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EMISSION CONTROL IN DI DIESEL ENGINE USING MIXTURE OF AQUEOUS SALT SOLUTION DIESEL EMULSION

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ABSTRACT

This study is conducted to reduce emission of DI diesel engine especially NOx by fuel modification. Here modified fuel using aqueous salt solution is used. The salt solution is prepared by mixing 0.2%,0.3%,0.4%,0.5% and 0.6% (sodium carbonate) salt by weight with 10% distilled water. To prepare the diesel emulsion 1% of the emulsifying agent (surfactant TWEEN 80) is added to the neat diesel fuel and stirred well in a mechanical mixer. The engine is run at 50% constant load with variable speed using diesel fuel and salt-solution diesel emulsion respectively. By this procedure formation of NOx is reduced up to 66%, CO is increased up to 20%, BSFC is reduced 8%, exhaust temperature is reduced up to 4% compared to neat diesel and the efficiency of diesel engine is increased about 4%. Results also show that among all percentage of salt-solution mixture with diesel emulsion 5% sodium carbonate solution with diesel give more reduction in emission levels.

Keywords: Aqueous Salt Solution, Diesel Emulsion and NOx Reduction.

1. INTRODUCTION

The rise in civilization is closely related to improvements in transportation. In the development of transport the internal combustion engines such as petrol and diesel engines occupy a very important position. However, in recent times the internal combustion engine powered vehicles have come under heavy attack due to various problems created by them. The most serious of these problems is air pollution.

Air pollution [1] can be defined as addition to our atmosphere of any material which will have a deleterious effect on life upon our planet. The main pollutants contributes by automobiles are carbon monoxide(CO), unburned hydrocarbons (UBHC), oxides of nitrogen(NOx), smoke, odor, particulate matter(PM). Researchers [2] [3] [5] all over the world have evaluated the health risks associated with the exposure to automobile emissions. Dirty air continues to plague the Dhaka and most major cities around the world. Although the specific pollution problems differ by locale, many U.S. cities have ambient air ozone and particulate levels that greatly exceed the national ambient air quality standards. Tadashi Murayama et.al. [2] [6] used water oil stable emulsion and obtained a significant reduction of NOx and an improved BSFC. Noboru Miyamoto et al. [3] examined the effect of several aqueous metal salt solutions on NOx reduction in a DI diesel engine. It was found that with sodium salt solution, NOx and smoke emission decreased by more than 60% and 50% respectively with respect to conventional operation. The effect of diesel/water emulsion and associated gaseous emission were Investigated by G.E Andrews et al. [4] .It was noticed that both NOx and particulate emission decreased with increased water content. The source of high ambient air ozone and particular levels include emissions from essentially all combustion devices, from backyard barbecues to power generation plants, and from lawnmowers to motor vehicles. Road traffic i.e., truck and bus diesel engines have been identified as a significant mobile source of both oxides of Nitrogen (NO_X) and particulate matter (PM). It produces 50% of the total amount of NO_X and HC emissions and as much as 80% to 90% of the CO an HC concentrations in urban air tend to rise. NO_X and a precursor to ozone formation in the lower atmosphere and diesel particulate matters.

So, it is the very urgent problem to reduce the exhaust emissions from diesel engine. To reduce these emissions many developed countries, such as U.S.A., U.K., European Union, Japan, etc., have introduced emission control regulations. These regulations strictly followed year by year. So, developments in engine technology and driven by exhaust emission and noise legislation as well as pressure from the market to reduce vehicle total life cycle cost but controlling NO_X and particulate emissions has been a formidable challenge to the diesel industries because most traditional NO_X control approaches tend to increase particulate emissions. Despite this challenge, there is significant evidence that heavy-duty highway engine manufactures can achieve substation emission

reduction. Many development programs carried out such as engine design modification, treatment of exhaust gas, fuel modification. Fuel modification included compressed natural gas (CNG), liquefied natural gas (LNG), and aqueous salt solution (ASS), oxygenated fuels [1]. This experiment is used mainly for reducing NOx by using fuel modification system with aqueous salt solution. Here study also performs about other particulate emissions with various engine efficiency parameters.

2. EMISSION CONTROL TECHNOLOGIES

An emission control programmed aims at reducing the concentration of CO, HC and NO_X in the exhaust. The main approaches which have been used for this purpose are[1]:

(i)Engine design modification

The engine modification approach for improving the exhaust emission is aimed as follows:

a) Use of leaner air-fuel ratios.
b) Retarding ignition liming.
c) Modification of combustion chamber configuration to reduce quenched areas.
d) Lower compression ratio.
e) Reduce valve overlap.
f) Alternation in induction system.

