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BIO-FUEL: AS AN ALTERNATIVE SOURCE OF ENERGY

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Abstract: Development of Biofuels as an alternative & renewable source of energy in engineering sector. Biofuels like ethanol & biodiesel being environmental friendly will help us to conform to the stricter emission norms. The focus of our presentation is to discuss & deliberate energy.

Conservation via energy audit is an economical efficient & effective technique. Conservation means reduction in energy consumption but without making any sacrifice to quality & quantity of production i.e. sustainable development. The potential viability & details of the National Mission are discussed hereafter.

I. INTRODUCTION

Petroleum products are dominating the economy, as a result of which an immense stress is there. Biofuels an alternate are emerging as an answer to cope-up the stress, also capable of providing immense opportunities and environmental friendly. Petroleum resources are finite and therefore search for alternative is continuing all over the world. Development of bio-fuels as an alternative and renewable source of energy for transportation has become critical in the national effort towards maximum Self-reliance- the corner stone of our energy security strategy. Bio- fuels like ethanol and Bio-diesel will help us to conform to the stricter emission norms. International experience has demonstrated the advantages of using ethanol and methanol as automotive fuel.

High Speed Diesel (HSD) is the main transport fuel hence introduction of bio diesel both as a diesel substitute and for blending with Petroleum diesel is an imperative need. Bio-diesel commands crucial advantages such as technical feasibility of blending in any ratio with petroleum diesel fuel, use of existing storage facility and infrastructure, superiority from the environment and emission reduction angle, its capacity to provide energy security to remote and rural areas and employment generation.

Jatropha curcas provide rich bio mass and nutrients to the soil and check degradation of land -a major problem affecting nearly 65 million hectares of land. Methanol is produced in sugar- mills as a by-product and it can be converted to ethanol. Ethanol can also be produced directly from sugarcane juice. On account of *continuing* glut of sugar in the market, there is a strong case for producing ethanol directly from sugarcane juice.

II. GASOLINE (MOTOR SPIRIT) & ITS SUBSTITUTE – ETHANOL

Problems with gasoline:

There are several problems in using gasoline or motor spirit or petrol which are derived from crude oil. Petroleum reserves are finite. Emissions from engines and particulate matter cause pollution. Gasoline has knocking tendency which limits the compression ratio of the gas engine. TEL is an additive that improves the anti-knocking rating of the fuel dramatically.

Ethanol as an automotive fuel:

The advantages of using ethanol and methanol as automotive fuels are that they are oxygenates containing 35% oxygen and are renewable. They reduce vehicular emission of Hydrocarbons and Carbon Monoxide and eliminate emission of lead, benzene, butadiene etc.

Problems in Using Petroleum Derived HSD:

Like all fossil fuels the use of HSD also makes net addition of Carbon to the atmosphere. In addition, diesel emits particulate matter (PM), specially below micron 2.5 which passes the protection system of the body to get lodged in lungs causing reduction in its vital capacity. In association with the particulate matter the un-burnt oil is carcinogenic. In addition Carbon Monoxide, Hydrocarbon, Sulphur and PAH emissions are on the higher side.

Characteristics of Biodiesel

Bio-diesel is fatty acid ethyl or methyl ester and has properties similar to petroleum diesel fuels. Similar to the HSD, bio diesel is its substitute. The specifications of bio-diesel are such that it can be mixed with any diesel fuel. Cetane number (CN) of the bio-diesel is in the range of 48-60 and the sulphur content is typically less than 15 ppm. Studies conducted with bio-

diesel on engines have shown substantial reduction in Particulate matter (25 – 50%). However, a marginal increase in NO_x (1-6%) is also reported; but it can be taken care of either by optimization of engine parts or by using De-NO_x catalyst. HC and CO emissions were also reported to be lower.

Economics of Biodiesel from *Jatropha curcas*:

The by products of Bio-diesel from *Jatropha* seed are the oil cake and glycerol which have good commercial value. These by-products shall reduce the cost of Biodiesel depending upon the price which these products can fetch. The cost components of Bio-diesel are the price of seed, seed collection and oil extraction, oil trans-esterification, transport of seed and oil. The cost of Bio-Diesel produced by trans-esterification of oil obtained from *Jatropha curcas* seeds will be very close to the cost of seed required to produce the quantity of biodiesel as the cost of extraction of oil and its processing in to biodiesel is recoverable to a great extent from the income of oil cake and glycerol which are by-products.

Engine Development & Modifications

The use of unrefined vegetable oil leads to poor fuel atomization due to high viscosity resulting in poor combustion and also more gum formation in fuel injector, liner etc. The results of emissions of using unrefined vegetable oils were unfavorable and were also accompanied by deposit formation

Gasoline:

These fuels are significantly safer from the view of their impact on environment and health. This has been discussed in detail in the portion dealing with Environmental & Legal Issues.

