Biodiesel Production in Mauritius

Prepared by:
Roopchund Jashvir, July 06

FOR ECOFUEL LTD

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Presentation Overview

- What is Biodiesel?
- The Biodiesel Reaction
- Biodiesel Process Technology
- Justification for producing and using biodiesel
- Main feedstock, Reactants, Products
- Advantages and Drawbacks of Biodiesel
- Emissions of Biodiesel as compared to Conventional Diesel oil
- Biodiesel Use, Handling and Transport
- Economic Feasibility
- Quality Restrictions on B100
- Conclusion

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What is biodiesel?

- Definition:

  Biodiesel consists of the alkyl monoesters of fatty acids derived from vegetable oils or animal fats. The oil and fats are composed of triglyceride molecules.

- Pure biodiesel is referred to as B100.

- Clean, biodegradable non-toxic naturally oxygenated, carbon neutral fuel, since (no sulphur, no aromatics, built in oxygen)

- substitute or an additive to diesel fuel

  It is renewable alternative domestically produced energy source that can be used in diesel engines with little or no modifications.

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The Biodiesel Reaction

- produced in conformity to EN14214 through transesterification reaction between methanol (or ethanol) and an oil or fat (triglyceride) in the presence of a catalyst (NaOH, KOH, $NaOCH_3$).

- There are three steps involved in the transesterification of vegetable or triglyceride (TG) oil into methyl esters (ME) with the formation of intermediates diglyceride (DG) and monoglyceride (MG) resulting in the production of 3 moles of ester and 1 mole of glycerol.

  The stepwise reaction is:

$$TG + ROH \leftrightarrows DG + R'CO_2R \text{ ----------[1]}$$

$$DG + ROH \leftrightarrows MG + R'CO_2R \text{ ----------[2]}$$

$$MG + ROH \leftrightarrows GL + R'CO_2R \text{ ----------[3]}$$

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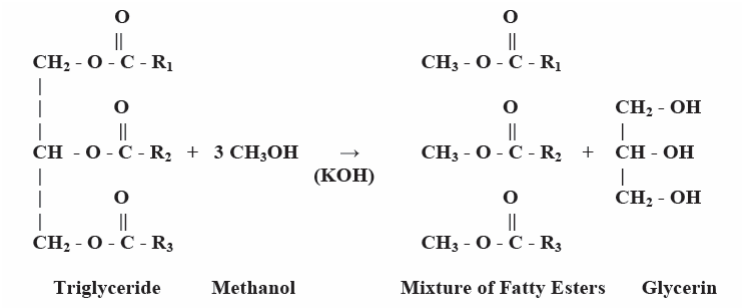
Standard Recipe

100 lb Oil + 21.71 lb Methanol →

100.45 lb Biodiesel + 10.40 lb Glycerol + 10.86 lb Excess Methanol



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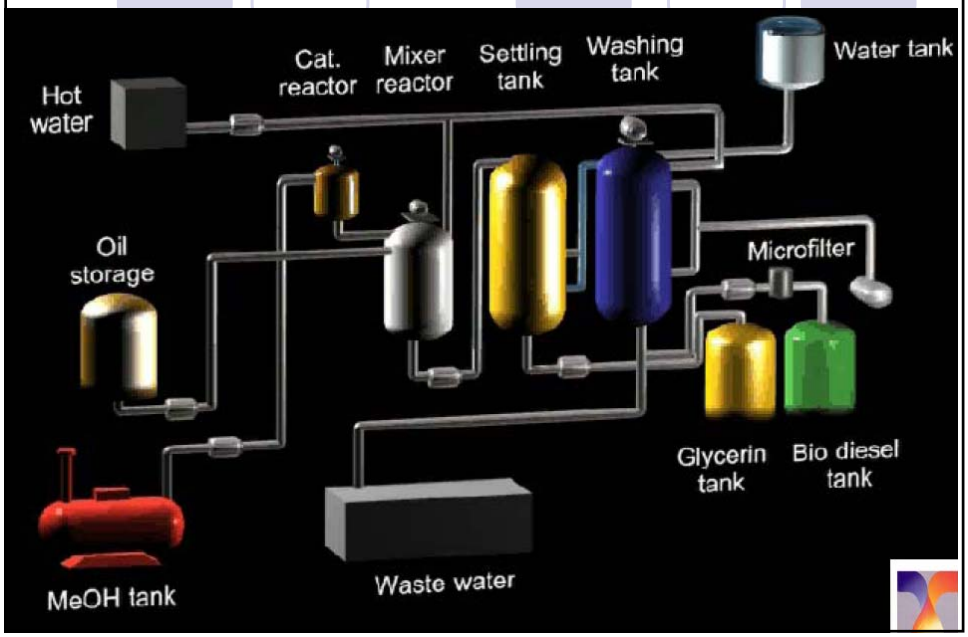
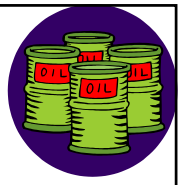
BIODIESEL PROCESS TECHNOLOGY



