

“Bio-DIESEL as avant-garde FUEL for INDIA”

Dr. Dharmendra C. Kothari^{#1}, Dr. Jayant P. Kaware (Principal)^{*2}, Prof. I. D. Patil, (HOD & Convener)^{#3}

^{#1}Department of Chemical Engineering & Technology, Shri Shivaji Education Society's CE &T, Akola, - 444 104, M.S., India.

^{*2}Bhonsla College of Engineering & Research, Hingna Barlinga, Washim Highway, Akola, - 444 608, M.S., India.

^{#3}Department of Biotechnology & Bioengineering, Shram Sadhana Bombay Trust's COE&T, Bambhori, Post Box No. 94, JALGAON – 425001, Maharashtra, India.

Abstract: - Public policies, current events; scientific and engineering advancements are dependent on economics, management, and legislations; apparently, they are closely intertwined. Legislative efforts can make technological advancement more economical while the industry develops (i.e. temporary biodiesel road tax exemption). Alternative fuels and energy sources are an issue of increasing importance; not only among the scientific and engineering community, but also in economics and global public policies. It can also demonstrate to engineers, technocrats and to entrepreneurs that chemical science is not independent of economics, and advancements in science can yield considerable benefit to the general public. This research covers the production of biodiesel from any kind of vegetable oil, animal fat or lipidic residues. It also addresses processing and comparison to petro-diesel issues associated with making biodiesel fuel, which is a clean, renewable fuel that can be made from various biomass, oil feedstocks such as waste vegetable oil, yellow grease, animal fats, and virgin vegetable oils.

Keywords- Sustainability, Biodiesel, Renewable Energy, Transesterification, Oils.

I. INTRODUCTION

A number of factors play into any fuel's cost, both in economic and environmental terms, and biofuel doesn't always come out as the most avant-grade option. True, a plant-based fuel comes from a renewable source, while fossil fuels will eventually run out. In 2000, biodiesel became the only alternative fuel in the country to have successfully completed the EPA (Environmental Protection Agency) required Tier I and Tier II health effects testing under the Clean Air Act⁽¹⁾. These independent tests conclusively demonstrated biodiesel's significant reduction of virtually all regulated emissions, and showed biodiesel does not pose a threat to human health. **Biofuels** like biodiesel and SVO (Straight Vegetable Oil) and simply means vegetable oils. Soybean oil, corn oil, canola (an edible variety of rapeseed) oil, cottonseed oil, mustard oil, palm oil, sunflower oil, linseed oil, Jatropha oil, and restaurant waste oils such as frying oils. **Biodiesel** is a renewable fuel, composed by fatty acid methyl (or ethyl) esters, produced by a

transesterification reaction between vegetable oil or animal fats and methanol (or ethanol)⁽²⁾.

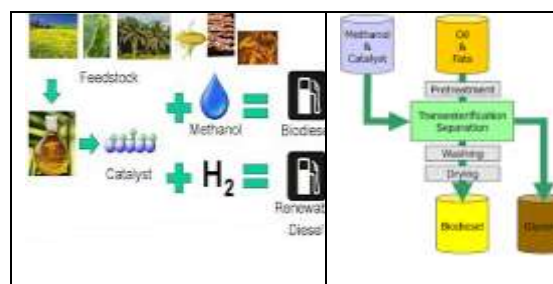


Fig. 1; Biodiesel flow process diagram.

Biodiesel is a renewable fuel that can also be produced in any climate using already developed agricultural and chemical processing practices. The Fig. 1 represent the biodiesel is as a liquid fuel, technically known as a mono alkyl ester, made from fats or oils and alcohols with glycerin as a byproduct.

II. LITERATURE REVIEW

The use of vegetable oils in diesel engines is nearly as old as the diesel engine itself. The inventor of the diesel engine, Rudolf Diesel, reportedly used groundnut (peanut) oil as a fuel for demonstration purposes in 1900⁽⁹⁾. Some other work was carried out on the use of vegetable oils in diesel engines in 1930's and 1940's⁽⁸⁾.

Table [1]: Comparative Studies of Biodiesel as a fuel.

