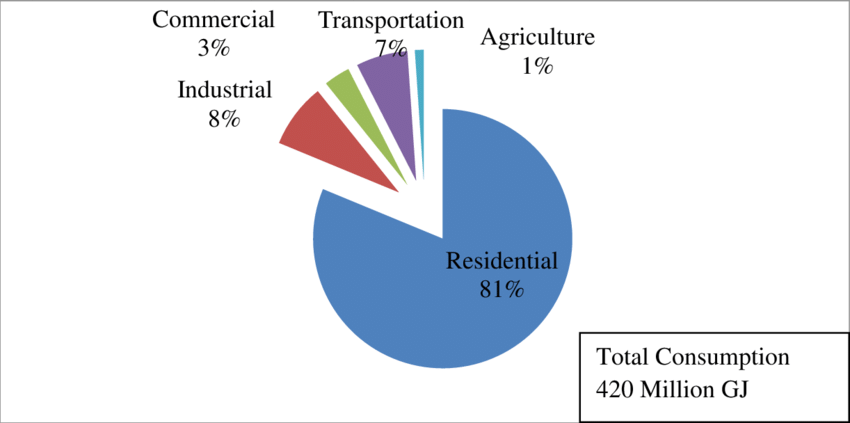
**1.INTRODUCTION**

The availability of energy resource plays a critical role in the progress of a nation. A almost all the human energy needs are currently met from the fast depleting fossil fuels associated with serious environmental consequences. Over the last century, there has been more than 20 fold increase in the consumption of energy worldwide and all major sources excepting hydropower and nuclear electricity are the finite sources and therefore are likely to be exhausted in near future [3].The rapid increase in the consumption of fossil fuels is resulting into climate change which is considered as the most important environmental problem of the present century and the recent studies hence indicates that the emission of green house gases to the atmosphere have contributed to the increase in the global mean temperature by approximately 0.8 °C during the past century. The impact of climate change on the ecosystem and human societies has prompted to develop ecofriendly and infinite renewable sources like solar, wind, small hydro, biomass, etc .

* 1. **ENERGY CONSUMPTION**

Energy is the prime mover of economic growth and is vital to the sustenance of modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible and environmentally friendly. India ranks sixth in the world in total energy consumption and needs to accelerate the development of the sector to meet its growth aspirations. The country, though rich in coal and abundantly endowed with renewable energy in the form of solar, wind, hydro and bio-energy has very small hydrocarbon reserves (0.4% of the world's reserve). India, like many other developing countries, is a net importer of energy, more than 25 percent of primary energy needs being met through imports mainly in the form of crude oil and natural gas. The rising oil import bill has been the focus of serious concerns due to the pressure it has placed on scarce foreign exchange resources and is also largely responsible for energy supply shortages.

The fig. shows energy demand projection in India. India had approximately 5.6 billion barrels of proven oil reserves as of January 2010. the second-largest amount in the Asia-pacific region after china. India produced roughly 880 thousand barrels per day (bbl./d) of total oil in 2009 from over 3,600 operating oil wells approximately 680 thousand (bbl./d) was crude oil and the remainder was other liquids and refiner.



**Figure 1.1 Energy consumption by different economic sectors**

* 1. **CI ENGINE AND ALTERNATIVE FUELS**

The future of alternative fuels for compression-ignition engine has become imperative due to exhaustion of petroleum products and its major contribution in pollution. As Dr. Rudolf Christian Karl Diesel had invented the compression-ignition engines and the first exhibition of compression-ignition engines was carried out at World’s fair in Paris fueled with peanut oil (Alternative Fuel) in 1911. However, due to the ample availability of petrodiesel and the unmatched properties of alternative fuel, researchers ignored it. But, after 1970 due to the hike in price and increased demand-supply gap, researchers had investigated the new alternative fuel source to overcome the dependency on crude oil and foreign exchange

**Alternative fuels**

A] Bio Solid fuel from nature (For direct burning)

B] Bio Gaseous fuel

1) Syngas from bio mass

2) Bio CNG

C] Bio Liquid fuel (Produced specially for C.I engine)

* 1. Bio Fuel (including biodiesel, Fischer-Tropsch and diesel blends)
  2. Bio methanol and other alcohols
  3. Green diesel
  4. Coal-derived liquid fuels
  5. Fuels (other than alcohol) derived from biological materials
  6. Tyre derived oil
  7. Plastic oil
  8. Oil from algal is also used in compression ignition engine
  9. **BIODIESEL**

