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A Review on Feasibility of Diesel/ Biodiesel/ Ethanol/ Bio-Ethanol Blend as CI Engine Fuel

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Abstract:- Today, fossil fuels are the main source of energy which fulfills the demand of energy of the worlds. The consumption of fossil fuels increasing day by day. This result in the non-stop rise in the prices and almost every country are trying to conserve their energy supply. Due to this, global market scenario changes rapidly which infuses the fear of gasoline depletion.

On the other hand, the use of fossil fuels has adverse effect on the environment due to emission of CO, HC, NOx etc. Fusel oil contain alcohols (methyl, isoamyl, isobutyl, n-propyl , ethyl), water (less amount), trace aldehydes, free acids and their esters. The carbon present in the alcohol and the fermentation process decides the composition of fusel oil. The fusel oil has near about same properties as alcohol fuels like octane number, high oxygen content, single boiling etc. That indicates that it can be used as alternative source of energy.

Therefore, This paper reviews utilization of different alternative fuels like natural gas, biogas, biodiesel, alcohols, etc.

Keywords:- *Fusel Oil, Diesel, BSEC, BTE, CO, NOx, Smoke Emission, DOE*

I. INTRODUCTION

Today's, fossil fuel is main fuel used for the generation of energy. Due to the continuous use of fossil fuel whole world facing two the twin problems i.e., (i) exhaustion of fossil fuels and (ii) pollution due to combustion of fossil fuels. The Development of mostly countries closely depends on the fossil fuels and mostly countries import the fossil fuel which leads to extra burden on the economy of the country. Due to rapidly exhaustion of fossil fuels and pollution due to combustion of fossil fuels researchers give attention towards the development of alternative effective fuels [1]. The alternative fuel must be sustainable, cost effective, fulfil the energy demand, creates less pollution and feasible to significant adoption.

Diesel engine is widely used for the power generation due to its capability to produce high power. Therefore, in the past numerous researchers examine the impact of different alternative fuels on the performance & the emission. From the past research it has been revealed that vegetable oils, alcohols, gases can be used as alternative fuels to the diesel [2].

II. ALTERNATIVE FUELS FOR DIESEL ENGINE

A. Vegetable Oils

These are the biodiesel fuel fabricated using biological processes from the vegetables. These fuels are appropriate fuel for the substitution of diesel because these are produced from the renewable sources. Also, these produces less percentage of toxic emission as compared to diesel. The non-edible oils are widely preferred as substitute fuel. On the other hand, continuous use of vegetable oil creates problems diesel engine because of the deposition of carbon residuals. Also, atomization, mixture formation and pumping of vegetable oil is very difficult due to high viscosity [1]. Due to this higher smoke, gummy deposits and NOx emissions takes place during the combustion. This problem can be solved by pre-treatment of vegetable oil like Transesterification and Micro-emulsification. Jatropha oil is widely used as an alternative fuel to diesel among all non-edible oils such as karanja, pongamia, etc. Among various Jatropha plants i.e, tanjorensis, Jatropha multifida, gossypifolia, Jatropha curcas etc, Jatropha curcas is the most excellent variety due to its nontoxicity and good capabilities [3].

B. Alcohols

Alcohol is used as substitute to diesel. Alcohols are fabricated by fermentation process of agricultural products like hemp, corn, potatoes, sugarcane etc. Methanol and ethanol are suitable alternative fuels to diesel among all the alcohols, especially ethanol due to its enhanced volatile nature and good latent heat. Blending of ethanol with diesel and biodiesel is not a simple process because of the final cetane number [1]. Cetane number of the final blend depends on the volume of ethanol in the blend. It increases with increase in Proportion of ethanol which results in ignition delay. Ethanol blended generates maximum in-cylinder temperatures and minimum NOx and smoke emissions [4].

III. EMISSIONS CHARACTERISTICS

Diesel engine is the most favored engine particularly for heavy duty vehicles due to its reliability and high efficiency at low running cost. On the other hand, emission of diesel engines contributes significant environmental pollution

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problems worldwide. Diesel engines are the leading producer of environmental pollution [4]. Policy makers made number of policies worldwide to minimize the negative impact of emission of diesel engine on environment and human health. The emissions characteristics of emission of diesel engines are:

- Carbon di oxide (CO_2);
- Carbon monoxide (CO);
- Nitrogen oxides (NOx);
- Hydrocarbons (HC);
- Particulate matter (PM);
- Hydro fluorocarbon 134a (HFC-134a);
- Methane (CH_4);
- Nitrous oxide (N_2O).

Among all the emission characteristics, CO, HC, PM and NOx are the main pollutant emissions from diesel engines [5]. The incomplete combustion of diesel produces HC and CO during emission.

Formation of NO in engines takes place due to thermal dissociation of molecular oxygen. Diesel engine emission produces high PM as compared to gasoline engine emission [6]. The particulate emissions increase with increase in incomplete combustion near the fuel injector. Even though mostly particulates are burned due to excess O_2 before exhaust from the engine, but some particulates carried out with engine exhaust. The emission of particulate in exhaust is a serious problem for diesel engines [3].

IV. REVIEW OF PAST PUBLISHED LITERATURE

Due to the inverse impact on environment, the researchers invest huge capital to explore renewable sources as an alternative fuel. In the past, a number of research were carried out on utilization of different alternative fuels like natural gas, biogas, biodiesel, alcohols, etc. some of them are presented here.

