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Performance and Emission Characteristics of Diesel Engine with Methyl Ester Sunflower Oil and Its Blends

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ABSTRACT: Biomass determined vegetable oils are very encouraging option fills for agrarian diesel engines. Utilization of vegetable oils in diesel engines prompts somewhat substandard execution and higher smoke emanations because of their high thickness. The execution of vegetable oils can be enhanced by adjusting them through the transesterification procedure. In the present work, the execution of single barrel water-cooled diesel motor utilizing methyl-ester of sunflower oil as fuel was assessed for its execution and fumes outflow. The fuel properties of biodiesel, for example, kinematic viscosity, calorific esteem, streak point, carbon buildup and particular gravity were found. Results showed that B25 has nearer execution to diesel and B100 has bring lower brake thermal efficiency, predominantly because of its high consistency contrasted with diesel. The brake thermal efficiency for biodiesel and its mixes was observed to be somewhat higher than that of diesel fuel at tried load conditions and there was no distinction between the biodiesel and its blended fuel efficiencies. For sunflower biodiesel and its mixed fills, the fumes gas temperature expanded with increment in power and measure of biodiesel. In any case, its diesel mixes demonstrated sensible effectiveness, lower smoke, CO2, CO and HC.

I. INTRODUCTION

The Majority of the universes vitality needs are provided through petrochemical sources, coal and characteristic gasses, except for hydroelectricity and nuclear energy. These sources are limited and a few assessments propose that at current utilization rates they will soon be expended. Diesel energizes have a fundamental capacity in the modern economy of a creating nation and are utilized for transport of mechanical and farming products, and for operation of diesel tractor and draw sets in the horticultural part. Financial development is constantly joined by similar increment in transport. The high energy request in the industrialized world and in addition in the residential area and contamination issues caused because of the far reaching utilization of petroleum products make it progressively important to build up the sustainable power wellsprings of boundless span and littler natural effect than the customary folds. This has empowered late enthusiasm for elective hotspots for petroleum - based fills.

Diesel engines are the most effective prime movers. From the perspective of ensuring the worldwide condition and worries for long haul energy security, it winds up noticeably important to create elective fills with properties tantamount to petroleum - based energizes. Not at all like whatever remains of the world, India's interest for diesel powers is about six times that of gas, consequently looking for contrasting option to mineral diesel is a characteristic decision. The fast exhaustion of petroleum holds and the rising oil costs have prompted the look for elective powers. Non palatable oils are promising energizes for farming applications. Vegetable oils have properties practically identical to diesel and can be utilized to run CI motors with almost no alterations.

An option fuel must be in fact possible, financially aggressive, ecologically satisfactory, and promptly accessible. One conceivable contrasting option to petroleum derivative is the utilization of oils of plant starting point like vegetable oils and tree borne oil seeds. This option diesel fuel can be named as biodiesel. This fuel is

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biodegradable and non-poisonous and has low emanation profiles when contrasted with oil diesel. Utilization of biodiesel will enable an adjust to be looked for between horticulture, financial advancement and the earth.
Of the different exchange powers under thought, biodiesel, got from vegetable oils, is the most encouraging option fuel to diesel because of the accompanying reasons:
1. Biodiesel can be utilized as a part of the current diesel engine with no changes.
2. Biodiesel is made totally from vegetable sources; it doesn't contain any sulfur, sweet-smelling hydrocarbons, metals or unrefined petroleum deposits.
3. Biodiesel is an oxygenated fuel; outflows of carbon monoxide and residue have a tendency to diminish.
4. Unlike non-renewable energy sources, the utilization of biodiesel does not add to an Earth-wide temperature boost as the plants developed for vegetable oil/biodiesel generation by and by ingest CO2 discharged. In this way CO2 adjust is kept up.
5. The word related wellbeing and wellbeing organization groups biodiesel as a non-combustible fluid.
6. The utilization of biodiesel can expand the life of diesel motors since it is more greasing up than oil diesel fuel.
7. Biodiesel is delivered from inexhaustible vegetable oils/creature fats and subsequently enhances the fuel or vitality security and economy freedom.
Much research work has been completed to utilize vegetable oil both in its flawless frame and changed shape. Studies have demonstrated that the utilization of vegetable oils in flawless shape is conceivable however not best. The high consistency of vegetable oils and the low instability influences the atomization and splash example of fuel, prompting fragmented ignition and serious carbon stores, injector gagging and cylinder ring staying.
The techniques used to decrease the thickness are
• Blending with diesel
• Emulsification
• Pyrolysis
• Transesterification
Among these, the transesterification is the normally utilized business procedure to deliver perfect and natural benevolent fuel. In any case, this includes additional cost of preparing, on account of the transesterification response including concoction and process warm information sources.