	Die sel	C N G	L N G	Meth anol	Alc ohol	BIOD IEEL
Vehicle Cost	10	5	5	5	5	10
Infrastr ucture	10	2	5	5	5	10
Safety	7	4	3	1	3	8
Operati ng Range	10	5	10	10	10	10
Reliabil ity	10	7	5	3	3	10
Custom er	5	8	8	8	9	8

Acceptance						
Funding Assistance	1	10	2	0	2	2
Training Cost	10	5	5	5	5	6
Fuel availability	10	10	5	5	5	6
Fuel Quality	9	5	10	8	8	9
Fuel Price Stability	6	8	8	6	6	6
TOTAL	98	74	73	61	66	96

Biodiesel contains virtually no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. The overall comparison and finding with respect to other fuels are represented in Table [1]⁽¹¹⁾.

At the same time, India is one of the largest importers of edible oil. *Where do we find the oil for biodiesel?* A sustainable source of vegetable oil is to be found before we can think of biodiesel. *Jatropha (Jatropha curcas, Ratanjot, wild castor)* thrives on any type of soil; needs minimal inputs or management, has no insect pests, not browsed by cattle or sheep, can survive long periods of drought, propagation is easy, rapid growth; forms a thick live hedge after only 9 months of planting. Yield from the 3rd year onwards and continues for 25-30 years, yield from established plantations in Brazil, 1.5 to 2.3 tons per hectare and 25% oil from seeds by expelling; 30% by solvent extraction. The meal after extraction an excellent organic manure (38% protein)⁽⁷⁾.

Table [2]:- Data showing initiatives towards biodiesel production in INDIA.

Year	Diesel Demand MMT	Bio-Diesel @5% MMT	Area for 5% Mha	Bio-Diesel @10% MMT	Area for 10% MMT
2006-07	52.33	2.62	2.19	5.23	4.38
2011-12	66.90	3.35	2.79	6.69	5.58
2012-15	80.00	4.00	4.88	8.00	9.60

According to the National Mission on Bio Fuels out of 197 million hectares, 13.4 MH are made available for *Jatropha* plantation. The table [2] showing data of government of INDIA's initiatives towards biodiesel

production. Biodiesel from *Jatropha*; 1million hectares of waste land is brought under *Jatropha* cultivation, can yield 0.8-1 million tons of oil, For 66.9 MMT diesel 13 MMT bio diesel for 20%⁽¹²⁾.

III.RAW MATERIALS AND METHODS

The easiest oils to use for biodiesel are neutral vegetable oils like canola, corn, and sunflower oil; these oils are readily available at grocery stores and have a low melting point, which means they won't solidify if they get too cold. However, avoid using peanut oil, coconut oil, palm oil, tallow, and lard all contains more acids than in the recommended neutral oils. These extra acids can interfere with the reactions that take place to create the biodiesel. These sources of oil solidify at relatively high temperatures. Biodiesel usually has a lower melting point than the oil solidify at relatively high temperatures. It is also possible to use waste vegetable oil which has been used for cooking. Apparently, waste oil should be filtered to remove particulates; then allowed to settle for 24 hours to separate the oil from any water or other impurities. Pure oil will be clear and bright, with no sediment, as shown in Figure [2] with its synthesis representation and the attachments of CARBONS⁽³⁾.

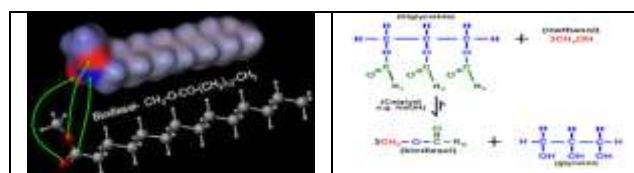


Fig. 2 Synthesis representation of Biodiesel.

WASHING of BIODIESEL; Although the glycerine or “soap” and water have separated from biodiesel, it would still be washed. Please do not violently shake unwashed biodiesel as it will form an emulsion that may take days or even weeks to fully separate. The gentle approach is what's we needed.

Wash One: Pour 1 litre biodiesel into a clean and dry plastic bottle. Gently pour in 500ml water (body temp). Replace bottle top. Now **GENTLY rotate** the bottle end for end for about 30 seconds.

Wash Two: Pour in another 500ml water and repeat wash one, except **rotate GENTLY** for about 1 minute. Drain as in wash one. You have finished wash 2.

Wash Three: Again pour in another 500ml water and **GENTLY** shake bottle for a minute or so. When water and biodiesel separated, discard water in same fashion as before.

Wash Four: 500ml water and a bit more agitation for about 1 min. After separation of water and biodiesel drain as above.