In the future, the demand for biodiesel may be predictable to increase due to fast exhaustion of fossil fuels and improvement of vehicle transportation. A lot of researches in the world are taken up to develop the biodiesel sources like edible and non-edible oils. But the edible oil source may not be a suitable and sustainable source for biodiesel production that would build food scarcity. In addition, most of the non-edible plants have better potential to be grown in wasteland which does not affect the food crop-cultivating regions. This proves the need to use non-edible oil seeds that can be the dependable, sustainable and potential resource for biodiesel production. Biodiesel can be prepared from both edible and nonedible oils. These edible oils produced are mostly from croplands. The production of edible oils involves usage of larger areas and is expensive which leads to the deletion of more usable resources. If it continues, surely it will lead to acute shortage of land and also food supply. But nowadays, it becomes a big issue that shortage of these resources competes with food storages. So the ultimate way to get rid off all this is non-edible oil. Due to such tremendous increase in edible oil, there should be such justification in order to use non-edible oil. There are many non-edible oil crops found globally, out of which nearly 150 crops are found to exist. Some of the crops include Jatropha curcas, Pongamia pinnata, mahua, Garcinia indica and Moringa Oleifera. The non-edible oils from seeds may vary in their properties according to the content of fatty acid, and it can be used successively in engine without any modification. The fuel properties are very much closure to diesel, and it is suitable for conventional engine. Hence, non-edible oils are considered as second generation biodiesel feedstock. The advantage of using non-edible oil is high resistance to pest and disease. It can eliminate food shortages and they restore degradable lands. The characteristics of Biodiesel are close to diesel fuels, and therefore Biodiesel becomes a strong source to replace the diesel fuels. The conversion of triglycerides into methyl or ethyl esters through the transesterification process, reduces the molecular weight to one-third that of the triglyceride and also reduces the viscosity by a factor of about eight and increases the volatility marginally. Biodiesel has viscosity close to diesel fuels. These esters contain 10–11% oxygen by weight, which may encourage more combustion than hydrocarbon-based diesel fuels in an engine. The cetane number of Biodiesel is around 50. The use of tertiary fatty amines and amides can be effective in enhancing the ignition quality of the finished diesel fuel without having any negative effect on its cold flow properties.Since the volatility increases marginally, the starting problem persists in cold conditions. Biodiesel is considered clean fuel it has no sulphur no aromatics and has about 10% built in oxygen, which helps it to burn fully its higher cetane number improves the ignition quality even when blended in the petroleum diesel. It is a general property of hydrocarbons that the auto ignition temperature is higher for more volatile hydrocarbons. Therefore, the less volatile middle distillate fractions of crude oil boiling in the range of 250–370 °C are suitable as diesel fuels.

**2. PROBLEM STATEMENT**

The world is facing many problem because of pollution which leads to major health problems (Asthama , various type of cancer , breathing problems ) also there is increase in global temperature. One of the cause of pollution is emission through vehicles which use crude oils and constantly emits HC, PPM , NOx ,CO , CO2 , SO2.The crude oil has to be replaced by an alternative biofuel.

**3. OBJECTIVE**

1. To obtain different engine performance parameters for the various blends of biodiesel.
2. To compare engine performance with pure diesel engine and blended bio diesel (B5,B10,B15,B20,B25) engine.
3. To obtain blend with nominal emission parameter at same compression ratio.

