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EFFECT OF INJECTING HYDROGEN PEROXIDE INTO DIESEL ENGINE

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ABSTRACT

An experiment was conducted with four stroke multi-cylinder, water cooled compression ignition engine operated with neat diesel and blends of hydrogen peroxide with diesel. Main focus of this research is to investigate the performance of diesel engine by injecting hydrogen peroxide as blends with diesel at 2%, 5% and 10% proportions. In the experiments, injection timing was also changed, which is an important parameter in the study. Results showed that, the efficiency of engine increased by injecting hydrogen peroxide at all fractions along with diesel and the exhaust gas temperature has found to be decreased reasonably. Also, efficiency of engine has increased by advancing the injection timing by five deg for both diesel and its blends with hydrogen peroxide. At injection timing of 15^0 BTDC, engine was unable to start when 2% and 5% of hydrogen peroxide with diesel is injected.

KEYWORDS

Diesel Engine, Hydrogen Peroxide, Exhaust Gas Temperature, Brake thermal efficiency

I. INTRODUCTION

In today's context, diesel engine has become an important power source in farming activities in rural areas where electrical energy is unavailable. Also, the market share of diesel car has increased in many countries because of its higher thermal efficiency. This trend is expected to be continued in the future. However, the problem with diesel engine is its higher emissions and exhaust gas temperature. An attempt is made to overcome this problem by injecting hydrogen peroxide into the diesel engine.

1.1 Review of Literature

Dava, A.W. et al. Newport, RI had carried the study on 'Control of diesel engine emissions by dilute oxidizer injection' and stated that the purpose of this study was to evaluate the effects of low concentration hydrogen peroxide (H_2O_2) injection into the inlet air stream of a diesel engine on exhaust emissions by analytical methods using chemical equilibrium computer simulation for a steady-state combustion process [1]. Dimitrios Theofanis Hountalas et al. carried a study on 'Use of Water Emulsion and Intake Water Injection as NOx Reduction Techniques for Heavy Duty Diesel Engines' and stated that Diesel engine manufacturers are currently intensifying their efforts to meet future emission limits that require a drastic reduction of NOx and particulate matter compared to present values [2].
Sajith V. et al. conducted experimental investigations on the Effects of Cerium Oxide claimed that flash point and the viscosity of biodiesel were found to increase with the inclusion of the cerium oxide nanoparticles while emission levels of hydrocarbon and NOx are appreciably reduced with the addition of cerium oxide nanoparticles[3]. Ho Teng et al. conducted experiments on using Dimethyl

ether as an alternative fuel for C.I. Engine and claimed that Dimethyl ether spray pattern in the engine cylinder will affect the mixing and combustion process in engine cylinder, which, also influence emission from combustion [4].
Bedford F. et al. carried a study on effects of direct water injection on DI Diesel engine combustion by modelling of water injection for diesel engines and claimed that for 44% load, SFC, PM, NOx emission decrease while at 86% load only NOx emission decrease[5]. Nagaprasad K.S. et al. described the overview of studies on effect of injecting water into the engine and mentioned that water injection is more suitable for compression ignition engine so that efficiency of engine can be enhanced by injecting water at the end of diesel injection [6].

II. EXPERIMENTAL SETUP

The main fuel used for the running of the engine is Diesel. Table 1 shows the properties of diesel used in the experiments. Hydrogen Peroxide solution is used as blends with diesel at various proportions. Hydrogen Peroxide is a strong oxidizing agent and a weak acid in water solution. The formula is similar to that of water, with an extra atom of oxygen attached, H_2O_2. Table 2 shows the properties of Hydrogen Peroxide used as blends with diesel in the experiments.

