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ANTICIPATING EMISSION & SUGGESTIONS FOR REDUCING EXHAUST EMISSIONS WITH CNSL AS FUEL

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AbstractBio-diesel is produced by mixing vegetable or animal oil with a small quantity of methanol in a process known as esterification. Bio-diesel is a promising nontoxic and biodegradable renewable alternative fuel compared to petroleum diesel in the light of the limited nature of fossil fuel and the environmental concerns.
The biodiesel is reported to be sulfur-free, nontoxic, biodegradable oxygenated and renewable. and the characteristics of biodiesel are very close to diesel fuel and some are better than diesel such as higher cetane number, no aromatics, almost no sulfur, and more than 10% oxygen by weight, which reduce the emission of carbon monoxide (CO), hydrocarbon(HC), particulate sulfur oxides(Sox) and volatile organic compounds(VOCs).although there are some advantages of using biodiesel instead of petroleum based diesel that biodiesel blends up to a maximum 5% should not cause engine and fuel system problem. so it can be seen that the properties of biodiesel can affect the engine performance and emissions. So in this paper we discussed anticipating emission and suggestions for reducing exhaust emissions with CNSL as a fuel in CI engine.
Key word- biodiesel, vegetable oil, esterification, diesel engine performance, emissions.

1.1 (1) Anticipating Emission with CNSL as Fuel

As not much literature is found regarding CNSL hence the kind of emissions that will be encountered while using CNSL as fuel in diesel engine will have to be anticipated. As from the structure of CNSL it can be easily said that fuel contains higher levels of aromatics and cetane number will be subsequently low, literature is studied for effects of cetane number and aromatics on emission of diesel engine. Spreen et al. conducted experiments on a prototype 1994 Navistar DTA-466 heavy-duty engine. This engine was an in-line 6-cylinder configuration of 7.6 liter displacement with compression ratio of 17:5:1 and had a DI combustion Chamber. They then construed certain statistical models, which were used to estimate independent effect of cetane number, aromatics and oxygen content of the fuel on the emissions. A similar experiment was done by Ullman et on a 1994 prototype DDC series 60 heavy-duty engine. This was a DI engine with an in-line 6-cylinder configuration of 11.1-liter displacement and compression ratio 16:1 [1]. Cetane number was determined to be most important fuel variable associated with emission of HC, CO, and NOX whereas fuel aromatics significantly affected PM emissions and was also observed changing emission of HC and NOX. Oxygen content in the fuel was important for estimating PM emission [1,2]. The statistical models are not include in the study but their results are presented below and there implication on CNSL as a fuel is stated.

Unburnt Hydrocarbons

They estimated using statistical models that an independent increase of cetane number by 10 reduces composite HC levels by 0.037 g/hp-hr. Decreasing aromatics by 10% was estimated to reduce HC levels by 0.014 g/hp-hr. Adding 2% by weight oxygen to the fuel using monoglyme was estimated to increase emissions by 0.051 g/hp-hr.

Carbon Monoxide

Only Cetane number seemed to have certain effect on CO emissions. An increase of 10 in cetane reduced CO levels by 0.28 g/hp-hr.

Nitrogen Oxide

NOX emissions were significantly related to cetane number and aromatics. An increase of 10 in cetane number reduces NOX emissions by 0.131 g/hp-hr. it was also predicted that a 10% decrease in aromatics will reduce NOX level by 0.052 g/hp-hr.

Particulate Matter

PM emissions were highly affected by aromatics in the fuel. A decrease of 10% in aromatics gave 0.004 g/hp-hr

reductions in PM levels. Increasing Oxygen in diesel fuel to 2% reduced PM by 0.009 g/hp-hr.
Tamanouchi et al. conducted experiments on similar lines and found a relationship between fuel properties and exhaust emissions. Their findings are shown in fig 2.9, which shows effect of cetane number on exhaust emissions [3].

As CNSL is fuel with high aromatic content, high density, and a lower cetane number can be expected. Following conclusions can be made from the above results:

- High HC emission is expected from CNSL
- Very high NOX emissions are expected from this fuel.
- Nothing can be said for sure about CO emissions.
- PM emissions are expected very high.

1.1 (2) Suggestions for Reducing Exhaust Emissions
In the last section it became evident that if CNSL has to be used as an alternative to diesel fuel then some techniques of reducing emissions will have to be used. Caused by the tightening of regulation on diesel emission around the world, engine and fuel technology for reducing emissions is also progressing. Following are some suggestions, which are found in literature for reducing emissions and improving working of engine.