**4. LITERATURE REVIEW**

**A. Tamilvanan** has concluded in the present work that non-edible feedstock of Calophyllum inophyllum seed oil (tamanu oil) is used for biodiesel production. This paper aims to investigate the effects of the copper additive nanoparticles with biodiesel blends on the engine performance, combustion and emission characteristics of single-cylinder direct-injection diesel engine and compared that with diesel fuel. In this work, Calophyllum inophyllum oil is chosen for investigation because it is non-edible oil source and available in the coastal regions of South India and South Asia. It contains higher amount of unsaturated fatty acids (70.8%) than saturated fatty acids (29.2%). The results showed that the addition of nano-additives enhances brake thermal efficiency and reduces specific fuel consumption compared to biodiesel blends but slightly lower than diesel. Combustion which resulted in higher heat release rate. The emissions of HC, NOx and O2 are significantly reduced for nano-additive blends compared to diesel but increased CO2 emission was observed. It is noticed that higher CO2 emission and substantial reduction of unused O2 emissions from engine fueled with nano-additive are evident for enhanced oxidation and better combustion. Nano-metal particles suspended in the base fluids result in improvement of the thermophysical properties, which makes them an observable choice for use in number of commercial applications including agriculture technology, biotechnology, engineering, medical sciences, transportation, etc.The results obtained were very hopeful due to enhancement in chemical and thermophysical properties of modified fuel such as elevated reactive medium for combustion, better heat and mass transport properties due to high thermal conductivity, more surface to volume ratio, improvement in fire point, flash point, pour point,. Addition of cerium oxide nanoparticles to the biodiesel resulted in increased viscosity, insignificant variation in cold temperature properties, improved efficiency and reduction of HC and NOx emissions. The brake thermal efficiency of biodiesel and their blends are lower than that of pure diesel. The decrease in brake thermal efficiency of biodiesel is mainly due to the lower heat of combustion. BSFC of biodiesel blends and biodiesel with metal additive is slightly greater than pure diesel. At all loads, BSFC of all biodiesel blends is higher compared to biodiesel blends with additive at higher loads. The addition of additives shows a significant reduction of SFCs at all loads. It is seen that the NOx emission of biodiesel blends is lower than pure diesel at 100% load. Addition of nanoparticle additives with biodiesel was found to be a better oxidizing agent of the fuels and augment its combustion characteristics. Finally, the nano-copper additive prepared by this electrochemical method was cheap and easy without many risk.

**M. Vijay Kumar** has shown in this literature review, the effects of additive on biodiesel are explained. The reviews conclude that the uses of additive to the 2nd generation of biodiesel are the best in improving the combustion performance and emission reduction. Using the biodiesel in CI engines can reduce the hydrocarbons (HC), smoke and carbon monoxide (CO) emissions. But oxides of nitrogen (NOx) will increase due to the oxygen (O2) content is present in biodiesel causes a NOx formation. As the oxygen levels increase in biodiesel the complete combustion will take place and the temperature increases and produces the NOx formation. the results from the experiment were found that SFC increases withincrease in percentages of biodiesel blends because of the lesser heating value of biodiesel and in emission it was found to besignificant reduction in HC, CO and smoke emissions for all Pongamia biodiesel blends which were compared to diesel characteristics. However, Pongamia biodiesel of NOx emission is a bit higher than that of diesel characteristics. It is concluded from the experiments that the increase in smokeemissions was observed by using neat poon biodiesel by 15% at full load and a very slight improvement of brake thermal efficiency was observed with standard diesel characteristic than with neat poon biodiesel and its diesel blends.From this article prove that mahua methyl ester and mahua ethyl ester can be used a substitute for diesel fuel in CI engine. From the literature investigation methyl ester lead ethyl ester and diesel fuel in conditions of performance and emission. Additives will help out the petroleum to recover its engine combustion, performance and emission environmental standards. The additives selection will be based upon the drawbacks of biodiesel fuel such as density, toxicity, viscosity, economic feasibility, additives solubility, auto ignition temperature, flash point, and cetane number for the fuel blending process. Here nano powder metal based plays a vital task as a fuel additive in improving the engine performance characteristics and reducing the harmful exhaust gas harmful emission of internal combustion engineBy addition of oxygenated additives, the ignition temperature of biodiesel will be minimized and also reduction in smoke emission is observed in the diesel engine . According to the composition of diesel and biodiesel, the oxygenated additives will affect directly the properties such as cetane number, density, viscosity, volatility, flash point and calorific valueA metal based additive will minimize the viscosity, pour point and increase the flash point properties of biodiesel fuel. The BSFC decreases significantly due to their catalyst effect by adding the metal based additives. Few catalysts have capability to reduce HC and smoke emission. The oxygenated additive helps in reducing the viscosity and density as well as raising the quantity of oxygen in biodiesel fuel. The ethanol, DEE and isobutanol reduce the BSFC. Normally all exhaust emissions of carbon dioxide, carbon monoxide, hydrocarbon and smoke emissions are decreased very much with the addition of oxygenated additives to diesel and biodiesel fuels. Finally, it can be concluded that the additives are most important for biodiesel, but there are more investigations needed on non-edible oils and to enhance better evaluation.

