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Impact of Biofuel in Internal Combustion Engine – A Review

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ABSTRACT

This article describes current advancements in internal combustion engine development employing different blends of gasoline, diesel, and biofuel. The use of ethanol as a mixed fuel and bio fuel made from vegetable oil improves engine performance. To boost engine performance, oxygen-containing additives such methanol, ethanol, methyl tertiary butyl ether (MTBE), and mono-alkyl esters of fatty acids are utilised. This study also discusses the various types of bio fuel that are mixed with petroleum products, exhaust emissions, and blending programmes in India. These studies show that a blend of biofuel and petroleum product has less ozone depletion and global warming potential than pure fossil fuel.

KEYWORDS: *Internal Combustion Engine, Ethanol, Methyl Esters, Transesterification, Performance*

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I. INTRODUCTION

With upsurge in consumption of fossil fuels as economies grow and the nearing depletion of such fuels has prompted a probe for their alternatives all over the world. Biofuels have emerged as a substitute for fuel oil, especially for oil importing countries and serve a various purpose. The most important advantage of these fuels is that they are renewable, and are being seen as maintainable sources of energy. Some studies have also pointed out that biofuels help minimise environmental emissions, apart from addressing the problem of the rising import cost of fuel oil. Among liquid fuels, there are numerous types of biofuels such as methanol, ethanol, diethyl carbonate (DMC), methyl tertiary butyl ether and alkyl esters of fatty acids, and they can be used either individually as fuels or for blending in petrol as well as in diesel. While ethanol is produced from starch contained in crops such as corn and sorghum or through fermentation of sugarcane, molasses, and sugar-beet and alkyl esters is produce from transesterification of vegetable oils and animal fats such as Groundnut oil, Sesame oil, Rapeseed and Mustard oil, Sunflower oil, Safflower oil and Niger oil. In India, ethanol production is mainly done using sugarcane as feedstock. Transport has been identified as a foremost polluting sector and hence the use of biofuels is important in view of the tightening of emission norms.

II. TYPES OF ALTERNATIVESFUEL

There are quite a lot of fuel have been used in compression ignition engine as well as in spark ignition engine. These fuels are mostly two types first is oxygen having fuel and other is methyl ester containing fuel. Several oxygen containing fuels have been used as fuel additives, such as methanol, ethanol, diethyl carbonate(DMC) and methyl tertiary butyl ether. MTBE is one of the most common oxygenated fuel additives. It is always used to raise octane range and to diminish the emissions of carbon monoxide and hydrocarbon in engines.

Methyl esters (biodiesel) have also been used as fuel additives such as rice bran methyl ester, jatropha methyl ester, karanja methyl ester, peanut methyl ester.

2.1. Ethanol was the first fuel among the alcohols to be meant for power vehicles in the 1880s and 1890s. It is an alcohol-based alternative fuel

formed by aerobic or anaerobic fermentation and distillation of starch crops that have been transformed into simple sugars. For this fuel there are several feed stocks contains corn, barley and wheat. Ethanol can be produced from cellulose feedstock like corn stalks, rice straw, and sugar cane which are examples of feedstock that comprise of sugar. As ethanol can be produced from agronomic crops, its cost can be inferior in the states whose economy is mostly based on agriculture and it can beused.

2.2. In current year methanol is likewise one of the most promising and as take special attention of chief researcher and developer to use pure methanol and mixture of methanol and gasoline in various percentage ratio in petrol engine and vehicle for number of years. The one of the most common mixtures are B85 (85% methanol and15% gasoline) B10 (10% methanol and 90% gasoline). Methanol can be achieved from many sources fossil and it is renewable. This comprises coal, petroleum, natural gases, bio mass, wood, landfills and even the ocean.