Table 1: Properties of Diesel

Density, @ 15.5 °C	700 kg/m^3
Boiling temperature	200°C
Cetane number	40
Viscosity	2.6 cp
Auto ignition temperature	315°C
Higher Calorific Value	44,800 kJ/kg

Table 2: Properties of Hydrogen Peroxide

Appearance	Colourless Liquid
Density	1110 kg/m^3
Boling Point	226 ºC
Freezing Point	-27 ºC
Viscosity	1.81 cp
Specific Gravity	1.11

Experiments were conducted on a four stroke multi-cylinder, water cooled compression ignition engine. The specifications of the engine are shown in the table 3. The engine has hydraulic dynamometer. The measuring of fuel consumption (both for diesel and blended fuel), air and Exhaust Gas Temperature, speed has been recorded manually. All tests are conducted at different loads viz, no load, 10 %, 20 %, 40 % and 50 % load. The engine speed is maintained constant at 1500 rpm. After every load the engine is allowed to attain steady state for duration of about 15 minutes. The injection pressure is kept constant at 150 bar with an injection timing of 10^0 BTDC and 15^0 BTDC.

Table 3. Specifications of engine

Engine Description	1.8L 68bhp 4 cylinder OHV
Engine Displacement	1817 cc
No. of Cylinders	4
Maximum Power	68 BHP @ 4800 RPM
Maximum Torque	13.7 Kgm @ 2250 RPM
Bore x Stroke	84 x 82 mm
Compression ratio	23:1

III. RESULTS AND DISCUSSIONS

Fig.1 shows the engine performance for different blends of hydrogen peroxide with diesel at injection timings of 10^0 BTDC and injection pressure of 150bar. Comparing performance of pure diesel and with blending of 2%, 5% of hydrogen peroxide with diesel, it is found that as the concentration of H_2O_2 is increased the brake thermal efficiency of the engine has increased. This is due to the presence of H_2O_2 in the fuel, which starts decomposing and releasing a large amount of oxygen. This oxygen helps in reducing the ignition lag as well as assisting complete combustion of the fuel. The highest efficiency of 15.48% was observed at fifty percent of full load when the engine used 5% of hydrogen peroxide with diesel.

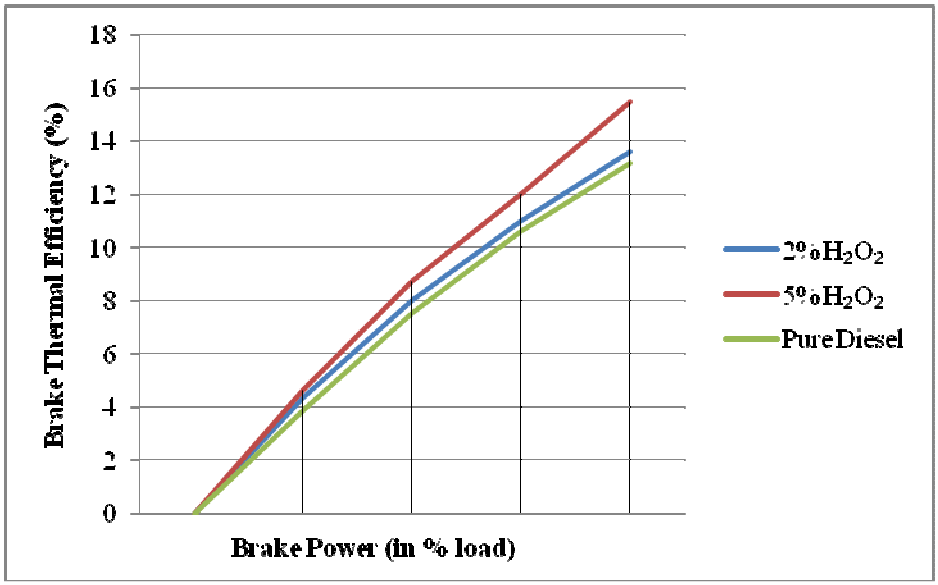

Fig1. Brake thermal efficiency v/s Brake power for diferent blends of H_2O_2

Fig.2 shows the Exhaust gas temperature for different blends of hydrogen peroxide with diesel at injection timings of 10^0 BTDC and injection pressure of 150bar. As the concentration of H_2O_2 is increased the exhaust gas temperature of the engine decreased, this is due to additional oxygen molecule released by hydrogen peroxide has led to better combustion. The lowest value of EGT has found to be 180^0 C with 5% of hydrogen peroxide with diesel.

