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Experimental Investigation on Performance Characteristics of Single Cylinder Diesel Engine using Emulsion of Cow Urine and Diesel

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Abstract --- *In the present work, an experiment is conducted to investigate the effect of different grades (G5, G15, G25) of cow urine - Diesel emulsions on the performance characteristics of a direct injection diesel engine under varying engine loads. The specific fuel consumption (SFC) of the engine when using emulsion is found to be reduced overall. This is observed when the total amount of diesel fuel in the emulsion is compared with that of neat diesel. Brake thermal efficiency increases with an increasing volume percentage of urine in the emulsion. Exhaust gas temperature reduce as cow urine proportion in emulsion increases , formation of nitrogen oxides emission reduced with increases the proportion of cow urine in emulsion under all load conditions.*

Keywords: *Diesel engine ,water , cow urine, Emulsion*

I. INTRODUCTION

Diesel engines offer better fuel to power conversion efficiency and due to their better fuel economy, diesel engines are the dominant class of engines in mass transportation, heavy industries, and agricultural sectors [1]. All countries of world have been devoting increased efforts to opening up new energy sources due to international oil crisis. Many researcher have put their effort to opening up new energy sources. From the urine analysis report, major constituent in cattle urine is water (95%) and nitrogenous constituents (2.5%) [2]. From the review of various researches it is found that nitrogen is supporter of combustion [3] while hydrogen proves good alternate fuel [4], also water introduction in combustion process of diesel engine proves good alternate way to improve engine performance and emission characteristic. So there is great possibility to use urine as fuel.

Different techniques to introduce water in diesel engine, namely fumigation, emulsion and direct injection [5]. After reviewing various literatures, emulsion technique found to be best as far as engine modification concerned. Emulsion technique improves combustion efficiency and reduce emission. Emulsion is the mixture of two or more liquids immiscible in nature, one present as dispersed and other as continuous phase. It is generated by means of mechanical agitator in the presence of surface active agent sometimes called surfactant or emulsifier for stability [1].

II. FUEL PREPARATION

A. Selection of Surfactant

Surfactant should easily burn with no soot and free of surfer and nitrogen. Nonionic surfactants Span 80 (HLB 4.3) and Tween 80 (HLB 15.0) surfactant were selected. In order to increase the stability of emulsion, combination of two surfactants were used. Both are regarded as non-toxic, non-irritating, non-corrosive in nature without any source for secondary pollutants formation in engines [6]. It does not generate any toxic byproducts during combustion. To stabilize the emulsion, two surfactants (emulsifiers) were blended; the resulting hydrophile lipophile balance (HLB) of the blend was easily calculated using Eqns. 1 and 2.

$$\%(A) = \frac{100(X - HLB_{(B)})}{HLB_{(A)} - HLB_{(B)}} \qquad \text{..... (Equation 1)}$$

$$\%(B) = 100 - \%(A) \qquad \text{..... (Equation 2)}$$

In present investigation emulsion using distilled cow urine and diesel made with the help of span 80/ tween 80 surfactant combination having HLB value of 5 is prepared.

B. Preparation of Emulsion

Emulsion made in two steps. In the first step blend of surfactant mixed with diesel by mechanical agitator at 800rpm for 2min. Pre-emulsion is formed by adding distilled cow urine in diesel - surfactant mixture at constant rate with continuous agitation by mechanical agitator at speed of 800rpm. The concentration of surfactant blend in total emulsion solution kept between 0.5 to 2% by volume, based on concentration of cow urine ranging 5% to 25%. In the second step prepared pre-emulsion sonicated by ultrasonic probe sonicator for 2 minute, cycle of 14 sec at frequency of 20 kHz. Prepared emulsified fuels named G5 (diesel with 5% cow urine), G15 (diesel with 15% cow urine) and G25 (diesel with 25% cow urine) respectively.

III. EXPERIMENTAL APPARATUS

A single cylinder, water cooled, vertical, self-governed C.I. engine used to carry out experimental. Technical specifications of the test engine are listed in Table 1. Water is circulated for cooling purpose and rate of cooling water flow kept constant during testing. Experimental arrangement is shown in figure 1. Various arrangements like load regulation, fuel and air flow measurement, energy generation measurement are provided in test rig.

Experiment carried out under variable load - constant speed condition for various emulsified fuels as well as for neat diesel. Ac generator type dynamometer coupled with engine for loading. Observed data recorded, comparison of various performance parameters of diesel fuel with emulsified fuels.