2.3. Raw Mahua oil is generally composed from the kernel of Mauha oil. One Mahua tree yields approximately around 20-40 kg of seeds per year. The typical mahua oil yield per annum is 1,35,000 million tons in India. The vegetable oil achieved from Mahua tree is in greenish yellow colour in appearances. Many researchers had done the analysis by making blend of biodiesel haul out from the Mahua oil and the conventional diesel fuel in proportions such as 85% blend, 90% blend, 95%, 100% blend with Mahua bio diesel. The physical and chemical properties of biodiesel have been obtained by them by conducting various tests on the biodiesel. Heating valve, fire point, flash point, kinematic viscosity etc. are the important properties which are very essential to be obtained for confirming the quality offuel.

2.4. Biodiesel can also be extract from non-edible oil seed like Jatropha Curcas. In compression to other vegetable oil premeditated so far, Rice bran oil (RBO) is an underutilized non-edible (Due to the presence of an active lipase in the bran, free fatty acid (FFA) content in RBO is much advanced than other edible oils. Because of this reason, RBO is non-edible vegetable oil, which is obtainable in the large quantities in rich cultivating countries, and very less amount of research has been done to use this oil as a replacement for mineral Diesel.

2.5. Karanja oil (Pongamia Pinnata) is non-edible in nature and is presented abundantly in India. SaswatRath et al. An experimental examination was made to estimate the performance, emission and combustion characteristics of a diesel engine using different combinations of methyl ester of karanja with mineral diesel. Karanja methyl ester was mixed with diesel in proportions of 5%, 10%, 15%, 20%, 30%, 40%, 50% and 100% by mass and studied under various load circumstances in a compression ignition (diesel) engine.

III. METHYL ESTER AS ANALTERNATIVE FUEL FOR CI ENGINE

Bio-diesel is fatty acid ethyl or methyl ester prepared from virgin or used vegetable oils (both edible & non-edible) and animal fats. The foremost product sources for bio-diesel in India can be non-edible oils obtained from plant species like as Jatropha Curcas (Ratanjyot), Pongamia Pinnata (Karanj), Calophylluminophyllum (Nagchampa), Hevcabrasiliensis (Rubber) etc. Bio-diesel has no petroleum, but it can be blended at any level with petroleum diesel to produce a bio-diesel blend in different ratio or can be used in its pure form. Just like petroleum diesel, bio-diesel functions in compression ignition engine; which basically require very little or no engine modifications because bio-diesel has properties analogous to petroleum diesel fuels. It can be deposited just like the petroleum diesel fuel and hence does not required individual infrastructure. The application of bio-diesel in conventional diesel engines results in considerable reduction of un-burnt hydrocarbons, carbon monoxide and unwanted particulate substances. Bio-diesel is considered clean fuel since it has almost no sulphur content, no aromatics compound and has about 10 % built-in oxygen, which aids it to burn fully. Its greater cetane number increases the ignition quality even when blended in the petroleum diesel.

TABLE. 1. PROPERTY OF METHYL ESTER BIODIESEL

Properties of fuel	Units	Diesel	Biodiesel
Kinematic viscosity 40°C	est.	4.57	5.39
Specific gravity at 15°C	-	.8668	.8712
Flash point	Degree Celsius	42	157
Fire point	Degree Celsius	68	183
Pour point	Degree Celsius	-18	2
Cloud point	Degree Celsius	-3	16
Cetane index	-	50.6	51.2
Calorific value	KJ/kg-K	42850	42293

IV. TRANSESTERIFICATION

Transesterification is one of the simplest methods for biodiesel production from vegetable oils and animal fats and frequently preferred in its place of direct esterification. It can be defined as the process of reacting a triglyceride (oil)in the occurrence of a catalyst, such as hydroxide of potassium or sodium with an alcohol (e.g., methanol or ethanol), the molecule of the oil chemically breakdown into methyl or ethyl esters. Glycerine, also known as glycerol, is the by-product of this reaction. The process is similar to hydrolysis, except than alcohol is used instead of water. Biodiesel is produced through a process called as transesterification. Available bio-diesel production technologies.

