion fuel on performance and emission characteristics of diesel engine. And the performance and emission characteristics of the diesel in water emulsion were compared to diesel fuel. Here, by using of water in diesel emulsion of characteristic of the brake thermal efficiency and indicated thermal efficiency and mechanical efficiency will be increased .And also the characteristic of the emission, the oxides of nitrogen and smoke, unburned hydrocarbon and carbon monoxide will be reduced.***

***Keywords: Diesel, Engine, Emulsion, Surfactant and Magnetic Stirrer.***

## I. INTRODUCTION

Internal combustion engines generate undesirable emissions during the combustion process. The pollutants that are exhausted from the internal combustion engines affect the atmosphere and cause problems such as global warming, smog, acid rain, respiratory hazards etc. These emissions are mostly due to improper combustion, dissociation of nitrogen and impurities in the fuel and air. Major emissions include Nitrogen Oxides, Hydrocarbons, oxides of carbon, oxides of sulphur and other carbon particles or soot. There are various ways to treat these pollutants. Two major ways are treatment inside the cylinder and after treatment or treatment outside the cylinder. In this project an emulsion is prepared which replaces the diesel fuel meant for the engine, and the emission and performance parameters are studied.

### *A. Diesel Fuel and Engine*

Diesel fuel in general is any liquid fuel used in diesel engines. The most common is a specific fractional distillate of petroleum fuel oil. The diesel engine (also known as a compression-ignition engine) is an internal combustion engine that uses the heat of compression to initiate ignition and burn the fuel that has been injected into the combustion chamber.

### *B. The Four Stroke Diesel Engine*

The four-stroke diesel engine is similar to the four stroke gasoline engine. They both follow an operating cycle that consist of intake, compression, power, and exhaust strokes. They also share similar systems for intake and exhaust valves. A diesel engine is much more efficient than a gasoline engine, such as the diesel engine does not require an ignition system due to the heat generated by the higher compression, the diesel engine has a better fuel economy due to the complete burning of the fuel, and the diesel engine develops greater torque due to the power developed from the high-compression ratio.

### *C. Intake Stroke*

The piston is at top dead center at the beginning of the intake stroke, and, as the piston moves downward, the intake valve opens. The downward movement of the piston draws air into the cylinder, and, as the piston reaches bottom dead center, the intake valve closes.

### *D. Compression Stroke*

Piston is at bottom dead center at the beginning of the compression stroke, and, as the piston moves upward, the air compresses. As the piston reaches top dead center, the compression stroke ends.

### *E. Power Stroke*

The piston begins the power stroke at top dead center. At this point, fuel is injected into the combustion chamber and is ignited by the heat of the compression. This begins the power stroke. The expanding force of the burning gases pushes the piston downward, providing power to the crankshaft. The diesel fuel will continue to bum through the entire power stroke (a more complete burning of the fuel). The gasoline engine has a power stroke with rapid combustion in the beginning, but little to no combustion at the end.

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*F. Exhaust Stroke*

As the piston reaches bottom dead center on the power stroke, the power stroke ends and the exhaust stroke begins. The exhaust valve opens, and, as the piston rises towards top dead center, the burnt gases are pushed out through the exhaust port. As the piston reaches top dead center, the exhaust valve closes and the intake valve opens. The engine is now ready to begin another operating cycle.

*G. Exhaust Process*

The diesel internal combustion engine differs from the gasoline powered Otto cycle by using a higher compression of than "spark ignition". In the diesel engine, air is compressed adiabatically with a compression ratio typically between 15 and 20. This compression raises the temperature to the ignition temperature of the fuel mixture which is formed by injecting fuel once the air is compressed. The ideal air-standard cycle is modelled as a reversible adiabatic compression followed by a constant pressure combustion process, then an adiabatic expansion as a power stroke and is volumetric exhaust. A new air charge is taken in at the end of the exhaust, as indicated by the processes a-e-a on the diagram.