II. SUNFLOWER SEEDS

Sunflower seeds are non-consumable oil being singled out for expansive scale for ranch on badlands. The sunflower plant can flourish under unfavorable conditions. It requires next to no water system and develops in a wide range of soils (from coastline to slope slants). The creation of sunflower seeds is around 0.8 kg for each square meter every year. The oil substance of sunflower seed ranges from 30% to 40% by weight and the part itself ranges from 45% to 60%. fresh sunflower oil is moderate drying, scentless and dull oil, however it turns yellow in the wake of maturing.

The main restriction of this yield is that the seeds are poisonous and the press cake can't be utilized as creature organizer. The press cake must be utilized as natural fertilizer. The way that sunflower oil can't be utilized for nutritious purposes without detoxification influences its utilization as vitality/to fuel source exceptionally appealing. In Madagascar, Cape Verde and Benin, sunflower oil was utilized as mineral diesel substitute amid the Second World War. Forson et al. utilized sunflower oil and diesel mixes in CI engines and discovered its execution and outflows qualities like that of mineral diesel at low grouping of sunflower oil in mixes. Pramanik endeavored to diminish thickness of sunflower oil by warming it and furthermore mixing it with mineral diesel.
The present research is aimed at exploring technical feasibility of sunflower oil in direct injection compression ignition engine without any substantial hardware modifications.

III. PRESENT WORK

In this work the methyl ester of sunflower oil was explored for its execution as a diesel engine fuel. Fuel properties of mineral diesel, sunflower biodiesel and sunflower oil were assessed.

Three blends were obtained by mixing diesel and esterifies sunflower in the following proportions by volume: 75% diesel + 25% esterifies sunflower, 50% diesel + 50% esterifies sunflower and 25% diesel + 75% esterifies

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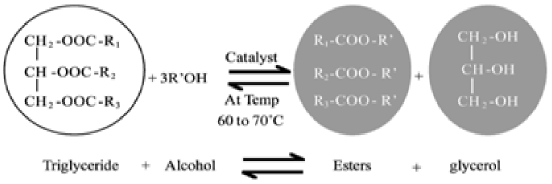
sunflower. Performance parameters like brake thermal efficiency, specific fuel consumption, brake power were determined. Exhaust emissions like CO_2, CO, NO_X and smoke have been evaluated. For comparison purposes experiments were also carried out on 100% esterifies sunflower and diesel fuel.

IV. TRANSESTERIFICATION PROCESS

The Transesterification process can accomplish the conversion of sunflower oil into its methyl ester. Transesterification involves reaction of the triglycerides of sunflower oil with methyl alcohol in the presence of a catalyst Sodium Hydroxide (NaOH) to produce glycerol and fatty acid ester.

Mechanism of Transesterification Reaction



Catalyst Use in Transesterification Reaction: KOH/NaOH

The production of biodiesel by transesterification of the oil generally occurs using the following steps:

1. Mixing of alcohol and catalyst. For this procedure, a predefined measure of 450 ml methanol and 10 gr Sodium Hydroxide (NaOH) was blended in a round base carafe.
2. Reaction. The liquor/impetus blend is then dashed into a closed reaction vessel and 1000 ml sunflower oil is included. Abundance alcohol is regularly used to guarantee add up to change of the fat or oil to its esters.
3. Separation of glycerin and biodiesel. Once the response is finished, two noteworthy items exist: glycerin and biodiesel. The amount of delivered glycerin shifts agreeing the oil utilized, the procedure utilized, the measure of overabundance alcohol utilized. Both the glycerin and biodiesel items have a generous measure of the overabundance alcohol that was utilized as a part of the response. The responded blend is here and there killed at this progression if necessary.
4. Alcohol Removal.
5. Glycerin Neutralization. The glycerin result contains unused impetus and cleansers that are killed with a corrosive and sent to capacity as rough glycerin. At times the salt shaped amid this stage is recouped for use as compost. Much of the time the salt is left in the glycerin.
6. Methyl Ester Wash. The most critical parts of biodiesel creation to guarantee inconvenience free operation in diesel engines are finished response, expulsion of glycerin, evacuation of impetus, evacuation of alcohol and nonattendance of free unsaturated fats.