**Rahul Krishnaji Bawane[ ]**has conducted an experimental work which is to conducted to obtain the operating and emission characteristics of Undi Oil Biodiesel on Variable Compression Ratio (VCR) engine run on various blends of biodiesel, compression ratios and load conditions. The result indicates that the variation in exhaust gas temperature is very minimal and showing the same trend at full load condition, but partial load condition upto 50% load, is distracted. For full load condition, when the compression ratio is varied from 14.5 to 17.5, the highest temperature obtained is 476°C for diesel, 467°C for H25, 434°C for H50 and 422°C for H75, all are at the compression ratio of 15.5. The lowest temperature obtained is 446°C for diesel, 434°C for H25, 394°C for H50 and 373°C for H75, all are at the compression ratio of 17.5. These performance characteristic curves of the biodiesel and its blends have been compared by with the diesel and found at all conditions, as shown in Figure, shows lower Exhaust Gas Temperature. When the load is increased, particularly at high loads. This could be due to low viscosity of biodiesel, which improve the spray formation in combustion chamber and thus leads to a less dominant diffusion combustion phase than diesel. For full load condition, the highest CO2 emission obtained is 4.47% for diesel with lowest emission obtained is 0.4% for H25, 2.86% for H50 and 3.19% for H75, all are at the compression ratio of 17.5. The lowest CO2 emission obtained is 1.96% for diesel, with highest emission obtained is 5.04% for H25, 3.75% for H50 and 4.32% for H75, all are at the compression ratio of 14.5. The HC emissions is higher at lower compression ratio, as expected, this is due to relatively less compression which retard the reactions of combustion, because of poor volatility, the poor spray characteristics, poor mixing, rich pockets formed in combustion chamber. Biodiesel and its blends results in slightly decreased brake thermal efficiency as compared to diesel over the entire range of compression ratio. BSFC for biodiesel and its blends are higher than that of diesel. Exhaust Gas Temperature, EGT, for the biodiesel and its blends found lower at all conditions as compared to diesel. The CO emissions are higher at lower compression ratio, and decreased at higher compression ratio.

The biodiesel and its blends emits lower percentage of CO2 as compared to diesel at higher compression ratio. The HC emission decreases with increase in compression ratio for the entire range of fuels, and for biodiesel and its blend it is higher than diesel. The NOx emission for entire range of fuel is higher at low compression ratio this is due to highest temperature is observed at this compression ratio. The O2 emission increases continuously with increases in compression ratio. Biodiesel and its blends shown higher O2 emission as compared to diesel. . From the comparison of results, it is inferred that the engine performance is improved with significant reduction in emissions for the chosen oils without any engine modification. Hence, it is proved that the biodiesel could be used as an alternative fuel in VCR engine without any engine modifications.

**Wail M. Adaileh** shows the experimental resultn that the fuel consumption rate, brake thermal efficiency, and exhaust gas temperature increased while the bsfc, emission indices of CO2, CO decreased with an increase of engine speed. Moreover, the engine power increased when increasing the biodiesel percentage varied from 1.23 to 3.2 for standard diesel while for B20 between 1.5 to 3.47.while brake specific energy consumption varied between 16.8 to 13.81 MJ/kW.kg for standard diesel, but for B5 found to be between 16.3 to 13 MJ/kW.kg. In particular, biodiesel produced with the addition of the peroxidation process had the lowest equivalence ratio and emission indices of CO2, CO. The emission of NOx among all of the test fuels found to be increased when using B5 and B20 instead of standard diesel and these results validate the data recorded by other previous work. Therefore, the peroxidation process can be used effectively to improve the fuel properties and reduce emissions when biodiesel is used. The performance of biodiesel and its blends (B5, and B20) were studied in comparison with diesel fuel. The biodiesel increased volumetric fuel consumption due to its chemically bound oxygen content. In contrast the petroleum derived fuels showed about the same consumption results. Overall, vegetable oil is an attractive alternative for diesel fuel in the frame of Single Fuel Policy. The fuel consumption increases as the biodiesel content in the fuel rises due to its lower heating power. Nevertheless, it should be noted that the biodiesel maintains approximately the same engine efficiency at that obtained with diesel fuel. Increasing the biodiesel content reduces the particulates in the engine exhaust prior to the after treatment. The engine after-treatment reduces particulate emissions drastically, hiding the potential benefits of biodiesel .Regarding NOx emissions the results obtained in this study1 show that the higher the biodiesel content, the higher the NOx emissions. In addition, it should be underlined that the effect of the fuel composition is less important than the effect of the EGR reduction due to the lower heating power of biodiesel. The increase in engine speed caused an increase in fuel consumption rate, brake thermal efficiency, equivalence ratio, and exhaust gas temperature, while at the same time decreasing the bsfc, emission indices of CO2, CO and the NOx for the four fuels.