## II. LITERATURE SURVEY

Anna Krister Holmberg, B.Chalmers Water-in-diesel emulsions are fuels for regular diesel engines". An important aspect is that diesel emulsions can be used without engine modifications. This review presents the influence of water on the emissions and on the combustion efficiency. Whereas there is a decrease in emissions of nitrogen oxides and particulate matters, there is an increase in the emissions of hydrocarbons and carbon monoxide with increasing water content of the emulsion. The review also covers related fuels, such as diesel-in-water-in-diesel emulsions, i.e., double emulsions, water-in-diesel micro emulsions, and water-in- vegetable oil emulsions, i.e. bio diesel emulsions. A brief overview of other types of alternative fuels is also included [1].

M. Abu-Zaid Emulsified Diesel fuels of 0, 5, 10, 15 and 20 water/Diesel ratios by volume were used in a single cylinder, direct injection Diesel engine, operating at 1200–3300 rpm". The results indicate that the addition of water in the form of emulsion Improves combustion efficiency .The engine torque, power and brake thermal efficiency increase as the water percentage in the emulsion increases. The proper brake specific fuel consumption and gases exhaust temperature decrease as the percentage of water in the emulsion increases [2]. Ali Alahmer Emulsified diesel fuels with water content of range 0–30% by volume were used. The experiments were conducted in the speed range from 1000 to 3000 rpm. The brake specific fuel consumption has a minimum value at 5% water content and 2000 rpm .the torque ,the break mean effective pressure and thermal efficiency are found to have maximum values unless the condition. The emission CO2 was found to increase with engine speed and to decrease with water content. As the percentage of water content in the emulsion increases, the emitted Amount of oxygen [3].

## III. PROBLEM DESCRIPTION

*A. Formation Of NOx In CI Engine*

Exhaust gases of an engine can have up to 2000 ppm of oxides of nitrogen. Most of this exhaust contains nitrogen oxide (NO) with small amount of dioxide. These all come under NOx, x representing some suitable number. NOx is very undesirable as it has many adverse effects on the environment. Regulations to reduce NOx emissions are becoming stringent day by day.

NOx is created inside the engine due to air. Nitrogen constitutes some 78 % by mass in air. So it is the most abundant gas found in the air injected into the engine. During the combustion process at very high temperature and pressure nitrogen reacts with oxygen to form oxides an other gases. There are a number of possible reactions that form NO. Some reactions that occur inside the CI engine are: At low temperatures, atmospheric nitrogen exists as a stable diatomic molecule. Hence only very trace amounts of nitrogen oxides are found in the ground. Chamber of a CI engine, some diatomic N2 breaks into monatomic nitrogen (N).

*B. Effect on Combustion Efficiency of the Engine*

Addition of water in any form of an emulsion has a positive effect on the combustion efficiency of the engine. The output torque increases with water content over the entire rpm range. When the charge is fired inside the cylinder under very high temperature and pressure, water is turned into steam. Another reason for the improved combustion efficiency is that the presence of the oil- water interface with very low interfacial tension, leads to finer atomization of fuel during injection. A finer dispersion of fuel droplets facilitates higher contact with air and thus increases the burning process, which is advantageous for the combustion. It has been postulated that water in fuel improves the combustion process owing to simultaneous rupture of drops, to elevate evaporation surface of drops and facilitates the better mixing of fuel burning in air.

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## IV. METHODOLOGYE

*A. Mulsion Preparation*

Components required for making emulsion are: Magnetic stirrer with heater diesel, water, surfactant, test tube, burette, and pipette. The pipette, burette, test tubes and beaker were thoroughly washed and cleaned dry. The first 5 trials were done manually using a test tube without heating. Sixth trial was done using the magnetic stirrer with heater. Diesel was measured in the burette in required volume and poured into beaker. Now calculated volume of surfactant is measured in the pipette and poured into the beaker. Same steps are done for water. Now the beaker is placed on the agitator and the mixture is thoroughly mixed for about 10- 15 minutes by heating it at 50-60 degree celcius. The emulsion thus obtained is checked for stability.

## V. EXPERIMENTAL SETUP

Variable compression ratio engine is an engine where the compression ratio of the engine can be adjusted while the engine is in operation. This is done to increase fuel efficiency while under varying loads. Higher loads require lower ratios to be more efficient and vice versa. Variable compression engines allow for the volume above the piston at 'Top dead centre' to be changed. For automotive use this needs to be done dynamically in response to the load and driving demands.

