ASSIGNMENT 2
ESSENTIAL BIODIESEL PROPERTIES FOR USE IN RAILWAY DIESEL LOCOMOTIVES

GROUP - 3

GROUP MEMBERS

AVVARU BADRI VISAAL 19CH10013

AWAIS AKHTAR 19CH10014

DEVESH GOBIND 19CH10015

DIPJOY BASAK 19CH10016

JYOTIRADITYA 19CH10017

WHAT IS BIODIESEL?

Biodiesel is a potentially low-carbon, renewable alternative fuel to diesel, sharing similar chemical and physical properties.
Unlike the vegetable and waste oils used to fuel converted diesel engines, Biodiesel is a drop-in biofuel, which is compatible with existing diesel engines and distribution infrastructure.

HISTORICAL BACKGROUND

Biodiesel was invented in 1890 by Rudolph Diesel himself, wherein pure vegetable oils were utilised by agricultural diesel engines that did not include oil diesel. However, research done in Belgium in the 1930s is converting vegetable oils into molecules referred to as fatty acid esters. This is because in many nations in the 1920s and 1930s and later in World War II, interest in vegetable oils as fuels for internal combustion engines was noted despite the broad usage of oil-derived diesel fuels.

Belgium, France, Italy, the United Kingdom, Portugal, Germany, Brazil, Argentina, Japan and China were reported to have tested and used vegetable oils as diesel fuels. Biodiesel is the trade name of fatty acid methyl esters.

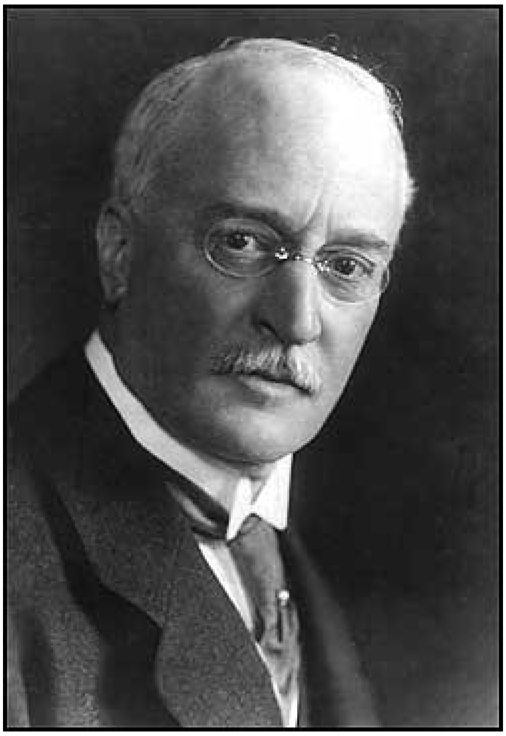


FIG. 2.0. RUDOLPH DIESEL

WHY BIODIESEL?

Biodiesel is used in diesel engines and is produced from high oil content crops such as sunflowers and rapeseed, waste vegetable oils such as cooking oil and animal fats such as tallow.

The first benefit of Biodiesel is that it is renewable and energy-efficient. It displaces petroleum-derived diesel fuel. Hence, it reduces global warming gas emissions. Furthermore, it is non-toxic, biodegradable and suitable for sensitive surroundings.

The main benefit of Biodiesel is that it can be described as 'carbon neutral. This basically means that the fuel produces no net output of carbon in the form of CO2.

This effect occurs because when the oil crop grows, it absorbs the same amount of CO2 released when the fuel is combusted.

Another composition feature of Biodiesel is that the Sulphur content is significantly less in it. The reason for it could be that it is majorly produced domestically from agricultural or recycled resources.
Using Biodiesel reduces life cycle emissions because the carbon dioxide released from biodiesel combustion is offset by the carbon dioxide absorbed from growing soybeans or other feedstocks used to produce the fuel.