V. METHYL ESTER (BIODIESEL) BLENDING PROGRAM IN INDIA

A. Biodiesel Blending Program (BBP) –2000-2006

1. In India, the Indian Power Alcohol Act 1948 instructed the blending of power alcohol in petrol as early as 1948.This Act was revoked in 2000, as part of an administrative modifies drive to repeal legislation that had not been used. Planning Commission submitted a report on advancement of Biofuel in June 2003.5% Ethanol blended Motor Gasoline was authorized in 9 major sugar cane growing states and 4 union territories from 1st Jan 2003. 5% ethanol blending in MG was prolonged to 20 states and 4 union territories from 1st Nov 2006 subject to commercial feasibility.

2. "National Mission on Biodiesel "was forced in 2003 to report socioeconomic and environmental concerns. The launch was projected in two phases:

- Phase 1-Demonstration project in 2006-07. Biodiesel Purchase policy issued-1st Jan, 2006. Up-to a blend of 20% can be promoted immediately provided the OMCsdo not suffer from loss due to pricing of bio- diesel.
- Phase2-Self-sustaining extension in 2011-12. The policy has reformed the national indicative targets for biofuel blending. The purpose of the policy is to project short term -5% by 2012, medium term-10% by 2017 and long term-20% afar2017.

B. Biodiesel Blending Program (BBP) –2007

1. In October 2007, the Bench of Ministers recommended to blend 5 % Ethanol in petrol across the country, with the exclusion of J&K, the Northeast and island territories. However, this was never implemented.

2. Unchange procurement price fixed at INR 21.50 / Liter (Ex-factory) for 3 years OMCs started procurement thro'tenders.

C. Biodiesel Blending Program (BBP) -2008

Lately, a group of ministers headed by external affairs minister Mr. Pranab Mukherjee has commended that oil companies should instantaneously move to 5 to 10 % blending in all states excluding Jammu & Kashmir, the north-east and the island territories.

The next stage is a voluntary change to 10% blending from October of this year, which might not be practicable due to lack of infrastructure. By October 2008, oil companies will compulsory have to blend petrol with 10% bio fuels.

D. Biodiesel Blending Program (BBP)–2008-2014

1. Advancement of high oil-yielding variations of Jatropha by the Department of Biotechnology, the Aditya Biotech Research Cente (Raipur), the Indira Gandhi Agriculture University (Raipur) and the Bhabha Atomic Research Centre (Trombay).

   A number of NGOs such as Utthan (Allahabad), Sutra (Karnataka); the Institute of Agriculture and Environment (Jind, Haryana); the BharatiyaAgro Industries Foundation (BAIF) Development (Pune, Maharastra); Pan Horti Consultants (Coimbatore); Typical Jatropha Oil (Coimbatore); and RenulakshmiAgro Industries (Coimbatore), etc.

2. Preliminary plants on transesterification set up by Indian Oil Corporation (R&D), Faridabad; the Indian Institute of Technology (IIT), Delhi; the Punjab Agricultural University (PAU), Ludhiana;

the Indian Institute of Chemicals Technology (IICT), Hyderabad; the Indian Institute of Petroleum (IIP), Dehradun; the Indian Institute of Science (IIS), Bangalore; and Southern Railways, Chennai.

Trial runs on range of transport modes using 5 % biodiesel blends, as well as:

- Railways (a locomotive used biodiesel on a regularly programmed train ride – the Shatabdi Express – from Amritsar to Delhi on 31 December2002). Tractors tested by Mahindra & MahindraCo.
- Mercedes cars tested on DaimlerChrysler.
- Communal transport buses tested by Haryana Roadways and Bombay Electric Supply and Transport (BEST).
- In addition, trial marketing of 5 per cent diesel blends through some retail outlets is being accompanied by the oil company Bharat Petroleum Corporation Limited (BPCL).

Awareness-raising seminars/conferences planned by NGOs and business groups such as Win rock International India; the Confederation of Indian Industries (CII); Utthan, Centre for Bharatiya Marketing Development (CBMD); and the PanchatatvaGarima Foundation.