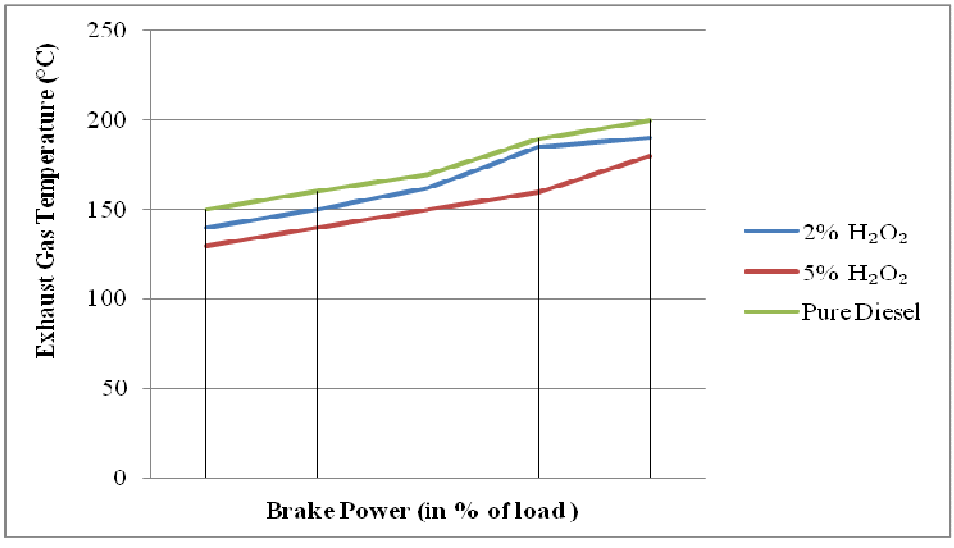

Fig 2. Exhaust gas temperature v/s Brake power for diferent blends of H_2O_2

Fig.3 shows brake thermal efficiency for different blends of hydrogen peroxide with diesel at injection timings of 10^0 BTDC and 15^0 BTDC for 40% full load. The engine couldn't start when 2% and 5% of hydrogen peroxide with diesel in injected at injection timing of 15^0 BTDC. The encouraging factor is that efficiency of engine increases with increase in blends for both injection timings. The efficiency of engine has increased by advancing the injection timing by five deg for both diesel and its blends with hydrogen peroxide. The efficiency has found to be highest of 15%, same for both diesel and 10% hydrogen peroxide with diesel when injected at 15^0 BTDC.