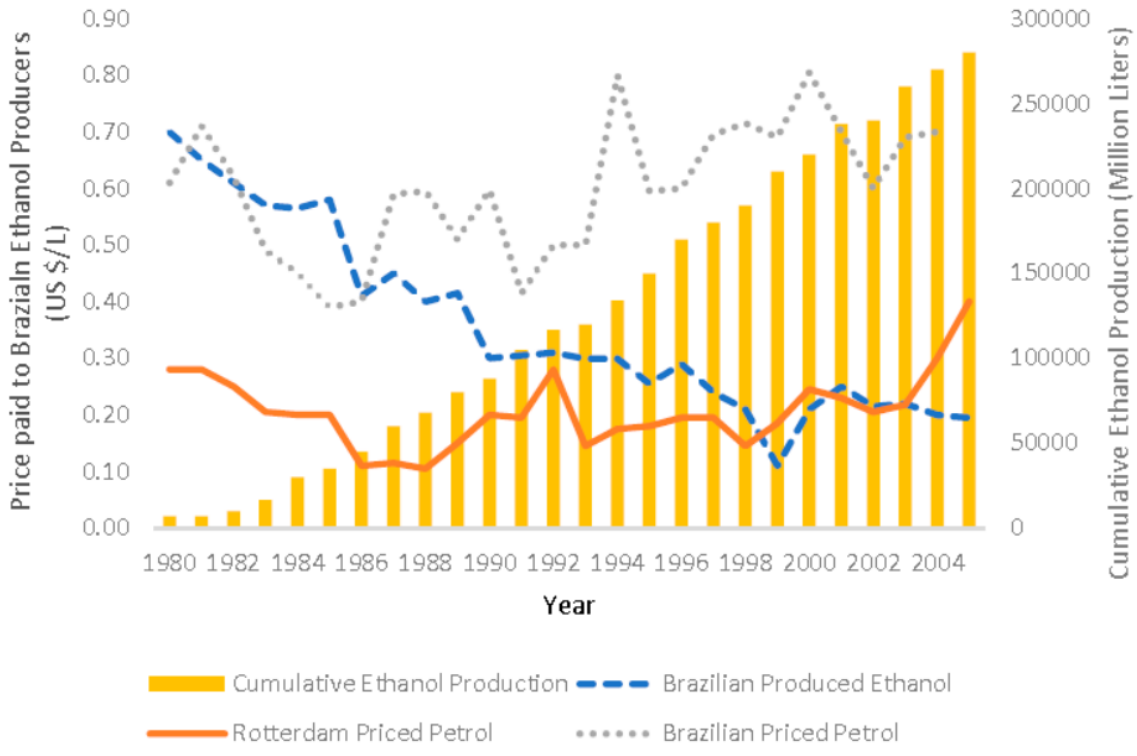
Moreover, Biodiesel improves fuel lubricity and raises the cetane number of the fuel. Also, Biodiesel in its pure, unblended form causes far less damage than petroleum diesel if spilt or released to the environment. It is safer than petroleum diesel because it is less combustible. Thus, Biodiesel is safe to handle, store, and transport.

ECONOMIC ASPECTS OF USING BIODIESEL

In the long term, production costs may reduce with the mass production of the fuel; as the process and technology are expected to improve with time, the marginal cost will also reduce in the future. Various governments provide subsidies for producers and customers to encourage the use of Biodiesel. There are other essential factors in play which include the low maintenance cost of Biodiesel when compared with diesel, cost of raw material and feedstock which will be used.

PRICE OF ETHANOL AND ECONOMIC OF SCALES

Figure 1 depicts ethanol output in Brazil From 1980 to 2005, as well as the prices of Brazilian ethanol, worldwide gasoline/petrol, and Brazilian gasoline. Brazilian ethanol cost more than double the price of international gasoline in 1980. From 2002 to 2005, the price of Brazilian bioethanol steadily decreased, but the price of international gasoline increased more quickly, making ethanol cheaper than gasoline by roughly $0.22 per litre. Bioethanol was 60–70% of the cost of international gasoline in 2005. Brazil is an excellent example of how Biodiesel may succeed with the proper structure and framework in place. As ethanol output grows, so does the price of ethanol. This diagram depicts the relationship between ethanol price and production size, i.e., the lower the marginal cost, the greater the output.