Features

*A.* CR changing without stopping the engine
*B.* No alteration in Combustion chamber geometry
*C.* PV plots, performance plots and tabulated results
*D.* Measurements and performance analysis
*E.* Data logging, editing, printing and export, Configurable graphs
*F.* Performance and emission analysis

*1) Specification of Engine*

| | | |
|---|---|---|
| 1 | Engine Make | Kirloskar AV-1 |
| 2 | Engine Type | (4-Stroke, Diesel Engine) |
| 3 | Number of Cylinder | 1 |
| 4 | Bore × stroke | 87.5×110 mm |
| 5 | Cylinder capacity | 0.66 L |
| 6 | Compression ratio | Variable (12-19) |
| 7 | Rated power | 3.7 kW , 1500 rpm |
| 8 | Dynamometer | Electric AC generator |
| 9 | Orifice diameter | 0.15mm |
| 10 | Injection pressure | (200-220) bar |

*2) Procedure*

*a)* The filters of the engine were replaced and the injectors were cleaned and calibrated according to the desired pressure.
*b)* The fuel tank was then filled with diesel and the engine was run.
*c)* The engine was run at various loads of the dynamometer – 5, 10,15,20,25 kgs and respective readings were taken for fuel consumption/ sec.
*d)* The readings of gas analyser and smoke meter were noted in each case.
*e)* After all the readings were taken, the leftover diesel was drained out of the tank and emulsion was poured.
*f)* Same steps were taken and the readings were noted down for the emulsion.
*g)* Before using the next emulsion the engine was again run with diesel so that the results are not biased.
*h)* After taking all the observations graphs were plotted to compare the performance characteristics and emission characteristics of the engine in case of diesel and emulsion.

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## VI. RESULT AND CONCLUSION

Brake specific fuel consumption of an engine is defined as the amount of fuel used in kilograms per brake power per second. This is an important performance parameter as it determines the mileage of the vehicle. In practical purposes this very important aspect a consumer looks for, as it determines whether the product is value for money or not.

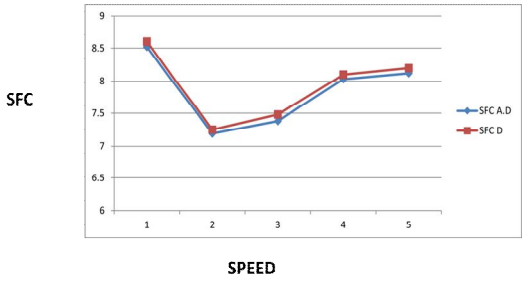



Figure.1 Specific Fuel Consumption with Load

This shows fig.1 the variation of specific fuel consumption with load. The specific fuel consumption increases with decrease in load.

### *A. NOx Emission*

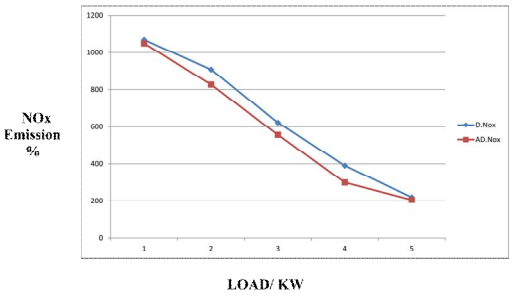



Figure.2 Load with NOx Emission

### *B. $CO_2$ Emission*

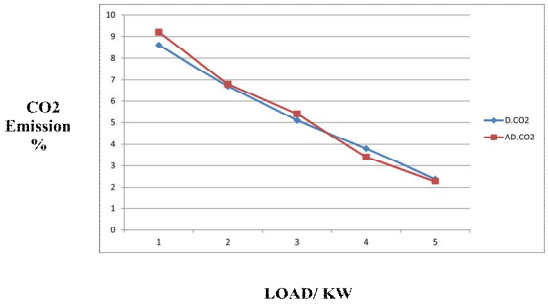



Figure. 3 Load with $CO_2$ Emission

## VII. CONCLUSION

The study was conducted to investigate the effect of water in diesel with using single surfactant. The composition was Trail-4 Diesel-92%, Water-5%, Surfactant-3% span 80 surfactant. The composition was mixed well at the speed range of 1200 rpm. After the mixture obtained, the performance and emission analysis in diesel engine Mechanical efficiency brake thermal Efficiency of emulsified fuel could be increased by 14% when compared in diesel fuel. And reduced the level of fuel consumptions20% Emulsified fuel of the oxides of nitrogen will be reduced up to 30% compare diesel. Carbon monoxide and hydrocarbon emission will be reduced 47%.