V. EXPERIMENTAL SET UP

The engine shown in plate.1 is a 4 stroke, vertical, single cylinder, water cooled, constant speed diesel engine having 5 BHP as rated power at 1500 rpm which is coupled to brake drum dynamometer to measure the output. The engine crank started. Necessary dead weights and spring balance are included to apply load on brake drum.

Appropriate cooling water course of action for the brake drum is given. Isolate cooling water lines fitted with temperature measuring thermocouples are accommodated motor cooling. A measuring framework for fuel utilization comprising of a fuel tank, burette, and a 3-way chicken mounted on stand and stop watch are given. Air admission is measured utilizing an air tank fitted with an opening meter and a water U-tube differential manometer. Additionally advanced temperature marker with selector switch for temperature estimation and a computerized rpm pointer for speed estimation are given on the board. A representative is given to keep up the steady speed. exhaust gas examination was performed utilizing a multi gas fumes analyzer. Bosch smoke pump is connected to the fumes pipe for measuring smoke levels.

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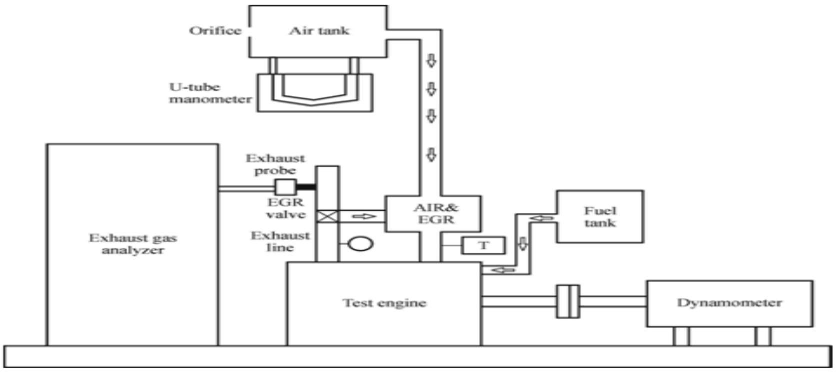

Plate 1. Experimental setup

Specifications of the Test Engine	
Particulars	**Specifications**
Manufacturer	Kirloskar engines Ltd
No of cylinders	One
No of strokes	Four
BHP of engine	5
Capacity	3.68 kw
Bore	80 mm
Stroke Length	110 mm
Speed	1500 rpm
Mode of injection	DI
Cooling system	Water

VI. EXPERIMENTAL PROCEDURES

Initially tests were carried out on the engine using diesel as fuel in order to provide base line data. The cooling water temperature at the outlet was maintained at 70^{0}C. The engine was stabilized before taking all measurements. Subsequently experiments were repeated with methyl ester of sunflower oil for comparison. In all cases the pressure and crank angle diagram was recorded and processed to get combustion parameters.

Sl.no	Property	Pure diesel	sunflower biodiesel	sunflower oil
1	density (kg/m³)	840±1.732	876	906±1
2	kinematic viscosity at 45ºc (cst)	2.44±0.27	4.82	35.96±1.3
3	pour point (ºc)	6±1	3±1	4±1
4	flash point (ºc)	71±3	193	219±4
5	conradson carbon residue (%,w/w)	0.1±0.0	0.01	0.7±0.1
6	ash content (%,w/w)	0.01±0.0	0.013	0.03±0.0
7	calorific value (MJ/Kg)	45.343	38.5	39.071
8	sulphur (%, w/w)	0.25	<0.001	0
9	cetane No.	46-54	51-52	22-40
10	carbon (%,w/w)	85.3	75.1	74.11
11	hydrogen(%,w/w)	12.72	11.82	10.53
12	oxygen (%,w/w)	1.17	10.86	11.05