Table 1. Engine Specifications

Parameter	Specification
Engine type	4-stroke, single cylinder, direct injection diesel engine.
Cooling system	Water cooled
No. of cylinder	1
Bore x Stroke (mm)	80 x 110
Cubic Capacity	533
Compression ratio	18:1
Maximum power (kW)	3.7
Rated revolution (rpm)	1500

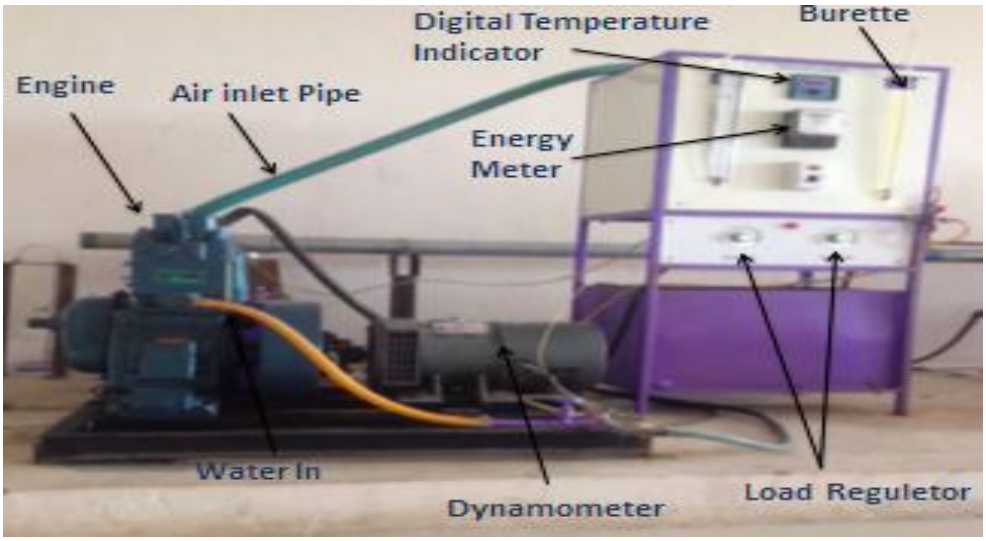

Figure 1. Experimental setup

IV. RESULT AND DISCUSSION

The aim of the experimental study was to investigate the effect of diesel, emulsion of diesel with 5% cow urien (G5), emulsion of diesel with 15% cow urine (G15) , emulsion of diesel with 25% cow urine (G25) on performance in a single cylinder diesel engine. The experimental data presented in graphical form in figure 2 to figure 6 .

A. Specific Fuel Consumption

As shown in figure 2 , the SFC of all type of fuel gradually reduce with increasing load. This indicates that the engine burns fuel efficiently during high load conditions. G5 shows almost similar fuel consumption to diesel at part load condition. With increase in cow urine % in emulsion SFC increase , due to lower calorific value of emulsified fuel.

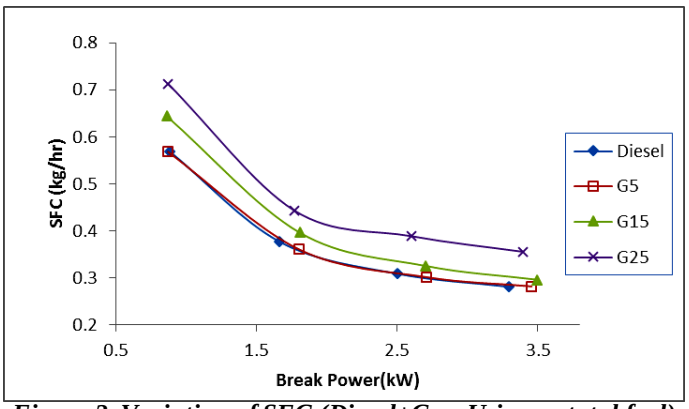

Figure 2. Variation of SFC (Diesel+Cow Urine as total fuel)

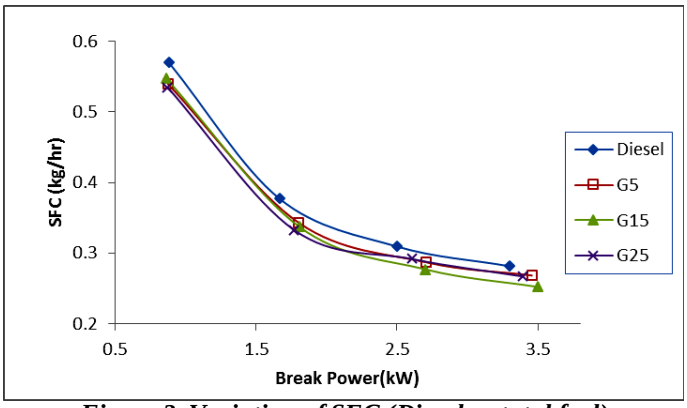

Figure 3. Variation of SFC (Diesel as total fuel)

If comparision is made by considering consumption of diesel only, remarkeble reduction of fuel consumption in various emulsions at every load condition compared with diesel, as shown in figure 3.