Storage & handling of Bio-Diesel:

As a general rule blends of bio-diesel and petroleum diesel should be treated like petroleum diesel. Though the flash point of bio-diesel is high, still storage precautions somewhat like that in storing the diesel fuel need to be taken. Based on experience so far, it is recommended that bio-diesel can be stored up to a maximum period of 6 months. Bio-diesel vegetable methyl esters contain no volatile organic compounds that can give rise to poisonous or noxious fumes.

III. BIOETHANOL

Biomass for Bio-ethanol

Ethanol made from cellulose biomass is called bioethanol. A major challenge is developing biocatalysts capable of fermenting lignocellulosic biomass for efficient industrial application. In the coming years it is believed that cellulosic biomass will be the largest source of bioethanol.

Raw materials for making bioethanol

Ethanol producers in the United States produce around 1.5 billion gallons of ethanol each year, mostly derived from corn.

IV. ECONOMICS OF ALCOHOL PRODUCTION

From sugarcane:

A tonne of sugarcane, on an average, would provide 110 kg of fermentable sugar in the juice. If all the sugar juice is fermented directly, the ethanol yield will be 70 litres taking a sugar loss of 2% in spent wash and specific gravity of ethanol as 0.79. The present price of sugarcane as fixed by Centre under the *minimum statutory price* stands at Rs. 695/- per tonne with 8.5% recovery.

Ethanol-gasoline blend:

- a. Performance of engine and corrosion of ethanol gasoline blend at higher ethanol percentage above 10%.
- b. Most conventional vehicles on the road today can use E10 (a 10% ethanol- 90% gasoline blend also known as gasohol) without any special modifications.
- c. Suitable additive for ethanol gasoline blend to be used in two stroke engines. The use of ethanol in specially designed two-cycle engines has been demonstrated on a limited basis.
- d. Aldehyde Emission: Aldehyde emissions from ethanol blends are generally higher than those from gasoline. Formaldehyde, the major constituent in aldehyde emissions, is a suspected carcinogen.

Ethanol production from biomass:

Development of more energy efficient and economical process for fermenting cellulose materials into ethanol.

V. BIO-DIESEL

Introduction

Bio-diesel is fatty acid ethyl or methyl ester made from virgin or used vegetable oils (both edible & non-edible) and animal fats. The main commodity sources for bio-diesel in India can be non-edible oils obtained from plant species such as *Jatropha Curcas* (Ratanjyot), *Pongamia Pinnata* (Karanj), *Calophyllum inophyllum* (Nagchampa), *Hevca brasiliensis* (Rubber) etc.

Bio-Diesel as an option for Energy Security

India ranks sixth in the world in terms of energy demand accounting for 3.5% of world commercial energy demand in 2001. The energy demand is expected to grow at 4.8%. A large part of India's population, mostly in the rural areas, does not have access to it. At 479 kg of oil equivalent the per capita energy consumption is very low

Esters of vegetable oil: they make good biomass fuels as diesel substitutes, provided the following factors receive special attention:

- The yield of transesterified product should be >90%.
- The fuel should be as neutral as possible (pH 6.5-8.0)
- The fuel should be centrifuged at a temperature below the expected ambient operating temperature. Winterization has been suggested as the ideal solution.
- The neutralizing agent should form fuel in soluble salts, free from carbonate groups.
- Ash content should be 0.01%. The fuel should be free from alcohol

VI WORK-DONE IN INDIA

In India, attempts are being made for using non-edible and under-exploited oils for production of esters. The non-traditional seed oils available in the country, which can be exploited for this purpose, are *Madhuca indica*, *Shorea robusta*, *Pongamia glabra*, *Mesua ferra* (Linn), *Mallotus philippines*, *Garcinia indica*, *Jatropha curcas* and *Salvadora*.

Storage of Bio-Diesel:

Pure plant oils are completely harmless to the environment, especially the groundwater. However, esterification of vegetable oil increases its water hazard. As per German EPA classifies waste vegetable oil as a toxic waste

Handling of Bio-Diesel :

As a general rule blends of bio-diesel and petroleum diesel should be treated like petroleum diesel. Bio-diesel vegetable methyl esters contain no volatile organic compounds that can give rise to poisonous or noxious fumes. There is no aromatic hydrocarbon (benzene, toluene, xylene) or chlorinated hydrocarbons.

Engine Development & Modifications

Studies conducted with bio-diesel on engines have shown substantial reduction in Particulate matter (25 – 50%). However, a marginal increase in NO_x (1-6%) is also reported. It may be noted that the marginal increase in NO_x can be taken care of either by optimization of engine parts or by using De-NO_x catalyst. HC and CO emissions were also reported to be lower. Non-regulated emissions like PAH etc were also found to be lower.

