

Mathematical Modelling for The Selection of The Best Source for The Preparation of Bio-Diesel



Engineering

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Micro algae AHP

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ABSTRACT

In present dynamic society, to meet the needs of different industrial and domestic operations, the major sources of energy is the burning of fossil fuels such as coal, petroleum and natural gases. There has been greater awareness on biodiesel in developing countries in the recent times and significant activities have picked up for the production of biodiesel. There is a need of biodiesel in the present day society, as the conventional and non-renewable resources depleting day by day by the over usage of increasing population. Global concerns regarding greenhouse gas emissions combined with soaring oil prices have driven the search for renewable diesel fuels derived from either virgin or waste vegetable oils. A key challenge in the emerging bio-diesel industry is cost-effective. To overcome this problem, research is going on by the scientists continuously, trying to find the alternatives to fossil fuels and succeeded to find the bio fuel (biodiesel) from vegetable and animal oils. At this juncture, as there are abundant resources, there is a need to find out the best among them. We have considered some of the resources, Jatropha curcas, Pongamea glabra, Salvalora oleoides, Madhuca indica and Micro algae, which are cheaper in cost, abundantly available and we tried to give the ranking among them with mathematical modelling.

I. Introduction

A major source of energy for our society is the burning of fossil fuels such as coal, petroleum and natural gas. These sources of energy have been found to have limited amounts available, and therefore are said to be depleting resources. Scientists are continuously looking to find alternatives to fossil fuels. Biodiesel is eco friendly, renewable and more biodegradable. Biodiesel is a much better lubricant than petro-diesel and extends engine life

One such alternative is using vegetable oils to make fuel. There are number of vegetable oils are available, like Jatropha curcas, Pongamea glabra, Salvalora oleoides, Madhuca indica, Azadiracta indica, Piper nigrum, castor, coconut, sunflower, ground nut, palm trees ect., While selecting the best one, it should be considered that such a raw material is to be selected which is abundantly available in all times at any place and which is not useful for other purpose rather than the production of bio-diesel. A diesel oil must contain the characteristics such as density, viscosity, flash point, acid value, total sulfur, ash content etc., We gone through the values of these characteristics of biodiesel prepared from the above said plant seeds and Micro algae.

Biodiesel refers to a vegetable oil or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow) with an alcohol producing fatty acid esters.

Biodiesel is made from vegetable oil or animal fat (triglycerides) reacted with methanol or ethanol and a catalyst (lye), yielding biodiesel (fatty acid methyl or ethyl esters) and glycerin as a by-product.

Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used alone, or blended with petrodiesel. Biodiesel can also be used as a low carbon alternative to heating oil. Biodiesel is a much cleaner fuel than conventional fossil-fuel petroleum diesel.

We have considered the plants like Jatropha curcas, Pongamea glabra, Salvalora oleoides, Madhuca indica and we compared them with Micro algae.

1. Jatropha curcas:

It is a species of flowering plant in the spurge family, Euphorbiaceae, that is native to the American tropics, most likely Mexico and Central America. It is cultivated in tropical and subtropical regions around the world, becoming naturalized in some

areas. J. curcas is a poisonous, semi-evergreen shrub or small tree, reaching a height of 6 m (20 ft). It is resistant to a high degree of aridity, allowing it to be grown in deserts. Cultivation is uncomplicated. It can be propagated by cuttings, which yields faster results than multiplication by seeds and Jatropha curcas starts yielding from 9-12 months time, the best yields are obtained only after 2 - 3 years time.

2. Pongamia glabra:

Pongamia is widely distributed in tropical Asia majorly in East Indies, Philippines, India. It is a deciduous tree that grows to about 15-25 meters in height with a large canopy. The leaves are a soft, shiny burgundy in early summer and mature to a glossy, deep green as the season progresses. Small clusters of white, purple, and pink flowers blossom on their branches throughout the year, maturing into brown seed pods. The tree is hardy, reasonably drought resistant and tolerant to salinity.

All parts of the plant are toxic and will induce nausea and vomiting if eaten, the fruits and sprouts, along with the seeds, are used in many traditional remedies. Juices from the plant, as well as the oil, are antiseptic and resistant to pests. It is used in pharmacy particularly for skin problems, in tanning and soaps.

3. Salvadora oleoides:

Salvadora oleoides is a small bushy evergreen tree found in India and Pakistan and southern Iran. In Iran it is called Tuch. It is a small tree with drooping branches, rarely with proper bole or exceeding a height of 20 feet and a girth of 3 feet. It is very common plant in arid tracts but becomes scarce where rainfall conditions are better. It can withstand great soil salinity. It produces new leaves during April, which on maturity become thick and leathery.

It is a valuable tree of agro forestry for the arid areas of the country. A tree of arid horticulture suitable for cultivation in salt effected/stressed environments.

It is a tree that yields non-edible oils and fruits. This survives in salt affected areas such as Rajasthan and Gujarat.