Wash Five: You should now be able shake fairly vigorously. The complete separation could be clearly visualized by Fig. 3, as two layers of biodiesel and glycerine and then clear biodiesel.



Fig.3:- Glycerin & dirty Vs washed biodiesel.

Modern plants of biodiesel (B100) yields 3.2 units of fuel product energy for every 1 unit of fossil energy consumed in its life cycle. The production of B20 yields 0.98 units of fuel product energy for every unit of fossil energy consumed. Substituting 100% biodiesel (B100) for petroleum diesel in buses reduces the life cycle consumption of petroleum by 95%. This benefit is proportionate with the blend level of biodiesel used. The developments of the modern diesel plants⁽⁴⁾ for small, medium and large production are shown in Fig.4.

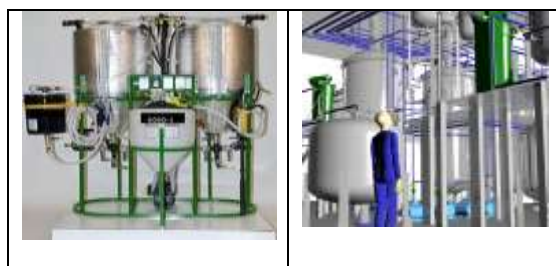


Fig.4; Different designs of plants for production of biodiesel.

IV. RESULTS AND DISCUSSIONS

The washed biodiesel would be VERY CLOUDY and much lighter in colour than the unwashed biodiesel. After a day or two settling and drying it would be clear then dry the Biodiesel. We must remove all that water from biodiesel before using it in a diesel engine or risk damaging the engine. The oldest method of drying is settling. Transesterification; catalysed based transesterification is best of all methods, 90% of all bio diesel made by this method, at low temperature⁽⁵⁾.

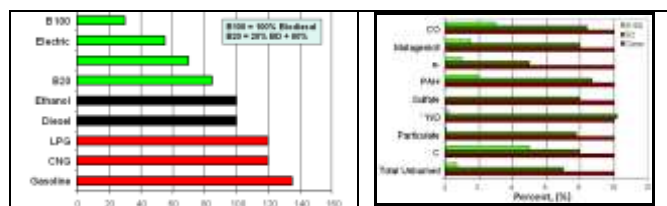


Fig.5. Comparison of FUELS with Biodiesel, (B100 i.e.100%).

For best conversion FFA (Free Fatty Acids) should be lower than 0.8%. Troubleshooting in high FFA containing oils; Formation of soap, Reduction in catalyst efficiency, Separation process would be difficult, with Low yield of Ester (Bio diesel). Therefore, two stage method should be used; for the esterification of FFA with mineral acid, and transesterification with lye⁽²⁾. Common catalysts for transesterification include sodium hydroxide,

potassium hydroxide, and sodium methoxide. Developing a strong market for bio diesel would have tremendous economic benefits. The investments in biodiesel technology may ensure that we have transportation fuel options and we will not be so vulnerable. The fig 5 represent the biodiesel 100%’s comparison with all other available fuel.



Fig.6 Biodiesel converted to 3rd generation Bio-fuel for different modes.

Applications; diesel vehicle industry having the wide acceptances around the world, apparently some of few famous names are; Audi, BMW, Case, Deutz, Iseki, John-Deere, Kubota, Massey-Ferguson, Mercedes-Benz, Nissan, Renault, Same, Seat, Skoda, Volkswagen, & Volvo.etc⁽⁷⁾. By the fuel trade; e.g, Texaco, Shell, Total. By the end-user bus companies, taxi fleets, forestry enterprises, boat owners. More than 100 production sites (capacity 500-120,000 tons/annum)⁽¹⁰⁾.

The fig 6 showing the final point of sale to the customers and showing the different types of transportations applications of the bio-diesel engines with feeding pumps and metering systems. Here we are also comparing various feed-stocks for diesel for the production in MT (Metric Tons). Apparently it is shown in Table [3 & 4] for biodiesel feed stock and ignition and emission engine respectively for various countries⁽⁶⁾.

Table [3] Comparison of various feed-stock for Biodiesel.

Country	Feedstock for Biodiesel	Price of Feedstock in \$/MT	Processing Cost in \$/MT	Total Cost in \$/MT
		1	2	3 = (1 + 2)
USA	Soyabean Oil	560	500	1,060
Europe	Rapeseed Oil	590	500	1,090
	Sunflower	565	500	1,065
India	Jatropha Oil	770	250	1,020

Table[4]:- Compression Ignition and emission engine.