B. Brake Thermal Efficiency

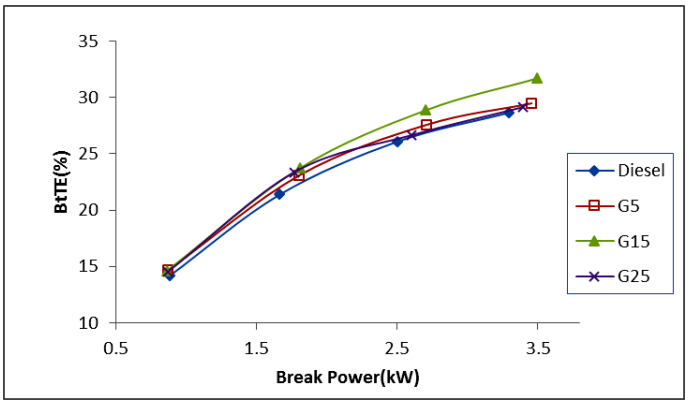

Figure 4. Variation of B.T.E.

Brake thermal efficiency is the rate of brake power to the calorific value of the fuel. As shown in graph, B.T.E increase with increased load for all test fuels. B.T.E increases with an increase in the volume percentage of cow urine in the

emulsion. Highest efficiency is observed for G15 fuel at full load, having value of 31% compared to diesel fuel having value of 28% at the same load.

C. Exhaust Gas Temperature

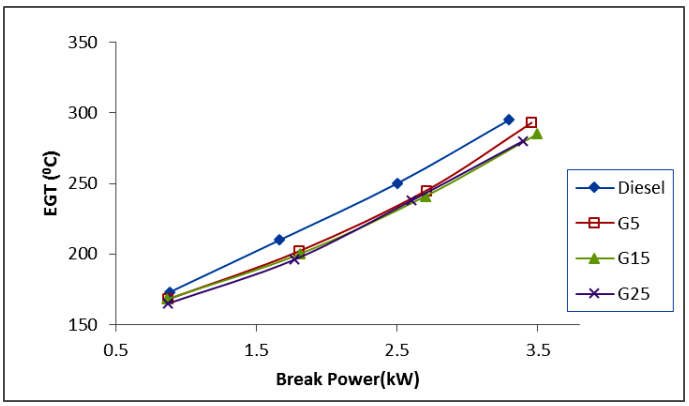

Figure 5. Variation of EGT

As shown in graph, EGT increase with increased load for all test fuels. Highest EGT observed for diesel at full load. With increase in the volume percentage of Cow Urine in emulsion EGT decrease gradually.

D. NO_X Emission

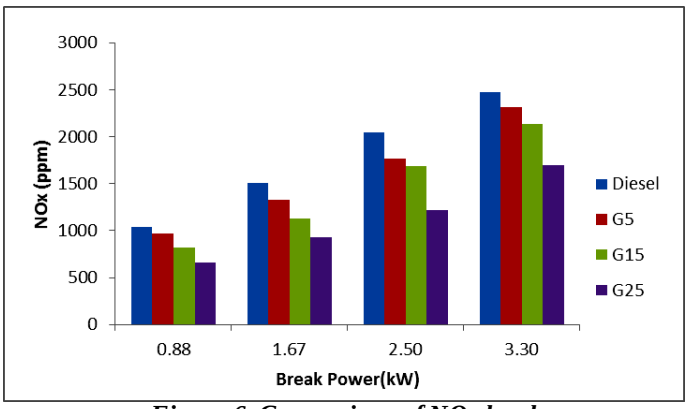

Figure 6. Comparison of NO_X level

The comparison of NO_X formation for different load conditions for different test fuels illustrated in figure 6. With increase in load, NO_X emission increases for diesel as well as other emulsified fuels. It has been observed that using cow urine - Diesel emulsion as fuel greatly reduces the NO_X emissions, compared to diesel. This happens because when cow urine along with diesel enters the combustion cylinder, due to water content and nitrogenous constituents presence, it vaporized quickly due to presence of high temperature and pressure inside the cylinder, takes some of the heat from the combustion chamber and bring down the cylinder temperature. Combine effect of absorbing heat developed by fuel and increased partial pressure of oxygen, reduction in combustion temperature and thus it helps to decrease formation of NO_X. Minimum NO_X value of 661ppm at 100% load for G25 fuel is observed. NO_X reduction in G25 fuel found to be best, with an average of 34% reduction at every load condition. Variations in NO_X emission are similar as EGT with variation in load condition. However, variations in NO_X emission with increasing brake power are more compared to EGT.

V. CONCLUSION

Based on the values obtained from the tests conducted on a single cylinder, naturally aspirated, vertical, water cooled self-governed C.I. engine, with different proportion of Cow urine-Diesel emulsion under varying load condition. After performing several experimental run and based on result obtained, following conclusions are drawn.

1. In comparison with diesel, calorific value of formed emulsion is lower, due to that fuel consumption increase as proportion of Cow urine in emulsion increase.
2. Brake thermal efficiency increases with an increasing volume percentage of Cow urine in the emulsion.
3. Considering only the diesel fuel content in emulsified fuel, the SFC of all emulsions is found to be improved compared with neat diesel.
4. At part load and full load, minimum EGT is 165^0C and 280^0C for G25 fuel, which is lower than diesel EGT of 173^0C and 295^0C respectively.
5. NO_X emissions found to be reduced for all types of emulsions compared to diesel.
6. G25 reported to be the best in reducing NO_X with an average reduction of 30% at every load condition.

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