VII. RESULTS AND DISCUSSION

The fuels (pure diesel, sunflower biodiesel and sunflower oil) have been analyzed for numerous physical, chemical and thermal properties and outcomes are proven in desk 2.Density, cloud point and pour factor of sunflower oil had been discovered to be higher than traditional diesel. Higher cloud and pour factor replicate unsuitability of sunflower oil as diesel gasoline in cold climatic conditions. The flash and fire points of sunflower oil become quite, excessive in comparison to diesel. So sunflower oil is extremely safe to deal with. Higher carbon residue from

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sunflower oil May probably lead to better carbon deposits in combustion chamber of the engine. Low sulphur content in sunflower oil effects in decrease Sox emissions. Pressure of oxygen in fuel improves combustion houses and emissions however reduce the calorific price of the gasoline. Sunflower oil has approximately 90% calorific value as compared to diesel. Nitrogen content material of the gasoline also influences the NOx emissions.
High viscosity is a primary trouble in using vegetable oil as fuel for diesel engines. In the existing investigation the transesterification technique decreased viscosity. Viscosity of sunflower biodiesel is 4.82 cst at 450c. Its miles observed that viscosity of sunflower oil decreases remarkably with growing temperature and it becomes close to traditional diesel at temperatures above 900C.
The objective of the observe is to locate performance, emissions and combustion characteristics of sunflower oil after transesterification and to determine the ultimate combination of transesterified sunflower oil to be used as an opportunity fuel in CI engine. Experiments are performed with transesterified sunflower oil by various the blends. By comparing the thermal efficiencies, particular fuel consumption and emissions of diverse blends the ultimate mixture concentration is determined. B25, B50 and B75 blends are as compared with diesel.

Brake thermal efficiency

Fig 1 shows the variation of brake thermal efficiency with brake power for diesel and various blends of biodiesel. It is observed that the blends have higher thermal efficiency than that of diesel. The molecules of biodiesel contain some amount of oxygen that takes part in combustion and this may be a possible reason for a complete combustion. Oxygen present in biodiesel molecule structure may be readily available for combustion. Thermal efficiency at all power output is found to be maximum with 25% biodiesel during the entire operating range. Thermal efficiency at 25% biodiesel is found to be 42% at power output when compared to 33.85% to that of diesel.

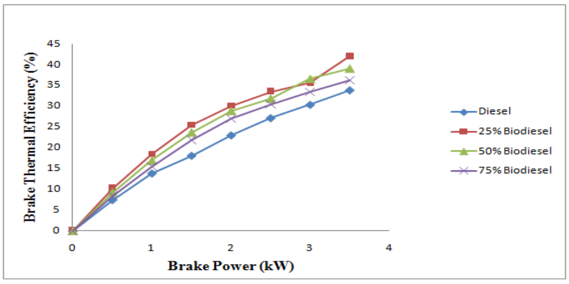

Fig 1 Variation of Brake Thermal Efficiency with Brake Power for different blends

Specific fuel consumption

Specific gasoline consumption for diesel and numerous blends of biodiesel are shown in fig 2. It's far discovered that minimum specific fuel consumption is located to be zero.2 kg/kwh with 25% biodiesel when in comparison to zero.279 kg/kwh than that of diesel and additionally precise gas consumption for distinct concentrations of biodiesel is lower than that of diesel at regular running conditioned. This is because of whole combustion, as additional oxygen available from gas itself. The percent increase in precise fuel consumption improved with reduced amount of diesel fuel within the mixed gas. This may be due to higher specific gravity and decrease calorific fee of biodiesel gasoline as compared with diesel gas.