Fuel Additives
In petroleum industry, it is a common practice to use cetane improvers to enhance the cetane number of the commercial diesel fuel. The addition of cetane improvers does not change other fuel properties much since its concentration is usually low. The cetane improvers enhance the ignition quality by generating a radical pool at a lower temperature than the component in the base fuel. Compared with other processing methods, the addition of cetane improver is a cost effective way for the refineries to produce diesel fuel with feedstock of low cetane rating [4]. A study for investigating cetane response of such cetane improves was conducted by sobotowaski. Cetane response is defined as the relationship between cetane number of the fuel and concentration of cetane improver. But no correlation was found to accurately characterize the response of fuels used in this study [5]. Li et al. conducted experiments on a single cylinder DI engine and two kinds of cetane improvers were used, nitrate-type additive and peroxide-type additive. The objective of his study was to compare the emission impact of both types of cetane improvers. Nandi et al. conducted similar experiment on these cetane improvers and come out with similar results. They found HC, CO; NOX and PM emissions were reduced significantly by treating fuels with either cetane improver. Similar reductions in NOX emissions were observed indicating that nitrogen introduced by the nitrate type cetane improver into fuel does not contribute to NOX formation. They also found that commercially used 2-ethylhexyl nitrate and di-t-butyl peroxide are mutually compatible i.e. mixing of fuels containing will not have negative effect on cetane number and engine emissions [4,6].

Oxidation Catalyst
It has been found in literature that use of oxidation catalyst enables HC, CO, and PM levels to be reduced. In addition, the effect is not sensitive to fuel used. It was also observed that blending of oxygen-containing fuel enchases the effect of the oxidation catalyst [3]. Results have shown that use of oxidation catalyst is more effective in reducing exhaust emissions than fuel modification.

High Pressure Injection
It has been found by Tamanouchi et al. that use of high-pressure injection is very effective in reducing PM emissions and NOX emissions.

Particular Traps
Particulate traps have evolved as a novel means of reducing PM in the exhaust gas. A great variety of fitter materials are being investigated like wire mesh tubes of Layered ceramic fibers, ceramic foam, cross-flow ceramic filters, honeycomb ceramic filters and others. The biggest problem with particulate trap is the regeneration of the fibers [7].

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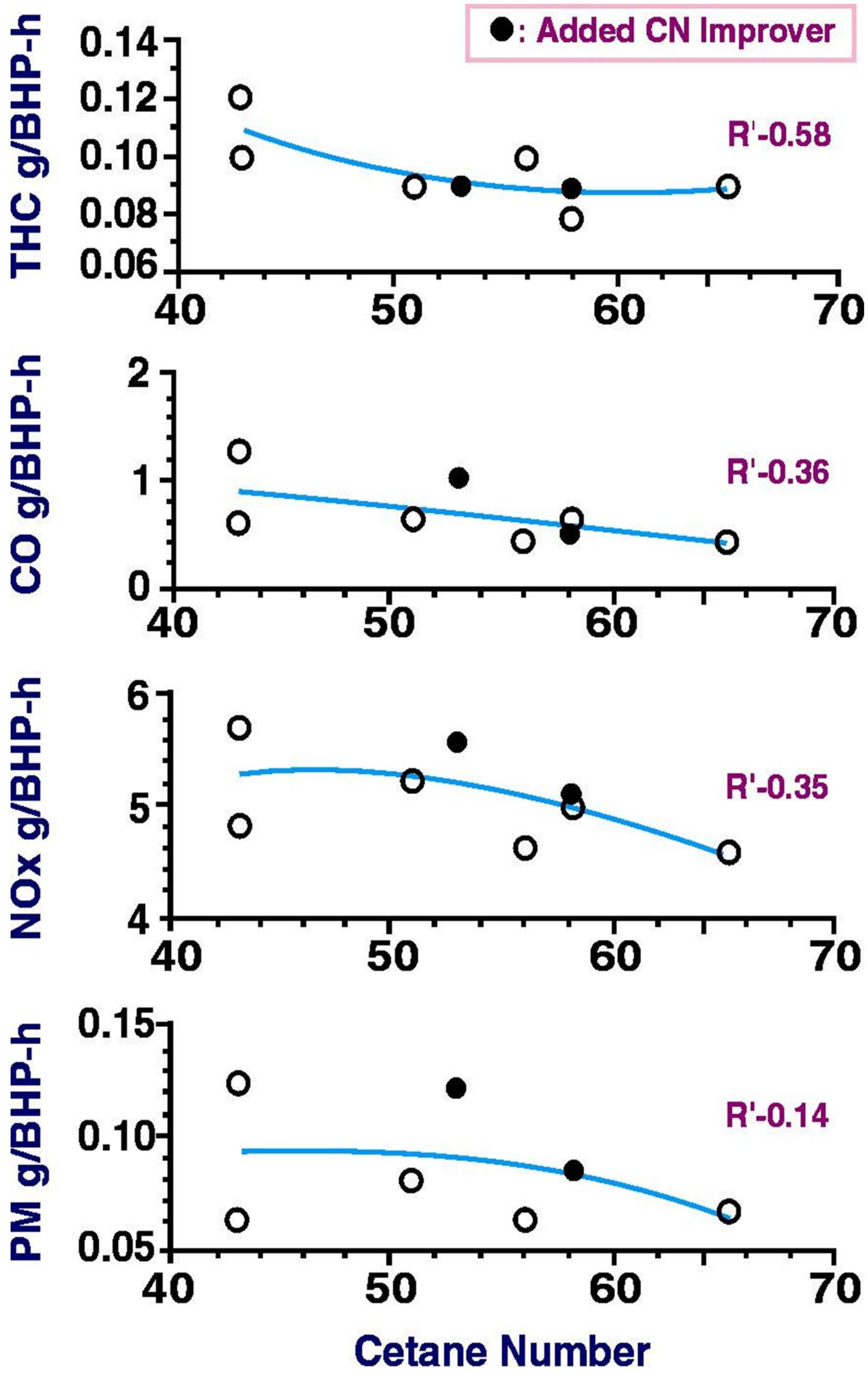