**Harshad.T.Magar** The experimental investigation proves that Undi oil has less emission as compare to fossil fuel Hydro carbon, CO, NOx emissions are reduced for blend of Undi oil. Emission of CO2, CO, HC is reduced as compression ratio changes and mainly the emission of NOx is slightly increases. We are using Blend 20% in that emissions are minimizes compare to the diesel fuel also mechanical efficiency is increases. B60 blends the emission of NOx is increases due to high combustion temperature otherwise for blends is proportionally increases For blend B10 Brake Specific fuel consumption is minimum as compare to diesel.For liquid fuels as an alternative to diesel, which is being used in large quantities in transport, agriculture, Industrial, commercial and domestic sector. Increase environmental awareness and depletion of resources are driving industry to develop viable alternative fuel from renewable resources that are environmentally more acceptable. Among the many alternative fuels biodiesel are considered are most desirable fuel and vegetable oil is potential candidate. The world is confronted with the twin crises of fuel depletion and environmental degradation. The indiscriminate extraction and consumption of fossil fuels have led to a reduce in petroleum reserve. Alternative fuel, energy conservation and management, energy efficiency and environmental protection have become important in recent years. The increasing import bill has necessitated the search in present study efforts can be made to investigate the performance characteristics of diesel blended Undi biodiesel in VCR compression ignition engine. This work also includes the combustion analysis and Emission modeling. There was no difference in thermal efficiency resulting from the use of the various fuels to power the engine. The esters showed a slight power loss and increased fuel consumption, which was attributed to the lower gross heating values. Engine wear was normal. There was, however, an increased carbon deposition on the pistons with the methyl and butyl esters. Emissions of oxides of nitrogen were significantly higher for the esters. They concluded that the ester should be used on a short term basis, and that further testing to be done for determining long-term ester fuel effects.

**S. A. Ransing** The test has been conducted on single cylinder four stroke constant speed diesel engine using pure diesel, 10%, 20%, 30%, 40% and 100% blends. The engine model has been validated using GT-Power simulation software. Diesel engines emit significant amounts of particulate matter (PM) and oxides of nitrogen (NOx). They also emit small percentages of hydrocarbon (HC) and carbon monoxide (CO). It is seen that use of biodiesel as an alternate fuel in CI engine reduces CO, HC and smoke emissions but increases NOx emission due to higher oxygen content of biodiesel as compared to diesel. Performance curves such as brake thermal efficiency (BTE), brake specific fuel consumption (BSFC) have been plotted for pure diesel and blends. Performance results for B20 (20% undi oil and 80% diesel) follow closely to that of pure diesel. The aim of this project is to experimentally investigate the effect of biodiesel and its blends on CI engine performance. Raw undi oil has more free fatty acid (FFA) contain in it. When oil is undergone through transestrification process, FFA contain in it decreases and viscosity of oil also drops down. The use of undi oil and its blends as alternative fuel has been studied. It is seen that undi biodiesel can be used in

diesel engine without any modification. Blends such as B10,B20, B30, B40 and B100 have been used to carry out test on single cylinder diesel engine and performance parameters are calculated. The BTE and BSFC graphs show that, among all blends B20 blend follow closely to that of pure diesel. From experimental results, B20 blend shows 2.51% variation in BTE and 7.17% variation in BSFC at maximum power when compared with that of pure diesel. The engine model has been validated using GT-Power simulation software. The experimental results for BTE and BSFC of pure diesel and B20 blend vary within 10% when compared with that of simulation results. Simulation results of emission show that NOx emission increases and HC emission decreases with increase in percentage of biodiesel in blend.