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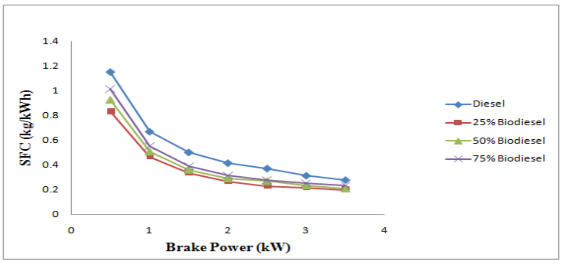

Fig 2 Variation of SFC with Brake Power for different blends

Exhaust gas temperature

The exhaust gas temperature gives a demonstration about the amount of heat going with exhaust gases. The exhaust gas temperature of different biodiesel blends with brake strength is shown in fig 3. The exhaust gasoline temperature of 25% biodiesel at 3.Five kW load is 15% higher than that of two. Five kW load situation. The exhaust fuel temperature expanded with increase of load and quantity of blended biodiesel in the gasoline. The exhaust gas temperature reflects on the reputation of combustion in the combustion chamber. The motive for boom within the gas temperature may be because of ignition delay and elevated amount of gas injected. The exhaust gas temperature can be reduced by adjusting the injection timing.

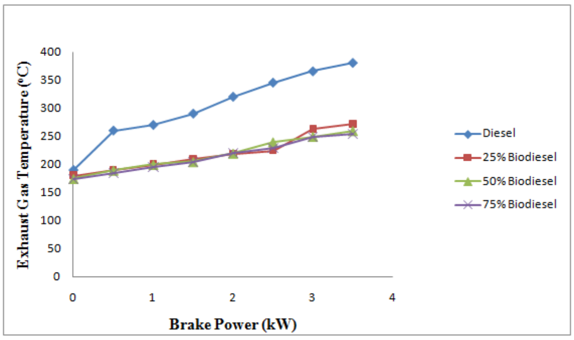

Fig 3 Variation of Exhaust Gas Temperature with Brake Power for different blends

Carbon monoxide emission

If the combustion is incomplete because of shortage of air or due to low fuel temperature, CO might be shaped. Carbon monoxide emission from diesel engine with different blends is shown in fig four. CO emission of all sorts of tested fuels expanded with the growth in brake energy. Carbon monoxide emission is reduced by means of 3% while using B25 as compared to diesel gasoline at peak load. CO emission decreased for biodiesel combined fuels in comparison to diesel because biodiesel contains 11% oxygen molecules, this will lead to finish combustion and reduction of CO emission.

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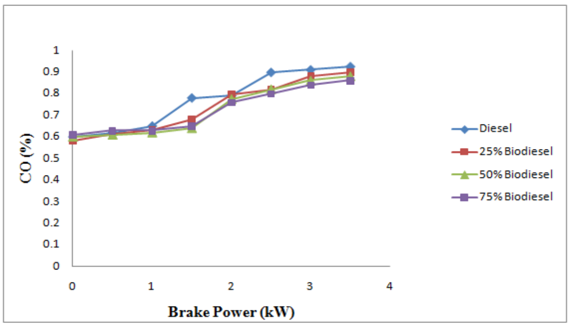

Fig 4 Variation of CO Emission with Brake Power for different blends

Carbon dioxide emission

The CO2 emission from diesel engine with special is display in fig 5. The CO2 improved with the increase of load situations for diesel and for biodiesel mixed fuels.

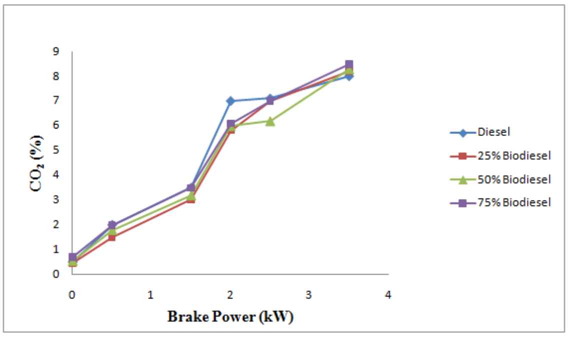

Fig 5 Variation of CO_2 Emission with Brake Power for different blends

Nitric oxide emission

Fig 6 shows the version of NOX with admire to brake power for exceptional concentrations of biodiesel. At better energy output conditions, because of higher height and exhaust temperatures the NOX values are tremendously higher as compared to low energy output conditions. A slight increase in NOX located for blends of esterifies sunflower oil compared to diesel. The cause may be due to postpone in burning of biodiesel blends for the duration of growth.