Fig. 1.1 (A) Effect of Cetane Number on Exhaust Emissions [3]

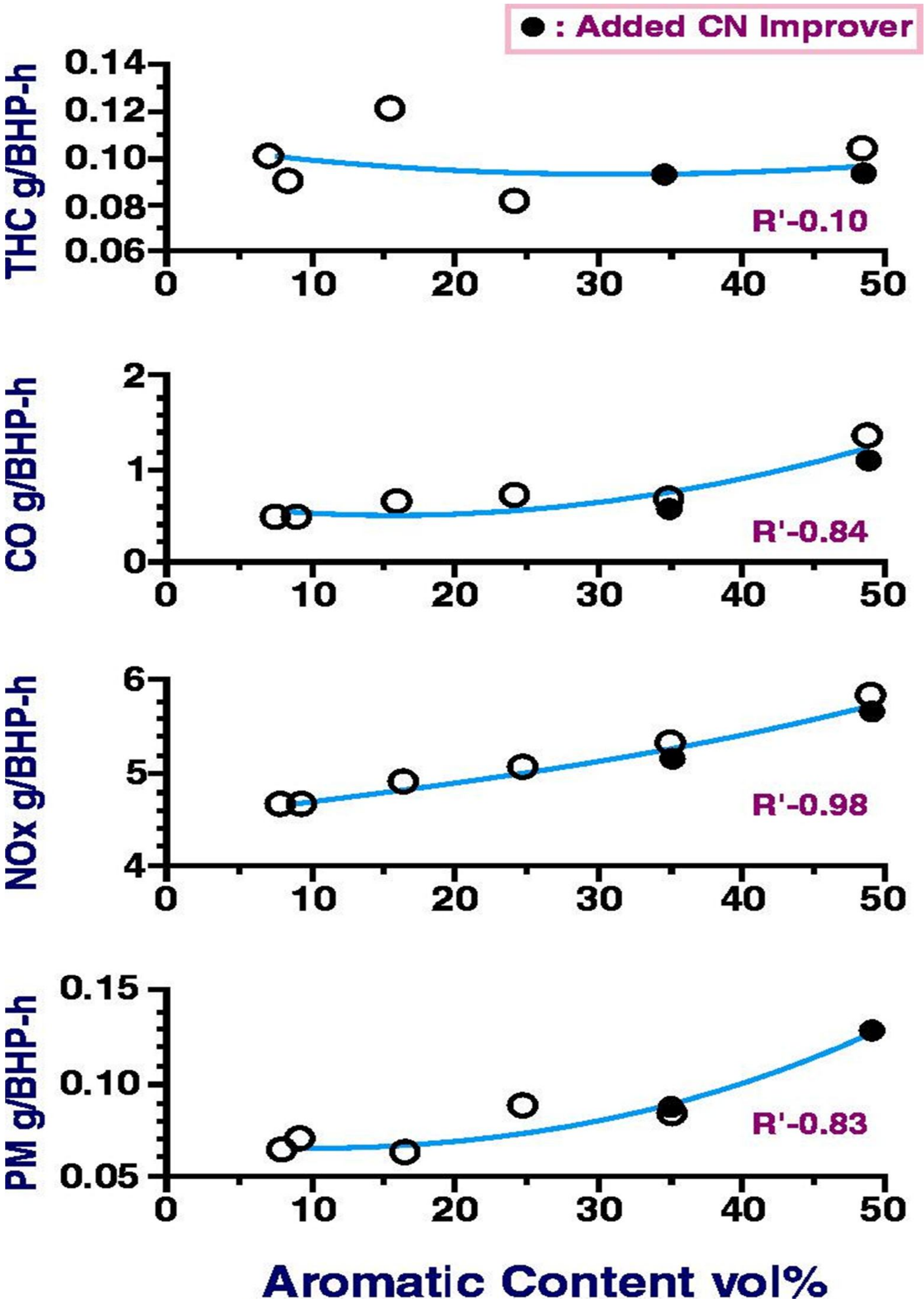

Fig. 1.1 (B) Effect of Aromatic