VI. BENEFITS FROM THE USE OFBIOFUELS IN INDIA

A. Effects on environment and human health - Biodiesel

Biodiesel (mono alkyl esters) is a non-populated cleaner-burning diesel fuel prepared from renewable sources such as vegetable oils. Like petroleum diesel, biodiesel works in combustion-ignition engines. The use of biodiesel in a conventional diesel engine result in considerable reduction of unburned hydrocarbons, carbon monoxide and particulate substance. However, Emissions of nitrogen dioxides are either somewhat reduced or somewhat increased depending on the duty cycle and testing methods. The use of biodiesel reduced the solid carbon element of particulate substance (since the oxygen in biodiesel enables more complete combustion to CO2), eliminates the sulphur portion (as there is no sulphur in the fuel), while the soluble or hydrogen fraction stays the same or is raised. Therefore, biodiesel works best with new technologies such as oxidation catalysts.

As per U.S.EPA biodiesel has been systematically evaluated in terms of emissions and prospective health effects under the Clean Air Act Section 211(b). These programmes comprise stringent emissions testing protocols required by EPA for certification of fuels in the U.S.

B. Reduction in greenhouse gas emissions

Life-cycle analysis for several fuels as shown in Figure-2 shows that biodiesel (RSME) has the lowermost Greenhouse emissions caused by ethanol from wood. Gasoline gives the large amount of greenhouse gas emissions. Emissions from CNG, diesel, water-diesel emulsified fuel and ethanol from slush are comparable.

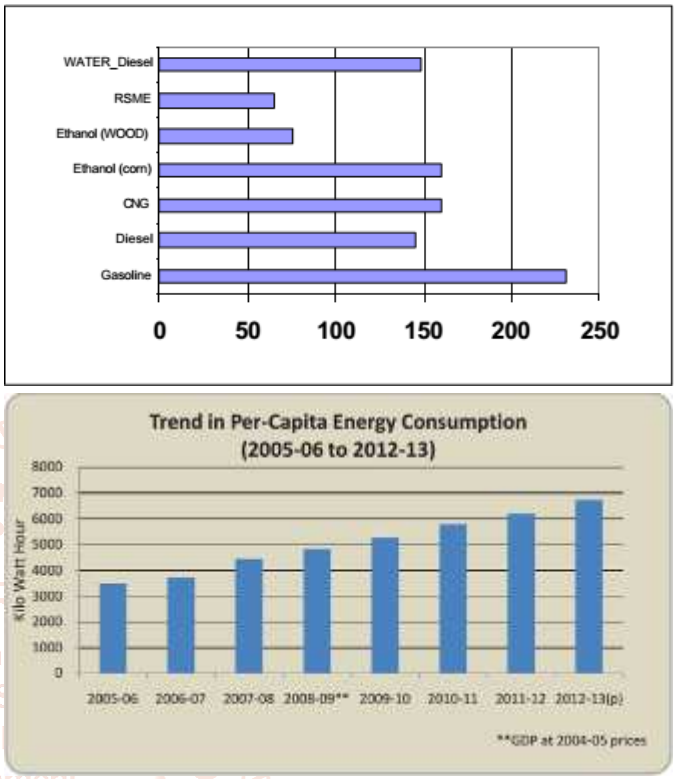

Fig.1.Comparsion between Water-Diesel Emulsified Fuel and Ethanol From Slush.

C. Improved social well-being

A huge part of India's population, mostly in rural areas, does not have access to energy services. The greater use of renewable (mainly biofuels) in rural areas is carefully linked to poverty reductions because greater access to energy services can:

- Increase access to pushed drinking water. Potable water can reduce hunger by allowing for cooked food (95 per cent of food needs cooking).
- Decrease the time spent by women and children on basic survival activities (congregation firewood, fetching water, cooking, etc.).
- Allow lighting which increases security and permits the night time use of educational broadcasting and communication at school and home, and
- Diminish indoor pollution caused by firewood use, together with a reduction in deforestation.