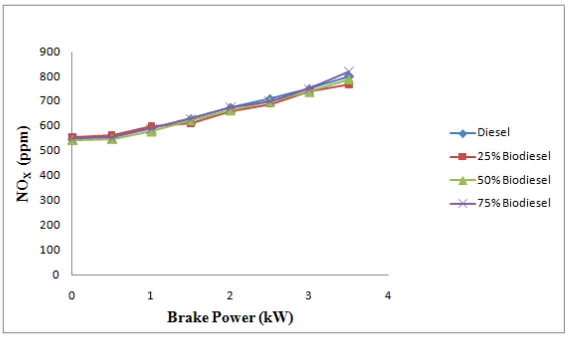

Fig 6 Variation of NO_X with Brake Power for different blends

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Smoke emission

Smoke emission for biodiesel blends is proven in fig 7. Smoke will increase with the boom of brake strength. It is determined that smoke cost is usually lower than that of diesel for all blends. The higher thermal performance of biodiesel blends approach better and whole combustion and lesser amount of unburned hydrocarbons in the engine exhaust consequently reducing the smoke emission.

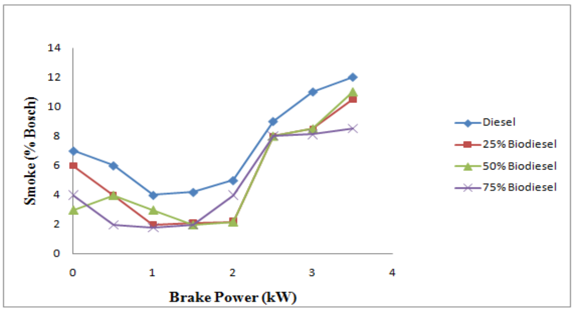

Fig 7 Variation of Smoke with Brake Power for different blends

Peak pressure

Variation of peak stress with brake electricity is shown in fig 8. It is determined that there is super development within the peak stress for the lower awareness of biodiesel. This is due to decrease ignition put off and development in cetane variety. It is likewise located that top stress for all higher concentration of biodiesel blends (B50, B75) is lower than that of diesel. Increase in viscosity of better concentration has lead to poor atomization and over rich gasoline pockets within the combustion chamber. Because of this, height pressures are decrease for the entire better awareness of biodiesel blends.

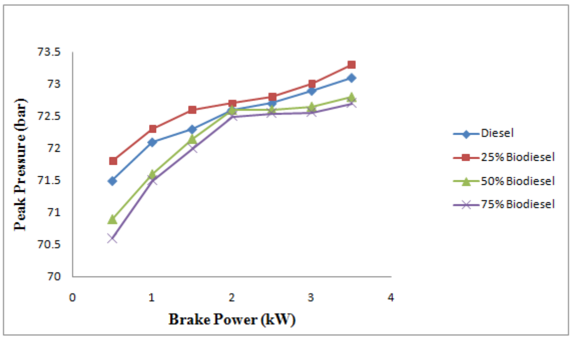

Fig 8 Variation of Peak Pressure with Brake Power for different blends

VIII. CONCLUSIONS

A 4 stroke unmarried cylinder compression ignition engine was operated efficaciously the use of methyl ester of sunflower oil because the simplest gasoline. The following conclusions were made based on the experimental effects.

- Using methyl ester of sunflower oil engine works easily for performance comparable to traditional diesel operation.
- Methyl ester of sunflower oil effects in a slightly extended thermal efficiency in comparison to that of traditional diesel.
- The exhaust gas temperature is reduced with methyl ester of sunflower oil in comparison to that of conventional diesel.
- CO_2 emission is low with the methyl ester of sunflower oil.

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- CO emission is low at better loads while compared with the methyl ester of sunflower oil.
- NOx emission is barely improved with methyl ester of sunflower oil compared to conventional diesel.
- There is great difference in smoke emissions when the methyl ester of sunflower oil is used. This methyl ester of sunflower oil in conjunction with diesel may additionally reduce the environmental impacts of transportation, reduce the dependency on crude oil imports and provide business possibilities to agricultural organisations for intervals of excess agricultural production. On the complete it's far concluded that the methyl ester of sunflower oil may be a great opportunity fuel for diesel engines used for agricultural programs.

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