Content on Exhaust Emissions [3]

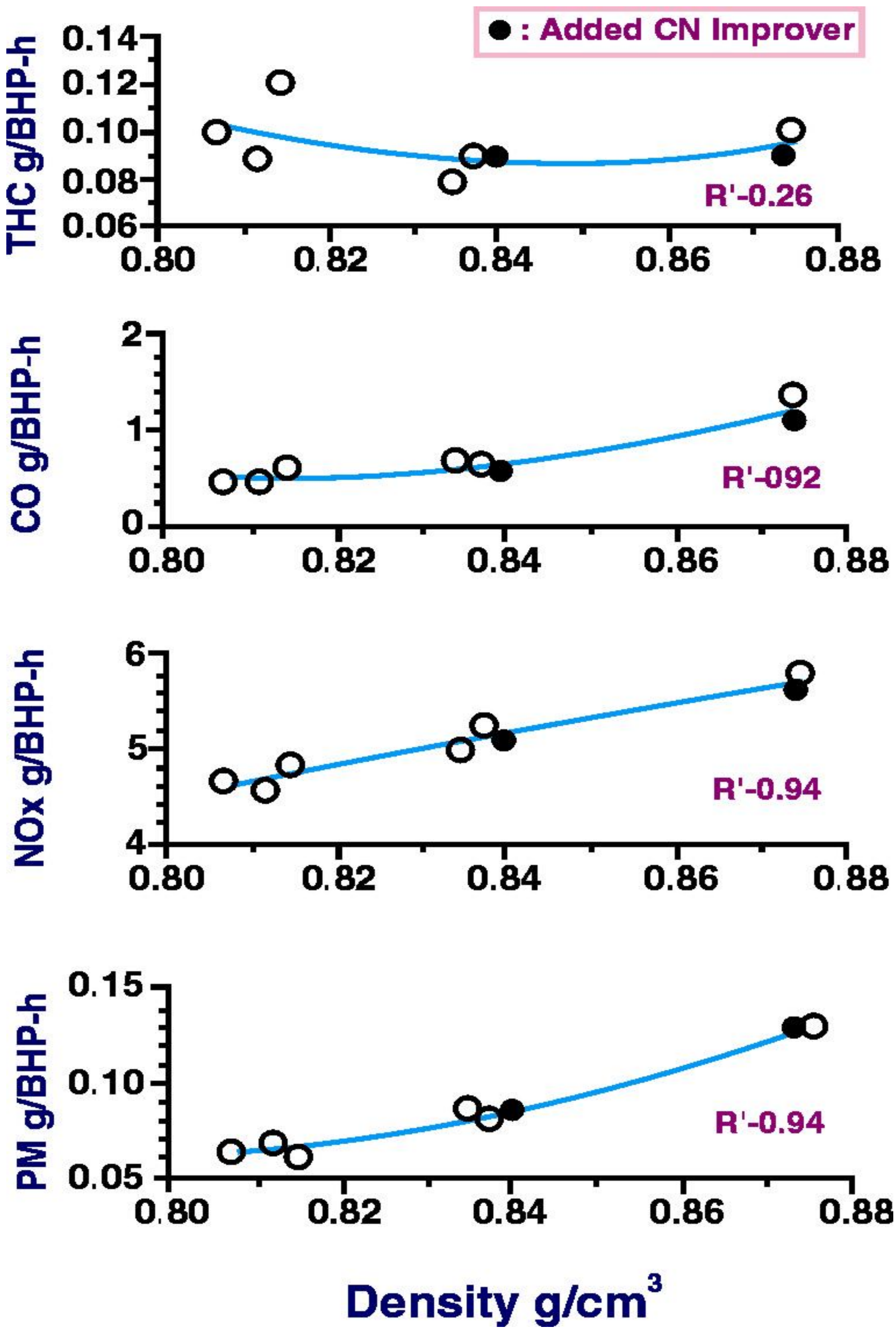

Fig. 1.1 (C) Effect of Density on Exhaust Emissions [3]