FIG, 1, THE PRODUCTION OF ETHANOL IN BRAZIL AND THE PRICES OF BRAZILIAN ETHANOL, INTERNATIONAL GASOLINE/PETROL AND BRAZILIAN PETROL FROM 1980-2005

MAINTENANCE COSTS

Aside from the fact that Biodiesel is generally more expensive for the customer than diesel, additional aspects might impact the user's prices. For example, two analyses of maintenance costs while utilising B20 in buses against diesel are shown in Table 1. Although the research is independent of one another, the outcomes are surprisingly comparable.

Both have similar fuel economy, with Biodiesel having a slight advantage. Although there is minimal difference in total maintenance costs, diesel was more expensive in study A due to high transmission repair costs. Biodiesel has greater monthly operating and maintenance costs.

According to Study A, there is a fourfold difference between Biodiesel and diesel at $0.08/km and $0.02/km for Biodiesel. On the other hand, Biodiesel is 50% more expensive than diesel, according to Study B. Overall, bus maintenance expenses are comparable for diesel and Biodiesel, although Biodiesel has higher engine and fuel maintenance expenses. However, as the mixture rises beyond 20%, gasoline filters should be replaced more regularly, and when the mixture rises beyond 80%, manufacturers recommend an extra oil change each year. This shows that, when using Biodiesel, consumers can expect little change in the costs of maintaining their vehicle if the blend is 20% or below.

Study	Time Frame	Number of Buses		Km/L		Maintenance Cost (US $/Km)		Bus Engine and System Maintenance Costs (US $/Km)		% Overall Difference Compared to Diesel
		Diesel	Biodiesel	Diesel	Biodiesel	Diesel	Biodiesel	Diesel	Biodiesel	
A Barnitt et al. (2006)	24 months	4	5	1.6	1.6	0.86	0.82	0.08	0.02	5.2% Lower
B Barnitt et al. (2008)	12 months	7	8	1.3	1.2	0.91	0.91	0.08	0.12	0.32% higher

Table-1. COMPARISON OF FUEL EFFICIENCY AND MAINTENANCE COSTS

COST OF FEEDSTOCK

Biodiesel can be made with a variety of feedstock, which can considerably affect the fuel cost and hence will be a deciding factor.

A comparison of diesel and Biodiesel generated from various feedstocks is shown in Table 2. The most costly Biodiesel is created from peanut butter oil, which costs $0.52 per litre, which is more than diesel. Waste-derived feedstock is the cheapest of the feedstocks, including diesel, with tallow being $0.36/L cheaper than diesel on average, however, this fluctuates.

This is beneficial because it eliminates the food vs fuel issue and the land conflict between feedstock grown for food and feedstock cultivated for fuel. The most costly edible feedstock is $0.52/L more costly than diesel, whereas the cheapest edible feedstock is soybean, which is $0.05/L less costly than diesel.

TECHNOLOGICAL DEVELOPMENT ENVIRONMENTAL EFFECTS

The use of Biodiesel can contribute to a decrease in greenhouse gases (GHGs). In general, the higher the mix, the more significant the decrease. Soybean b20 is down in PM, HC and CO (10.1%, 21.1%, and 11% correspondingly), whereas nitrogen oxide (NOx) emissions are up 2% compared with B0. The majority of experts consider NOx to be up to 14% higher in B100 than B0.