(ii)Treatment of exhaust gas

Exhaust gas from the engine manifold is treated to reduce HC or CO emissions. A number of devices have been used as follows:

a) Exhaust gas recirculation (EGR).
b) Water injection.
c) Catalytic converter.

(iii)Fuel modification

g) Compressed natural gas (CNG)
h) Liquefied natural gas (LNG)
i) Aqueous salt solution (ASS)
j) Oxygenated fuels, such as alcohols, ethers, carbonates, acetates, glycols and esters.

3. EXPERIMENTAION

The experiment is conducted on a 4-stroke diesel engine. The specification of the test engine is given in table-1.The measured parameters through the experiment are rpm, fuel consumption; exhaust temperature inlet and outlet temperature and rate of flow of the circulating water NO_x, CO etc. Revolution per minute is reported with the help of tachometer directly indication. The rate of fuel consumption is measured by the time to consume a calibrated one of fuel in a suitable glass tube attached to the engine block. Exhaust gas temperature is measured by using thermometer. Air consumption is measured buy using an air drum through which air enters from the atmosphere by an orifice. Water inlet and outlet temperature is measured by using two thermometers which were permanently set up in the inlet and outlet path of water. Emissions like NO_x, CO are measured directly by the exhaust gas analyzer IMR - 1400.

Table 1: Engine Specification

Engine type	Four stroke Diesel Engine
No. of cylinders	Single
Bore	95 mm.
Specific fuel consumption at 12 hour rated output	Not greater than 185 gm/ps. Hr
Compression ratio	20:1
Rated output	13.2 hp (maximum)
Type of cooling	Water evaporative type
Type of starting	Hand cranking

3.1 Preparation of Salt-Diesel Emulsions

The procedure for preparing the salt solution-diesel emulsions is given below.

(i) At first 1% of the emulsifying agent (surfactant TWEEN 80) is added to the neat diesel fuel and stirred well in a mechanical mixer for 15 minutes.

(ii) The salt solution is prepared by mixing 0.2%,0.3%,0.4%,0.5% and 0.6% (sodium carbonate) salt by weight with 10% distilled water

(iii)The salt solution is then added with neat diesel-surfactant blend and stirred well for 30 minutes to obtain a macro emulsion with larger fuel droplets.

In order to reduce the interfacial tension between the two liquid phases (salt solution and diesel) and to form a homogeneous stable solution surfactant is added. Only non-ionic surfactants are suggested for preparing the emulsion for engine applications owing to its non-reactive and non-corrosive nature.

3.2 Test Procedure

At first diesel fuel is used to run the engine and test is conducted at constant load with variable rpm. For each rpm different reading is taken such as time taken to the oil consumption, exhaust gas temperature, water inlet and outlet temperature etc. Ample time is allowed at each point for steady state condition to be reached before recording any data .Diesel fuel is changed and mixture of salt-solution diesel emulsion is used to run the engine and also test is repeated at same condition. All the data are taken following the same procedure as taken during the diesel fuel.