D. Energy security and decreased dependence on oil imports

India ranks third in the world in terms of energy demand and the total consumption of energy from

conventional sources increased from 46,958 petajoules (PJ) during 2011- 12 to 50,741 petajoules (PJ) during 2012-13, showing an raised of 8.06%.Per-capita Energy Consumption (PEC) (the ratio of the estimate of total energy consumption during the year to the estimated mid-year population of that year) rised from 3,497.59 KWh in 2005-06 to 6748.61 KWh in 2012-13, a CAGR of 8.56%(Table 6.2). The annual rise in PEC for 2012-13 over 2011-12 was 8.76%.Fig.2. Trend in Per-Capita Energy Consumptions

India's gross domestic production of crude oil presently satisfies only about 25 per cent of this consumption. Dependence on imported fuels shrubberies many countries vulnerable to possible interruptions in supplies which may result in physical adversities and economic burdens. The volatility of prices of oil poses great risks for the world's economic and political stability, with unusually melodramatic effects on energy-importing developing nations. Renewable energy, including biofuels, can assistance diversifies energy supply and increase energy security.

VII. TRADE INBIOFUELS

The Doha Ministerial Declaration emboldens negotiations on "the reduction or, as appropriate, elimination of tariff or non-tariff barriers to environmental goods and services" (EGS). Biofuels produced from sustainable agricultural practices have many characteristics that qualify them as EGS. They are simply transported and deposited, and thus tradable, they are environmentally desirable and with lower production costs, they compete auspiciously with petrol and petroleum diesel. They will be important in the successful execution of economic development strategies. Modern energy is essential for economic development and poverty alleviation - key elements of the Era Development Goals - particularly when oil prices are suspended around $55 per barrel.

It is becoming progressively evident that ethanol and biodiesel are going to play critical roles in India's energy plans. In malice of the government's plans to produce these biofuels nationally, India may have to trust on foreign imports to meet some of their demands. To found biofuel trade, the infrastructure for biofuel transport, store, blend and allocate biofuel must be created from scratch.

VIII. PURPOSE OF BIODIESELSUMMIT

The month of January 2007-2008observed a landmark event in the Biodiesel Summit: "A Discussion Forum for Biodiesel Stakeholders" headed by IRADe which taken foremost stakeholders and contributors across the country. It provided new intuitions into the Biodiesel Development in India. Presently there are many issues and concerns still to be resolved. Not much advancement has been made to develop and better utilize of available resources to achieve liquid energy. Interfaces among several components of biodiesel system viz. oil seeds production, processing, marketing, economics and end uses need to be conferred for effective formulation of policy and roadmap to get the practical result. Wide ranging contribution of well-known experts led to information allotment, capacity building and awareness creation through this summit. The effort of Biodiesel Summit was to bring together stakeholders active in the biodiesel system to evaluate the potential, to review progress, to find barriers to growth, to promote biodiesel pleasant policies by various organisations and scrutinize prospects in terms of rural employment creation, energy security and climate change mitigation. The purpose of the summit was following:

- To converse the equitable and accessible biodiesel policy.
- To provide technical know-how for marketable cultivation of oilseeds crops and biodiesel treating and handling.
- To confirm energy security and climate change mitigation.
- To establish liaison and linkages among all stakeholders.
- To provide technical know-how for saleable cultivation of oilseeds crops and biodiesel processing.
- To gather views of stakeholders, government legislatures, and other business entity with an objective of concluding "consensus and differences.

IX. CONCLUSION

Internal combustion engines have grown exponentially in terms of design, operating fuel, efficiency, and environmental considerations. Biofuels were the best alternative fuel compared to all fossil fuels due to their excellent thermal and chemical qualities. The CO and HC emissions were dramatically decreased as a consequence of the leaning effect caused by the ethanol addition, as was the substantial quantity of CO2 emissions as a result of the enhanced combustion. The use of oxygen and methyl ester-containing compounds enhanced fuel consumption. Due to the high latent heat of vaporisation of ethanol, ethanol addition resulted in a reduction in NOx emissions. The addition of ethanol and methyl ester to petroleum products raises the octane and cetane numbers. As a result, it allows the internal combustion engine to run at greater compression ratios. The use of mixed biodiesel

increases braking power and torque while decreasing BSFC.

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