Kahraman et al. [10] experiments on hydrogen fuelled spark ignition engine to find out the effects over the performance and emission. They concluded that brake power in the hydrogen fuelled engine will be less than gasoline-fuelled and also with hydrogen fuelled brake thermal efficiency will be high in comparison to gasoline. Hydrogen fuelled engine results in low NO_x, very low CO and CO_2. Barabas et al. [11] used mixture of diesel, rape seed biodiesel and ethanol in different proportion as a fuel to investigate the effect of % volume of rape seed biodiesel and ethanol on the performance & emission at different load of engine. The lower CO emission has been found with mixture having 80% diesel, 10% rape speed biodiesel and 10% of ethanol w.r.t diesel. Also, at medium and lower load conditions, NOx emission increases with increase in ethanol while HC emission has been found less at every loads w.r.t diesel.

Huang et al. [12] made a comparison of diesel engine performance with Chinese pistachein biodiesel (CP), diesel and Jatropha curcas biodiesel (JC). A comparison has also been carried out to compare the emission and engine performance with biodiesel and baseline diesel fuel. The result of experimental study indicates that engine perform better with JC and CP w.r.t diesel. Also, the HC and CO emission has been found less w.r.t. diesel at high load. Mahajan et al. [13] used neem oil, coconut oil, groundnut oil, soybean oil and rapeseed oil mixed with diesel as a fuel to study the impact of these fuels on the performance of diesel engine. Also, specific gravity, flash and pour point, heating value, viscosity and cloud point have been studied and compare with diesel fuel. The coconut oil and neem oil are found not suitable for the engine as a fuel.

Wang et al. [14] experimentally studied and compare the performance of SI engine mixed with hydrogen & mixture of hydrogen/oxygen. They use hybrid electronic control unit (HECU) and original electronic control unit (OCEU) to regulate the flow of hydrogen, oxygen and gasoline. They obtained that indicated thermal efficiency (ITE) and fuel energy flow rate increases with the addition of hydrogen as well as hydroxygen as the cylinder peak pressure increases too. They also found that with the addition of hydrogen and hydrogen there is a reduction in HC emissions whereas CO emission increase with the hydrogen addition and decreases with hydroxygen respectively. Further, they found that the cylinder pressure increase with addition of hydrogen and hydroxygen. Chauhan et al. [15] experimentally investigate the impact of JB on emission of diesel engine. For the investigation, different % of JB with diesel have been taken. A comparison has also been carried out to compare the emission with JB and diesel fuel. It has been found that Jatropha biodiesel with diesel reduces the smoke emission, HC and CO and increases the NOx.

Shivaprasad et al. [16] work on high-speed spark ignition engine by replacing carburetor with Electronic Control Unit (ECU). They mix gasoline fuel with the different concentration of hydrogen. They found reduction in hydrocarbons and CO emissions. Cylinder peak pressure increases so as the NO_x emission. These results are valid up to 20% of the hydrogen concentration. Yilmaz et al. [17] used the mixture of biodiesel-diesel-ethanol and biodiesel-diesel-methanol as a fuel in different proportions to examine the impact of these fuels on engine performance & engine emission. The BSFC for both fuels has been found lower w.r.t. diesel. Also, low NOx & high HC and CO emissions have been noticed with Ethanol based fuel. On the other hand, increase in NOx emission and decrease in HC and CO emissions have been observed with Methanol based fuel.

Fang et al. [18] used mixture of diesel, bio-diesel & ethanol in different proportion to investigate the outcome of ethanol on the emission of engine. A comparison has also been carried out to compare the emission and engine

performance with biodiesel and baseline diesel fuel. Use of ethanol reduces the NOx and smoke emissions. Also, use of ethanol increases the HC and CO w.r.t. the mixture of diesel and bio-diesel. Jain et al. [19] used oxidatively stabilized jatropha curcas biodiesel to assess the diesel engine emission. It has been revealed that oxidatively stabilized jatropha curcas biodiesel deceases the BSFC, NOx, CO, & HC w.r.t. biodiesel without antioxidants. A comparison has also been carried out to compare the emission and engine performance with Jatropha biodiesel and baseline diesel fuel. It has been found that the diffusion combustion phase decreases with increase in % volume of ethanol in ternary fuel. Also, ternary fuel decreases the particulate emission and NOx w.r.t. diesel.

Ji et al**.** [20] studied the engine performance with hydrogen-oxygen by the help of computational fluid dynamics (CFD). Due to adding of hydrogen, there is an increase in the flame propagation speed and degree of flame wrinkling also improves. Their results also confirm a rise of 37.18% and 60.47% in peak flame propagation speed with the hydrogen fraction of 3% and 6% respectively. Hosseini et al. [21] studied the impact of aluminium oxide nanoparticulates mixed in different proportion of WCO biodiesel and diesel on engine. It has been revealed from the study that WCO biodiesel with 10% and 90ppm alumina nano particles provide maximum torque, power,BTE and miniumum HC and Co w.r.t. diesel fuel. Also, NOx and CO_2emission obtained maximum with WCO biodiesel with 10% and 90ppm alumina nano particles.

Sivakumar et al. [22] investigated the impact of aluminium oxide nanoparticulates in different size mixed in pongamia biodiesel and diesel on engine & emissions. It has been revealed that addition of nano particles reduces the HC, smoke & CO emission with both size of alumina nano particles. On the other hand, high NOx emission has been observed with the addition of nano particles of both sizes.

V. CONCLUSION

It has been revealed from the review of past published literature that huge work has been carried out by the researchers in the field of alternative fuels to the petroleum and diesel fuel. Mostly researchers used alcohols, natural gas, hydrogen, acetylene, biodiesel, oils, and similar fuels as substitute to fossil fuel. From the review of literatures, it has been revealed that very less effort have been made to use of fusel oil as an alternative fuel for CI engine. Therefore, study on the use of fusel oil as fuel for CI engine will be quite useful. The aim of present research work is to investigate the effect of percentage proportion of fusel oil in diesel on the performance of diesel engine and emission at different load condition.

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