4. RESULTS AND DISCUSSION

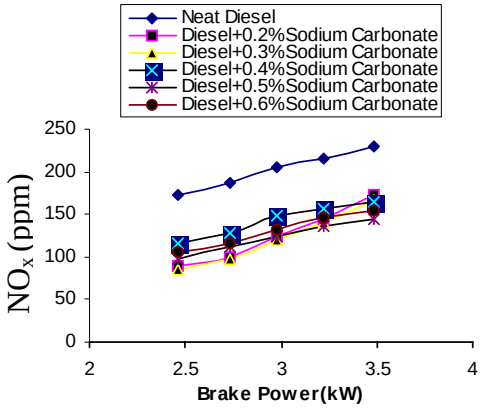

Fig 1: NO_x VS Brake Power

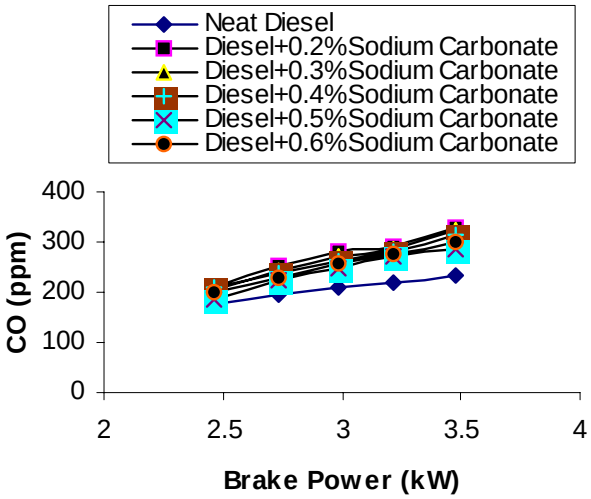

Fig 2: CO (ppm) VS Brake Power

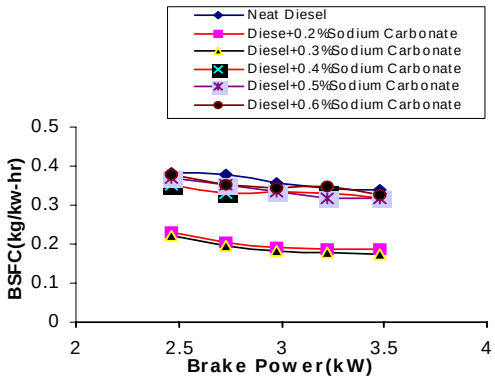

Fig 3: BSFC VS Brake Power

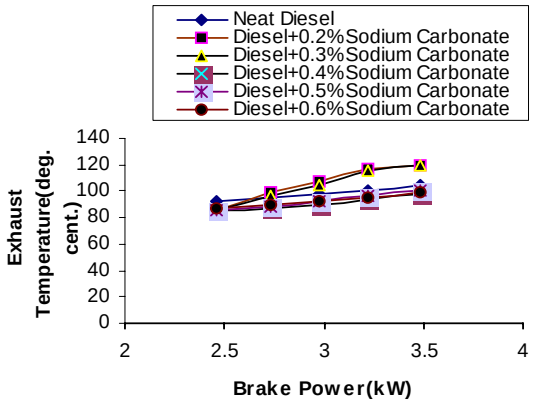

Fig 4: Exhaust Temperature VS Brake Power

Experiments are conducted with neat diesel and mixture of salt solution diesel emulsion for the 50% fixed loading. During observation NO_X Vs Brake Power fig. 1) shows that NO_X is reduced significantly by using salt-diesel emulsion and it is found that 0.5% Na_2CO_3

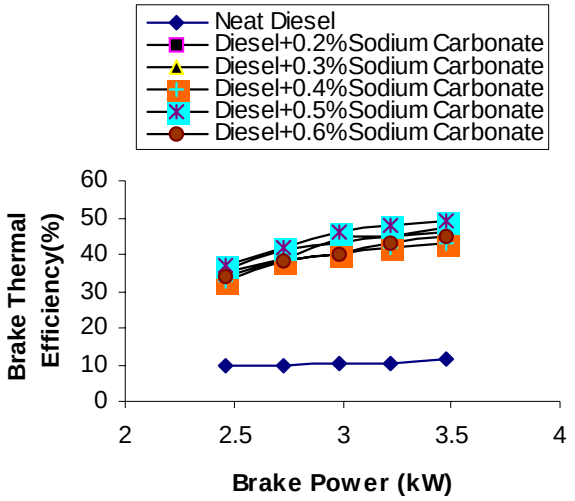

Fig 5: Brake Thermal Efficiency VS Brake power

salt-solution is more effective than others. Tween 80 contains N-butyl alcohol which has excellent emission reducing characteristics. Hence, the combustion of N-butyl alcohol and peroxide based cetane improver may be tried for reducing NO_X simultaneously compared with neat Diesel. NO_X is gradually increased with brake power since temperature is increased. It is seen from the fig. 2 that CO is increased by using salt solution diesel emulsion compared with neat diesel. CO is increased because of higher fuel consumption and incomplete oxidation when air is insufficient. The fig.3 shows that BSFC is reduced significantly by using salt-diesel emulsion when brake power is increased. It is comparatively lower than neat diesel. The improvement in BSFC can be ascribed to the improvement in the centane number of the formulated fuel. The Fig 4 .shows exhausts temperature Vs Brake Power where it is seen that the temperature is gradually increased with brake power. But it is comparatively lower than neat diesel for 4%,5%,and 6% specially. Brake thermal efficiency Vs Brake Power (fig. 5) shows that the brake thermal efficiency is gradually increased by using aqueous salt solution diesel emulsion mixture. It is comparatively higher than neat diesel due to lower BSFC at higher brake power of the mixture of salt solution diesel emulsion than neat diesel.

5. CONCLUSIONS

The following conclusions are drawn from the experimental work on salt solution-diesel emulsions with compared to neat diesel:

(a) BSFC is reduced 8% by using salt-solution diesel emulsion compared with neat diesel.

(b) Brake thermal efficiency is increased 3.54% by using salt-solution diesel emulsion compared with neat diesel.

c) NO_X is reduced 66% by using salt-solution diesel emulsion compared with diesel.

d) CO is increased 20% by using salt-solution diesel emulsion compared with diesel.

e) Exhaust temperature is reduced 3.8% by using salt-solution diesel emulsion compared with diesel.

f) Among all proportional mixture of salt-solution diesel emulsions only 5% sodium carbonate with diesel gives more reduction in emission levels.

6. REFERENCES

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