**Gaurav Dwivedi** The aim of the present paper is to do a comprehensive review of engine performance and emissions using biodiesel from different feedstocks and to compare that with the diesel. From the review it is found that the use of biodiesel leads to the substantial reduction in PM, HC and CO emissions accompanying with the imperceptible power loss, the increase in fuel consumption and the increase in NOx emission on conventional diesel engine with no or fewer modification. However, many further researches about modification on engine, low temperature performance of engine, new instrumentation and methodology for measurements, etc., are recommended while using biodiesel as a substitute of diesel. The cetane number of all the oils is slightly lower than the diesel indicating that straight vegetable oil SVO are the potential substitute of diesel but the viscosity ranging from 27.2 (linseed oil) to maximum of 51.15 mm2 /sec (tallow oil) is considerably higher than diesel which indicates that there is a need to bring the viscosity of oil near to the diesel either by physical or chemical modification producing the resulting product as perfect substitute of diesel in all respect. The cold flow properties of SVO are lower than diesel indicating that performance of oil as fuel is difficult at low temperature due to its solidification as compared to diesel. The combustion product should not be toxic when exhausted to the atmosphere. These requirements can be satisfied using a number of liquid and gaseous fuels. The biodiesel from non edible sources like Jatropha, Pongamia, Mahua, Neem etc meets the above engine performance requirement and therefore can offer perfect viable alternative to diesel oil in India. The use of biodiesel will lead to loss in engine power mainly due to the reduction in heating value of biodiesel compared to diesel, and it result in the increase in biodiesel fuel consumption. From the review it can be concluded that the use of biodiesel favours to reduce carbon deposit and wear of the key engine parts, compared with diesel. It is attributed to the lower soot formation, which is consistent to the reduced PM emissions of biodiesel, and the inherent lubricity of biodiesel. The vast majority of literatures agree that NOx emissions will increase when using biodiesel. This increase is mainly due to higher oxygen content for biodiesel. Moreover, the cetane number and different injection characteristics also have an impact on NOx emissions for biodiesel. It is accepted commonly that CO emissions reduce when using biodiesel due to the higher oxygen content and the lower carbon to hydrogen ratio in biodiesel compared to diesel. It is predominant viewpoint that HC emissions reduce when biodiesel is fuelled instead of diesel. This reduction is mainly contributed to the higher oxygen content of biodiesel, but the advance in injection and combustion of biodiesel also favour the lower THC emissions. Literature has further reveals that the engine operation on biodiesel blend with diesel emit lower gaseous emission than diesel fuel expect NOX which increase to 2% with B20 and 10% with B100 use.

**Raahul Krishna & Ashish G** This paper presents experimental results on single cylinder vertical diesel engine with Calophyllum Inophyllum (Undi) biodiesel blends. Experiments were performed using pure diesel, 25%, 50% and 75% blends by varying the compression ratio and the exhaust emissions, namely hydrocarbon (HC), carbon monoxide (CO) and NOx were obtained using a computerized exhaust gas analyzer are presented here. From the results obtained, it wasconcluded that the biodiesel blends had equivalent emission characteristics with no modifications in the VCR engine.The percentage of CO emission for low compression ratio increases due to the rising temperature in the combustion chamber. The CO emission of the biodiesel and its blends are found to be lower for high compression ratio. For full load condition, when the compression ratio is varied from 14.5 to 17.5, the highest CO emission obtained is 1.054% for diesel, 1.585% for H25, 1.938% for H50 and 1.905% for H75, all are at the compression ratio of 14.5.The lowest CO emission obtained is 0.365% for diesel, 0.06% for H25, 0.066% for H50 and 1.187% for H75, all are at the compression ratio of 17.5.The effects of compression ratio on CO emissions for all engine load conditions are shown in Figures. The CO emissions are higher at lower compression ratio, however, decreased at higher compression ratio. The CO emissions for biodiesel and its blends are higher, compared to diesel over the entire range of fuel blends, except H25, due to poor volatility of biodiesel resulting in poor mixing, rich pockets formed in combustion chamber, and consequently, poor combustion, which leads to higher CO emission. The HC emission decreases with increase in compression ratio for the entire range of fuels, and for biodiesel and its blend it is higher than diesel. This is due to the complete combustion of fuel at a higher compression ratio, hence less amount of HC will emits. Biodiesel and its blends, due to poor volatility and poor mixing retard the chemical reaction which results in higher HC emission as compared to diesel. The NOx emission for entire range of fuel is higher at low compression ratio this is due to highest temperature is observed at this compression ratio. But the expected was, highest NOx emission obtained at highest compression ratio as the higher peak temperature observed with higher compression ratio. Therefore, it is proved that Calophyllum Inophyllum (Undi)biodiesel could be used as an alternative fuel in VCR engine without any engine modifications.