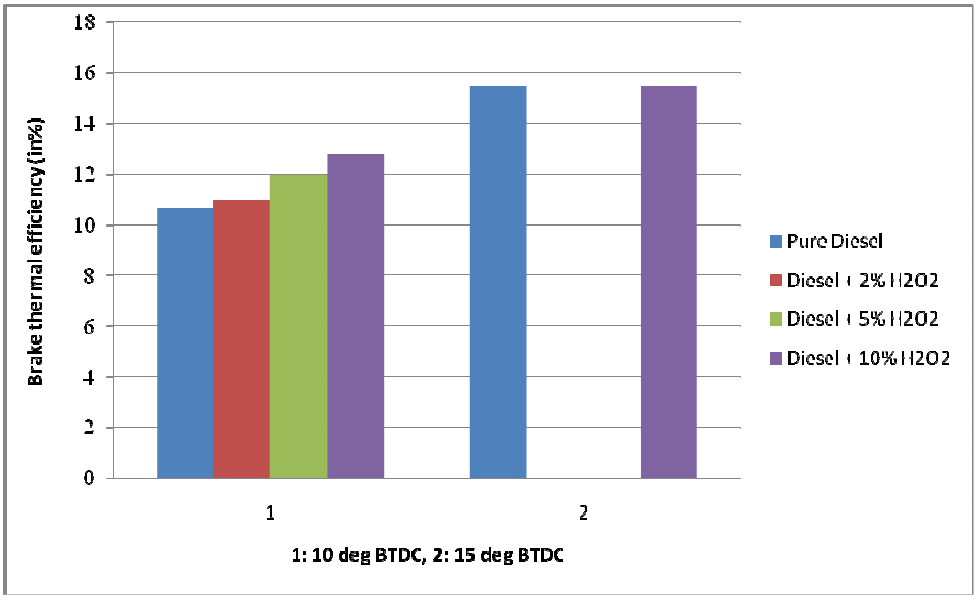

Fig 3. Effect of injection timing on Brake thermal efficiency for different blends of H_2O_2

Fig.4 shows exhaust gas temperature for different blends of hydrogen peroxide with diesel at injection timings of 10^0 BTDC and 15^0 BTDC for 40% full load. The EGT has decreased with increase in blends at 10^0 BTDC but it remained same at 15^0 BTDC. The minimum EGT of 149^0C was found for 10% hydrogen peroxide at injection timing of 10^0 BTDC, which is an appreciable value for a better performance of any after treatment devices.

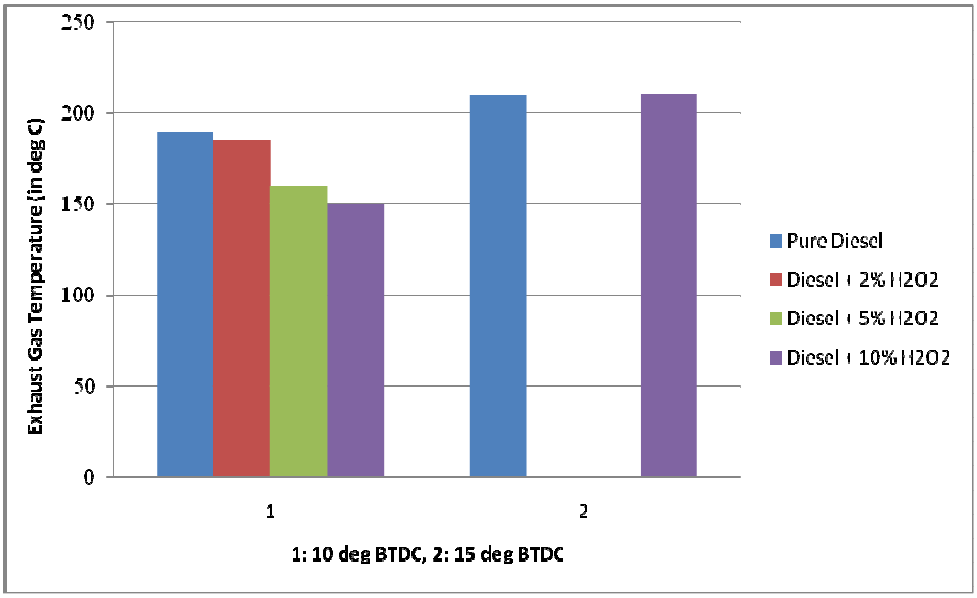

Fig 4. Effect of injection timing on Exhaust Gas Temperature for different blends of H_2O_2

IV. CONCLUSIONS

The brake thermal efficiency of the engine increased while exhaust gas temperature decreased with increase in concentration of hydrogen peroxide with diesel at all the loads due to additional oxygen molecule released by hydrogen peroxide has led to better combustion. The maximum efficiency of 15.48% was observed at fifty percent of full load when the engine used 5% of hydrogen peroxide with diesel for injection pressure of 150 bar, and injection timing of 10^0 BTDC while minimum value of EGT has found to be 180^0C at same condition. The efficiency of engine has increased by advancing the injection timing from 10^0 BTDC to 15^0 BTDC for both diesel and its blends with hydrogen peroxide. The engine didn't start when 2% and 5% of hydrogen peroxide with diesel is injected at injection timing of 15^0 BTDC.

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