Emission Component	B100	B20	Bio Diesel Standard for SAFETY	
Unburned Hydrocarbons	- 67%	- 20%	Distillation Temp, atm. equiv. Temp.	360°C
Carbon Monoxide	- 48%	- 12%	Phosphorus Content	0.001 % mass
Particulate Matter	- 47%	- 12%	Total Glycerin	0.240 % mass
NOx	+ 10	+ 2	Acid Number	0.80m gKOH/g

The fig. 7 representing the comparison of technologies of different types of engine's economic versus environmental aspects CO₂ emission through exhaust with compared to all types of available fuels.

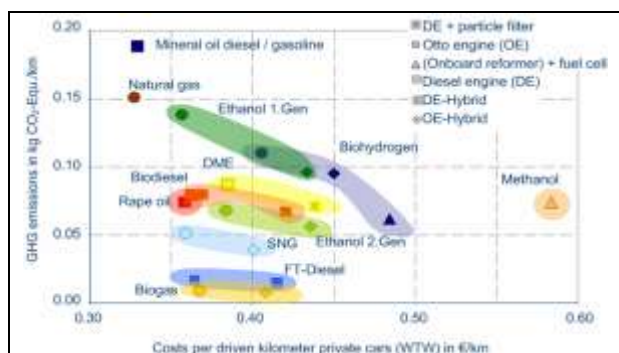


Fig. 7:- Comparison of Economic versus Environmental aspects⁽⁸⁾

V. CONCLUSIONS

Biodiesel is intended to be used as a replacement for petroleum diesel fuel, or could be blended with petroleum diesel fuel in any proportion. Biodiesel does not require modifications to a diesel engine to be used. Biodiesel has reduced exhaust emissions compared to petroleum diesel fuel. Biodiesel has lower toxicity compared to petroleum diesel fuel. Biodiesel is safer to handle compared to petroleum diesel fuel.

Biodiesel quality is governed by ASTM D 6751 quality parameters. Biodiesel is biodegradable. Biodiesel must be produced from naturally occurring fats and oils using transesterification. It has been observed the excellent transesterification if we use pure and virgin oils. Biodiesel is a cleaner burning replacement fuel made from renewable sources like new and used vegetable oils and animal fats.

Low-level blends (≤20% biodiesel) can be used in almost any existing diesel engine. High-level blends (>20% can be used in most new diesel engines.

VI. RECOMMENDATIONS

A avant-grade source of vegetable oil is to be found before we can think of biodiesel. *Jatropha* is a genus of approximately 175 shrubs, a plant tree from the family of *Euphorbioceae*. *Jatropha* (*Jatropha curcas*, Ratanjyot, wild castor) thrives on any type of soil; needs minimal inputs or management, has no insect pests, not browsed by cattle or sheep, can survive long periods of drought, propagation is easy, rapid growth; forms a thick live hedge after only 9 months of planting. Yield from the 3rd year onwards and continues for 25-30 years, yield from established plantations in Brazil, 1.5 to 2.3 tons per hectare and 25% oil from seeds by expelling; 30% by solvent extraction.

Table [5] Cost of Bio Diesel Production in India.

	Rate (Rs. Kg)	Quantity (Kg)	Cost (Rs.)
Seed	5.00	3.28	16.40
Cost of collection & oil extraction	2.36	1.05	2.48
Less cake produced	1.00	2.23	-2.23
Trans-esterification cost	6.67	1.00	6.67
* Less cost of glycerol produced	*40 to 60.00	0.095	-*3.8 to - 5.70
Cost of Bio-Diesel per Kg			19.52-17.62
Cost of Bio Diesel per lit. (SP. Gravity 0.85)			16.59-14.98

Various State Governments have taken initiatives for *Jatropha* plantation in INDIA. Government allowed, the land being offered to private entrepreneur, action initiated to allot 70000 hectare land on lease to private entrepreneur, research & development a 'National Network on *Jatropha* the objectives was set up selection of superior planning material.

The Table [5] showing the cost of biodiesel production in India as per Planning Commission's report⁽¹²⁾. Key Factors of Production; Feed stock cost, Yield, Conversion cost, Product quality, Bio-diesel & Glycerin sale price, Energy cost and Investment. The price of glycerol is likely to be depressed with processing of such large quantities of oil and consequent production of glycerol. However, new applications are likely to be found creating additional demand and stabilizing its price.

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