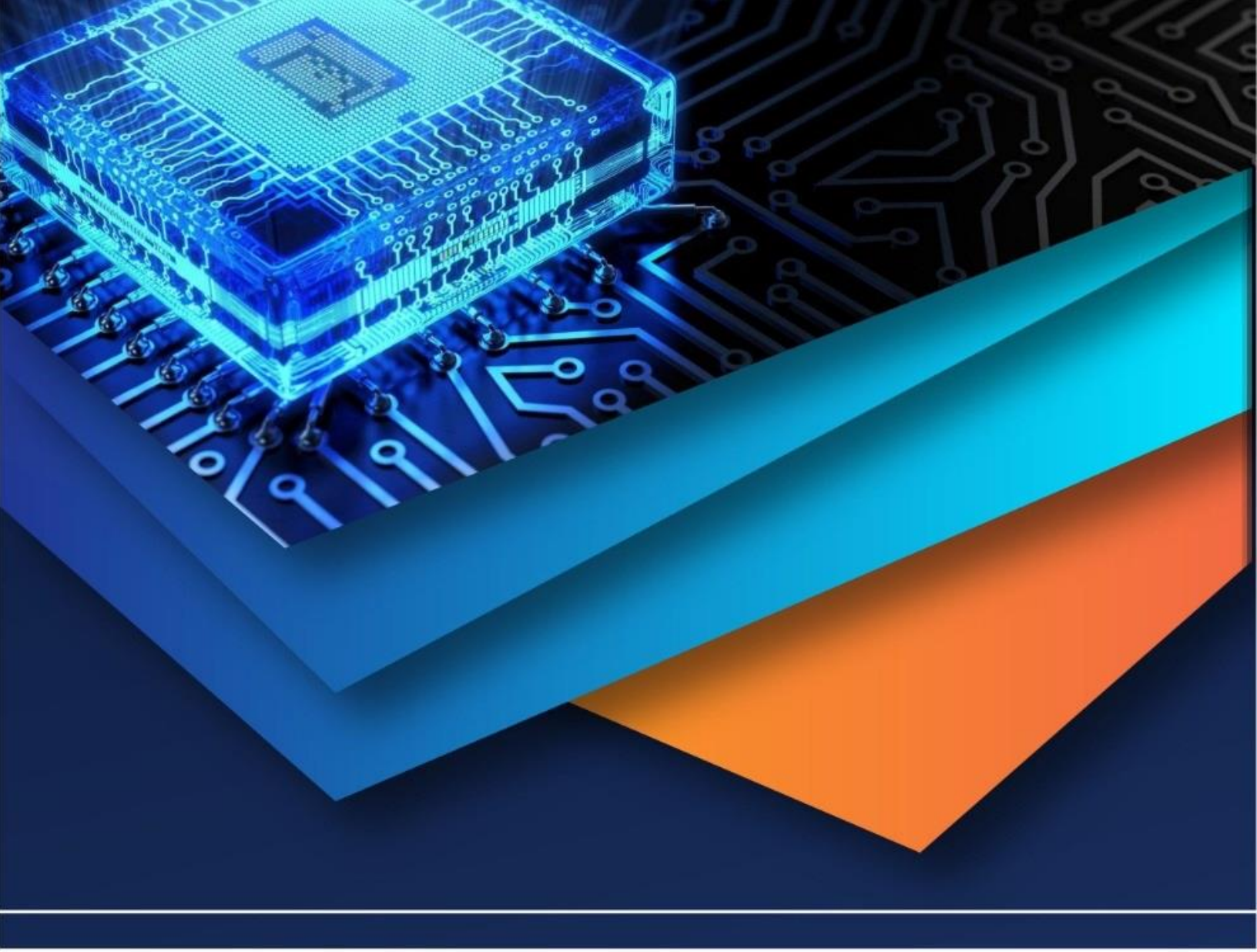
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