Justification for Producing and Using Biodiesel



- Light Crude oil ++ US $70 per barrel
- Import ++ 322,000 MT of diesel oil and 277,000 MT of fuel oil annually.
- Reduce dependence of Petroleum Products and thus trade deficit
- renewable energy sources in line with KYOTO protocol
- Increasing concern over global warming as a result of Greenhouse gases emissions.
- Generates employment opportunities for rural masses thereby providing them livelihood support. Plantation of oil yielding plants such as Jatropha Curcas for bio-diesel will result in greening of waste and fallow lands.
- Eco-restoration, drought proofing and environmental security.

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Environmental Problems

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CO_2 curve?

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Main Feedstocks, Reactants and Products

- Bio-diesel from virgin or used vegetable oils (both edible and non-edible), used restaurant frying oil. Sunflower and Rapeseed is the raw material used in Europe whereas Soyabean is used in USA.
- Vegetable oil available as crude oil or semi-refined oil. The crude vegetable oil will need to be degummed, refined and filtered. Used restaurant oil frying on the other hand will need to undergo passive and active filtration before transesterification.
- blended in any ratio with petroleum diesel fuel. Worldwide trend is to initiate the programme with 2-5% blending and increase it to 20% and thereafter 100% in a phased manner. Blending target of EU is 5.75 % by 2010 and 20% by 2020. Technology offered by Italy (Novamont, Ballestra), France (IFP), Germany (Lurgi), Austria (Energea), UK (D1 Oils)

Feedstock	Iodine Number (g/100g)	Melting Point °C
Soybean oil	125-140	-12
Sunflower oil	125-135	-18
Rapeseed oil	97-115	5
Jatropha curcas oil (Pignon d'Inde)	96-105	8 – 10
Palm oil	44-58	30 – 38

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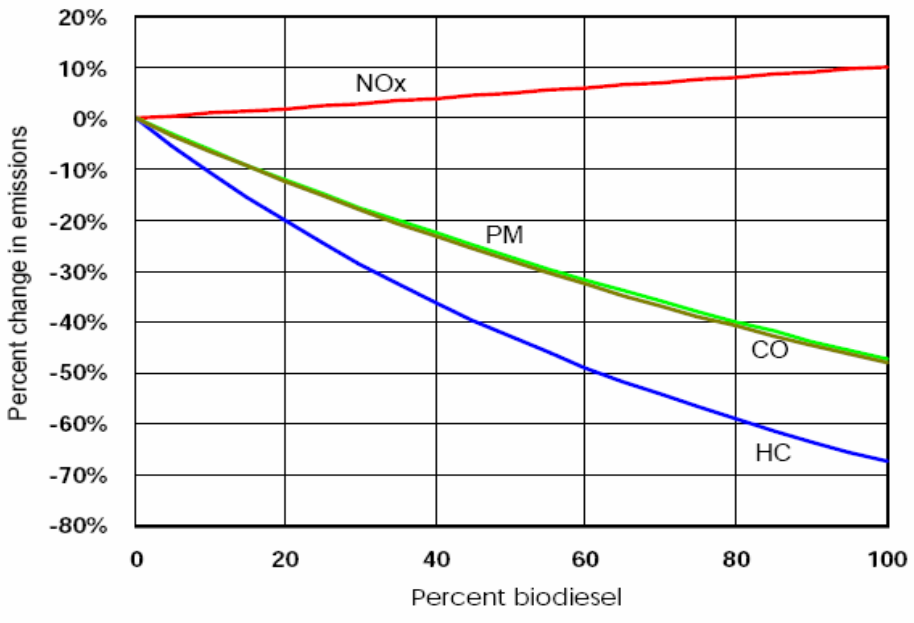