4. Madhuca indica:

It is Found in north Indian plains and in forests of Karnataka, Kerala, M.P. and Rajasthan. It is one of the forest based tree-borne non-edible oils with large production potential of about 60 million tons per annum in India.

Madhuca fat is satisfactory for production of washing soaps. Seed Oil is used as ointment, in rheumatism and to prevent

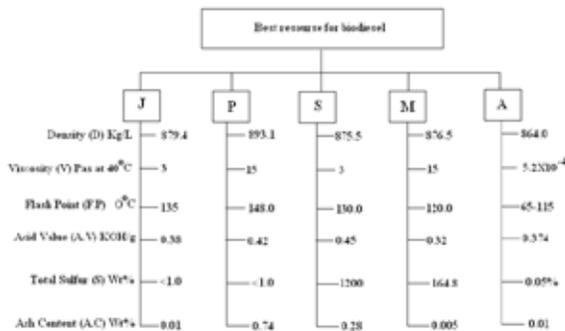
cracks in the skin in winter. Bark decoction is used in curing bleeding gums and ulcers.

5. Micro-algae:

Microalgae comprise a vast group of photosynthetic, heterotrophic organisms which have an extraordinary potential for cultivation as energy crops. They can be cultivated under difficult agro-climatic conditions and are able to produce a wide range of commercially interesting byproducts such as fats, oils, sugars and functional bioactive compounds. As a group, they are of particular interest in the development of future renewable energy scenarios. Certain microalgae are effective in the production of hydrogen and oxygen through the process of biophotolysis while others naturally manufacture hydrocarbons which are suitable for direct use as high-energy liquid fuels.

Microalgae contain oils or lipids, that can be converted into biodiesel. The idea of using microalgae to produce fuel is not new, but has received recent renewed attention in the search for sustainable energy. Using microalgae as a source of biofuels could mean that enormous cultures of algae are grown for commercial production, which would require large quantities of fertilisers. While microalgae are estimated to be capable of producing 10-20 times more biodiesel than the conventional crops.

However, many technical and environmental issues, such as land use and fertiliser input still need to be researched and large-scale commercial production has still not been attained and if the goal is to produce biodiesel, the key implication is that the species used for cultivation should be chosen carefully and should find the best one among them.



Structuring of the problem into a hierarchy:

The Analytical Hierarchy Process(AHP) is named by T. Saaty(1980s) is the most widely used decision making approach in the world today.

In general hierarchies concern the distribution of a property (the goal) among the elements being compared, to judge which one influences or is influenced more. In the present problem- Ranking the resources for producing biodiesel, the goal is to select the best resource among them. Thus this phase consists of individuating the hierarchy of attributes and indexes to measure possibilities of difficulty.

The key problem is to identify the best resource for producing bio diesel.

Objective:

Ranking the resources for producing biodiesel.

Criteria :

Density[D], viscosity[V], Flash point[FP], Acid value[A.V], Total sulfur[S], Ash content[A.C].

Alternatives:

1. Jatropha curcas (J)
2. Pongamea glabra(P)
3. Salvalora oleoides (S)
4. Madhuca indica (M)
5. Micro algae (A)

Then the following calculations were made.

1. Synthesizing the pair wise comparison matrix
2. Calculating the priority vector for a criterion such as teacher's explanation.
3. Calculating the consistency ratio
4. Calculating λ_{max}
5. Calculating the consistency index, C.I.
6. Selecting appropriate value of the random consistency ratio from tables.

Checking the consistency of the pair wise comparison matrix to check whether the decision-makers comparisons were consistent or not.

Comparative Matrix for criteria:

	D	V	F.P	A.V	S	A.C	Weights
D	1	1/2	1/4	1/3	2	3	0.10063
V	2	1	1/3	1/2	3	4	0.15958
F.P	4	3	1	2	5	6	0.38249
A.V	3	2	1/2	1	4	5	0.25040
S	1/2	1/3	1/5	1/4	1	2	0.06408
A.C	1/3	1/4	1/6	1/5	1/2	1	0.04282

$\lambda_{max} = 6.12246$ C.I.=0.0244927 R.I=1.24

Comparative Matrix for criteria:

	D	V	F.P	A.V	S	A.C	
J	879	3	135	.38	.9	0.01	0.101
P	893	15	148	0.42	0.9	0.74	0.160
S	875	3	130	0.45	1200	0.28	0.383
M	876	15	120	0.32	165	0.005	0.251
A	864	.001	100	0.374	5	0.01	0.065
							0.043

CONCLUSION

It is a must to find the alternative to fossil fuels to overcome the problem of depletion of conventional non-renewable resources and environmental issues. One such alternative is the production of biodiesel, which can be produced by various vegetable and animal oils. Though many resources are available, one has to choose the best one, which is abundantly available and cheaper in cost. A study is made by using an AHP process for ranking the alternatives in increasing order. From the comparative matrix for criteria, it is observed that S (215.4), P (149.1), M (147.2), J (140.8), A (125.6) which shows the Algae is the best resource among the remaining for the production of biodiesel.

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