Biocatalyst

Conventionally bio-diesel is produced through trans-esterification of oils with a short chain alcohol in the presence of a homogenous catalyst. With this catalyst, water treatment or neutralization is required. New tools/ techniques can be applied using heterogeneous catalysts, which will eliminate the pollution and handling problems. Heterogeneous slurry catalysts are filterable from the oil.

Compatibility with additives

Bio-diesel may have different response with present day additives. There is a need to study in detail the response of different available additives, their dosages on the biodiesel

e.g.

- a) Bio-diesel thickens at low temperature so it needs cold flow improver additives with acceptable CFPP
- b) Pour point depressants commonly used for diesel may not work for biodiesel.
- c) Poor oxidation stability of bio-diesel may require increased amount of stabilizer

Stability of Bio diesel

Bio-diesel ages more quickly than fossil diesel fuel due to the chemical structure of fatty acid esters present in bio-diesel. There are three types of stability criteria, which need to be studied:

(a) Oxidation stability (b) Thermal Stability and (c) Storage Stability

Engine Performance

No or very little data on effect of bio-diesel from *Jatropha and Karanj Oil* on emission and engine performance using various proportion of bio-diesel is available. This needs validation on test engine beds. Apart from the study on engine performance on different capacities of engines/ vehicles the following aspects need to be studied further

Properties of Bio-diesel :

A general understanding of the various properties of bio-diesel is essential to study their implications in engine use, storage, handling and safety

- a. **Density/ Specific Gravity**
- b. **Cetane Number:**
- c. **Viscosity:**
- d. **Distillation characteristics etc**

VII ENVIRONMENTAL & LEGAL ISSUES

Effects on environment and human health - Biodiesel:

Biodiesel (mono alkyl esters) is a cleaner-burning diesel fuel made from renewable sources such as vegetable oils. Just like petroleum diesel, biodiesel operates in combustion-ignition engines.

Toxicity issues:

Biodiesel does not present any problems of toxicity as discussed below:

- Biodiesel is non-toxic. The acute oral LD50 (lethal dose) is greater than 17.4- g/Kg-body weight.
- Very mild human skin irritation. It is less than the irritation produced by 4% soap and water solution.
- It is bio-degradable.
- There is no tendency for the mutagenicity of exhaust gas to increase for a vehicle running on biodiesel (20%RSME80% diesel).

VIII. CONCLUSIONS AND RECOMMENDATIONS

Background:

It is clear by now that for us blending of Bio-diesel produced from non-edible vegetable oil with conventional diesel i.e. H.S.D. is unavoidable to achieve the objectives of emission standards, regeneration of degraded lands, poverty alleviation, employment generation, better use of natural resources etc. A National Mission is, therefore, proposed to be launched. The potential, viability and details of the National Mission are discussed hereafter

The envisaged bio fuels programme is based on several compulsions and imperatives each strengthening the case for bio fuels. Some of these are:

- the impending international oil crisis;
- the growth momentum generated since the 1990s causing a steady spurt in oil demand for transport;
- domestic crude oil output reaching a plateau and hence the need to reduce dependence on imported crude oil; reduction of Carbon Dioxide emissions.

These imperatives and the estimates of incremental demand of diesel and motor spirit in 2006-7 and 2011 suggest that a programme to produce biofuels which are transport fuel substitutes and blend them - ethanol with motor spirit and Biodiesel with HSD - must be started right now to create necessary plantation base and infrastructure which takes time.

Ethanol – its Prospects:

The advantages of using ethanol and methanol as blends in motor spirit are that they are oxygenates containing 35% oxygen and renewable. They reduce vehicular emission of Hydrocarbons and Carbon Monoxide and eliminate emission of lead, benzene, butadiene etc. availability of molasses being far in excess of quantity needed for producing and meeting domestic demand of industrial and potable Alcohol. Under the present demand and supply of ethanol, 7% blend of ethanol is a feasible objective if the facility to dehydrate ethanol at our distilleries is created and restriction on movement of molasses and putting up ethanol manufacturing plants removed. Measures, as mentioned below, may also need to be considered:

Bio diesel:

Since diesel constitutes 50% of oil consumption chiefly for transportation and other purposes, its demand is integrally related to economic growth and is seen as a growth inducing factor. The estimated increase of demand for diesel from the 2001-02 level of 38.815 Million MT to 52.324 Million MT in 2006-7 and 66.095 Million MT shows a massive hike of 34% to 70% respectively over 2001-02 level in physical terms which will lead to increase of crude oil import from the present level of 85 Million MT

***Jatropha Curcas* – Source of Biodiesel:**

There are many tree species which bear seeds rich in oil. Of these some promising tree species have been evaluated and it has been found that there are a number of them such as *Jatropha curcas* and *Pongamia Pinnata* ('Honge' or 'Karanja') which would be very suitable in our conditions.

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