Non Edible Vegetable Oils

Possible raw materials for biodiesel

Ratanjyot	Jatropha curcas
Karanja	Pongamia glabra
Mahua	Madhuca indica
Pilu	Salvadora oleoides
Sal	Shorea robusta
Nahor	Mesua ferra linn
Kamala	Mallotus phillipines
Kokam	Garcinia indica
Rubber Seed	Hevea Brasilensis

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Samples of used edible oil being processed

Sample	Description
1	Waste vegetable oil sample (used French fry oil).
2	Sample showing the biodiesel separated from the bottom darker layer of glycerin.
3	Biodiesel byproduct (glycerin), that can be used to make soap and is both biodegradable and compostable.
4	Sample showing effect of excess Sodium hydroxide (Lye) on waste vegetable oil.
5	Sample showing water wash, which separates the biodiesel from materials that did not process out of the reaction.
6	100% biodiesel, 0% petroleum (B100).

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Jatropha Curcas for Bio-Diesel - Why ?

	Jatropha Curcas	Pongamia Pinnata
Maturity -fruiting	3-4 years	7 years
Plants/hectare	2500	156 – 200
Seed/tree	2 Kg avg (1 – 4 Kg)	15 Kg avg (10–20 Kg)
Seed yield /hectare	5000 Kg	3500 Kg
Oil yield/hectare	1750 Kg (30-40%)	1075 Kg (25-30%)
Tree height	2 Metre	10 Metre
Fruit Shell	Too thin (easy de-shelling)	Too thick (de-shelling difficult)
Physico-chemical characteristics :		
Sp. Gravity (15 deg C)	0.918 – 0.923	0.925 – 0.940
Flash Point	191 deg C	134 deg C
Cetane Index	57 - 62	56.2
Sulphur %	0.014	0.02
FFA %	5.8 – 7.5	8.3

Source : NBRI, Lucknow

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	Methylester			
Property	Palm oil	Soybean	Rapeseed	Jatropha curcas
Specific gravity ASTM D1298	0.87@23.6°C	0.87	0.88	0.81
Sulphur content (%wt) IP 242	<0.04			
Viscosity mPa-s at 20oC		3.6	3.6	2.6-4.1
Viscosity at 40°C (cst), ASTM D445	4.5			
Pour point (°C) ASTM D97	16.0	-3	-15	-23
Cetane Index ASTM D976	50	52	62	40-55
Gross heat of combustion (kJ/kg) ASTM D93	40.135	32	37	35-37
Flash point (°C) ASTM D93	174	-	179	74
Conradson carbon residue (%wt) ASTM D189	0.02			
Carbon (% wt)		78	81	84-87
Hydrogen (%wt)		11	12	13-16
Oxygen		11	7	0

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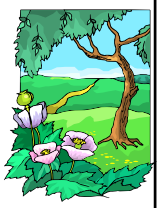
Jatropha curcas seeds :

- The meal: feedstock for ethanol production or cogeneration
- Oil: feedstock for biodiesel production.

Plant oils are harmless to the environment, especially the groundwater.

However, esterification of vegetable oil increases its water hazard.

In the case of a spill, biodiesel is a fairly environmentally benign chemical that is fully biodegradable.



Conversely, petroleum diesel releases into the environmental are a serious threat to the ecosystems receiving these chemicals because many of the components of petroleum diesel are carcinogenic and persistent.

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Two major environmental issues:

- Occupational Health Welfare and Safety concerns
- The handling/storage of class A flammable liquids (methanol)

The main risks: spillage of hazardous substances or products.

B100 spillages would pose little threat to the marine environment and any impacts to groundwater would be minor and temporary.

Chemical spills would affect human health and safety.