Attempts to reduce the amount of NOx by up to 15 per cent have been made, but this is costly and Biodiesel is currently higher than diesel, so it cannot be used at this time, unless the societal costs are far higher than privately held. Other research found that NOx emissions can be reduced by engine changes as NOx appears to be the most susceptible to driving circumstances. The initial chemical composition of the feedstock can

Feedstock	Type of Feedstock	Cost (US $/L)	Difference to Diesel (More to Less Expensive) (US $/L)
Palm Oil	Edible	0.63 -0.64	0.0 to 0.06
Rapeseed	Edible	0.54-0.62	0.04 to -0.04
Tallow	Waste	0.22-0.63	0.06 to -0.36
Waste oil	Waste	0.25-1.01	0.16 to -0.48
Soyabean	Edibile	0.53-0.57	-0.01 to -0.05
Sunflower	Edibile	0.54-0.62	0.04 to -0.04
Peanut	Edibile	1.1	0.52
Diesel	Crude Oil	0.58	na

Table 2-. COMPARISON OF DIESEL AND BIODIESEL PRODUCED FROM A VARIETY OF FEEDSTOCK

also be altered as feasible to reduce the emissions of NOx. There are many more studies showing a rise, however the accurate measurement of nOx emissions is difficult to establish, which is a likely explanation why a range of values are positive and negative.

FUEL PERFORMANCE

The higher the mixture, the lower the energy content, but B does not have the change. Biodiesel is an excellent solvent and is capable of dissolving glasses and gums that can create filter blockages, along with wax generated at lower temperatures. Furthermore, a combination of more than 80 percent biodiesel may harm the engine and generate more engineering complications. When using B100, some metals, such bronze, tin, zinc and plum, might be deteriorated, so that the engine should not utilise them. For instance, France intended to boost its mandatory blending from 7% to 8%, while car makers have objected, saying that vehicle guarantees would not be applicable if an 8% mix is applied

Germany was permitted to utilise B100 since the government and groups promoting the use of biodiesel work with car manufacturers and developed the following parameters for using B100 in specific cars.

CONCLUSION

BioDiesel is an excellent substitute for diesel for railway locomotives, not only because the same engine can be used if the composition of Biodiesel is less than or equal to B20, but also because it has less carbon footprint, maintenance cost of the engine, and is a renewable source of energy. If we were to use pure BioDiesel as our fuel, the engine will have to be modified, at the same time, as the calorific value of Biodiesel is less by 9% the power of the new engine will be less. We also need to keep in mind that a major factor in deciding the cost of Biodiesel is the feedstock.

REFERENCES

1. International Energy Agency (IEA). World energy outlook 2015. In Organization for Economic Co-Operation and Development (OECD/IEA); IEA: Paris, France, 2015. Available online: - IEA

2. International Energy Agency (IEA). Tracking Progress: Transport. 2017. Available online: - IEA

3. Yin, X.; Chen, W.; Eom, J.; Clarke, L.E.; Kim, S.H.; Patel, P.L.; Yu, S.; Kyle, G.P. China's transportation energy consumption and CO2 emissions from a global perspective. Energy Policy 2015, 82, 233–248.

4. Zhao, X.; Zhang, X.; Shao, S. Decoupling CO2 emissions and industrial growth in China over 1993–2013: The role of investment. Energy Econ. 2016, 60, 275–292.

5. Azad, A.K.; Al, E. Prospect of biofuels as an alternative transport fuel in Australia. Renew. Sustain. Energy Rev. 2015, 43, 331–351.

6. Kim, I.; Ismai, M. Growing Demand for Biofuel and its Impact on Sustainable Rural Development in Nigeria.Economy 2014, 1, 1–4.

7. Papong, S.; Chom-In, T.; Noksa-nga, S.; Malakul, P. Life cycle energy efficiency and potentials of biodiesel production from palm oil in Thailand. Energy Policy 2010, 38, 226–233.

8. de Souza, S.P.; Pacca, S.; de Ávila, M.T.; Borges, J.L.B. Greenhouse gas emissions and energy balance of palm oil biofuel. Renew. Energy 2010, 35, 2552–2561.

9. Eshton, B.; Katima, J.H.Y.; Kituyi, E. Greenhouse gas emissions and energy balances of jatropha biodiesel as an alternative fuel in Tanzania. Biomass Bioenergy 2013, 58, 95–103.