To mitigate Occupation Health and Safety impacts, emergency response strategy in case of spill.

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Advantages and Drawbacks of Biodiesel

- Lower emissions (Example: DDC Series 50)
- Requires no engine modifications (except replacing some fuel lines on older engines).
- Can be blended in any proportion with petroleum diesel fuel.
- High cetane number and excellent lubricity; high flashpoint
- Can be made from waste restaurant oils and animal fats.

- Lower energy content – 8 to 12%
- Power drop.

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Emissions of Biodiesel as compared to Conventional Diesel oil

Emissions	*B100*	*B20*
Total Unburned Hydrocarbons	-93%	-30%
Carbon Monoxide	-50%	-20%
Particulate Matter	-30%	-22%
NOx	+13%	+2%
Sulphates	-100%	-20%
Polycyclic Aromatic Hydrocarbons (PAH)	-80%	-13%
NPAH (Nitrated PAHs)	-90%	-50%
Ozone Potential of Speciated HC	-50%	-10%
Carbon Dioxide (LCA)	-80%	
Sulphur Dioxide (LCA)	-100%	

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Biodiesel Use, Handling And Storage

B100 can be used directly without any modification as vehicular fuel.

Natural rubber, fittings, seals and composite material of the fuel system, susceptible to slow degradation with biodiesel;

Replacement with synthetic parts (Teflon, Viton and Nylon).

A mild solvent and will scrub out all the tars, varnishes, and gums left by fossil diesel in your fuel system.

superior lubricity in the machines, increase functional engine efficiency and reduces toxic and particulate matter emissions.

Very low temperature increases the viscosity of B100 and may cause it to gel; additives will be used for low temperature storage and pumping of biodiesel.

The biodiesel and its blends will be stored at temperatures at least higher by 15^{o}C that the pour point of the fuel.

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With a high flash point, B100 will be stored in clean, dry and approved stainless steel tank, built as per American Petroleum Institute tank construction standard.

B100 and its blends are susceptible to microbial degradation, require biocide.

For long term storage of B100 (> 6 month), a small conc of synthetic anti-oxidants will be added to the biofuels to minimize stability changes.

Biodiesel will be splash blended with conventional diesel oil using procedures that do not allow the temperature of B100 to drop below the cloud point.

Biodiesel is biologically active and biodegrades rapidly when compared with mineral diesel

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Economic Feasibility

Biodiesel Production capacity	Equipment cost, US $
800 LPD	15,320
1200LPD	18450
1600 LPD	21,500
2000 LPD	24,200
50,000 gallons per year	55,000
300,000 gallons per year	170,000
1000 LPH	1,360,000
3000 LPH	2,900,000

The relative cost distribution for biodiesel production is as follows: 1% Labour, 3% depreciation, 1% Overhead and Maintenance, 1% Energy, 10% Catalyst and 84% feedstock.

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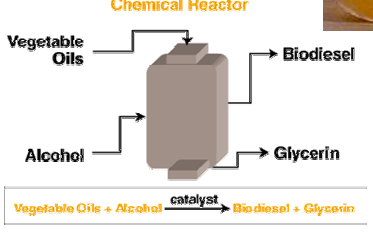
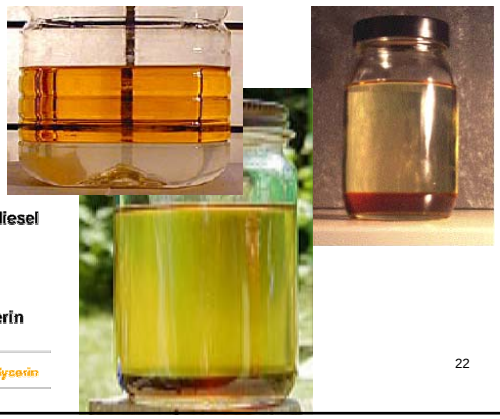
Conclusion

- Biodiesel represents the future, but issues such as mandated biodiesel blends, tax and incentive to encourage local entrepreneurs in investing investment in biodiesel production capacity remains to be addressed.
- Biodiesel production is open to anyone. The technology and instructions on the biodiesel process is accessible.

WHERE ARE THE CONSTRAINTS ????





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