**Himansh Kumar** This review paper is about the various types of alternative fuels and the modification needed in compression-ignition engines to run effectively fueled with biofuels. All the modifications are considered on single cylinder four-stroke CI engine with rated power of 5.2 kW at 2000 rpm. Six types of modifications in compression-ignition engines are detailed and almost every performance and emission test results were described, i.e., BSFC, BTE, hydrocarbon emission, oxide of nitrogen emission, and carbon monoxide emission in this review paper. The outcomes of this survey shows that each and every modification have their own advantages and disadvantages but for modification of guide vanes at the inlet passage increased the breathing capacity of the CI engine and due to this brake thermal efficiency was increased and emissions were decreased. Alternative fuel preheating through exhaust gasses was also an optional solution to reduce the kinematic viscosity of liquid alternative fuel because it created the major problems like failure of rubber seals, injector coking, cold shut in winter time, etc. Thermal barrier coating is also a useful modification technique for increasing the efficiency and decreasing the emission, but due to insulation, inside temperature gets increased and NOx emission gets increased, but by adding additives in the alternative fuel it can be reduced. Dual fuel CI engine is also a good technique for using gaseous fuel, but the negative point is that the efficiency gets decreased and emissions gets increased, but the positive point is that the fuel cost gets decreased. Varying piston bowls type modification is also useful for proper mixing of the air–fuel mixture and complete combustion and toroidal combustion chamber type piston bowl is reported for good results. Intake air preheating by exhaust gasses is also a good modification technique for increasing the BTE, BSFC and less emissions, but for stationary engine it was not good because the breathing capacity decreased because of addition of heat exchanger in the intake passage, but for automobile industries, by the use of turbocharger and supercharger, the breathing capacity was also increased and an intercooler was added to control the temperature of intake air.

**M.M. Sayed** Diesel engine performance and exhaust emissions were studied experimentally for burning waste cooking-oil blend with diesel fuel. This experimental was applied on a diesel engine at different engine loads from zero to full load. Thermal efficiencies for waste cooking-oil biodiesel blends were lower than diesel oil. Specific fuel consumptions of biodiesel blends were higher than diesel fuel. Higher exhaust gas temperatures were recorded for biodiesel blends compared to diesel oil. CO2 emissions for waste cooking-oil biodiesel blends were higher than diesel oil. CO, smoke opacity and HC emissions for biodiesel blends were lower than diesel fuel. NOx emissions for biodiesel blends were higher than diesel fuel. Exhaust gas temperature increases with increase of engine load for all fuels. Thermal efficiency decrease for biodiesel blends about diesel fuel led to increase of heat loss in exhaust gases and increase of fuel consumption. The trend may be due to higher cylinder temperature inside the engine as more fuel is burnt. The heat loss in exhaust gases increased with the increase in engine load. Higher exhaust gas temperatures are recorded for biodiesel blends compared to fossil diesel for the entire engine load. Thermal efficiencies of waste cooking-oil biodiesel blends with diesel fuel were lower compared to diesel fuel and specific fuel consumptions were found to be higher. Higher exhaust gas temperatures were recorded for waste cooking-oil biodiesel blends compared to diesel fuel for the entire engine load. Air-fuel ratios for diesel-biodiesel blends B10, B20 and B30 were lower than diesel fuel. CO, HC and other emissions were lower for waste cooking-oil biodiesel blends compared to diesel fuel. NOX and CO2 emissions are increased with the increase of the percentage of biodiesel fuel in the blends.

**Hassan Abdulkadhim Abbas**  had verified with simulation study done by Dieselrk software and it reveals that they are in good agreement. The maximum pressure reduced as a result of increasing MEWCO blends due to the reduction in the heating value of the blended fuels. Both sides are reported promising reduction in nitrogen oxides (NOx) on the behalf of carbon emissions. Mixing 20% MEWCO is the best compromise, mixing ratio and beyond that, dramatic reduction in the outcome of the performance has been observed**.** Used cooking oils, which are no way wasteful, are one of the best efficient selections for production of biodiesel. The prepared biodiesel can be profitably be employed in an existing diesel engine. The performance characteristics follow the same trend for diesel and MEWCO. A reasonable agreement has been detected between experimental work and simulation study. Increasing the substitution of MEWCO came with a reduction in the BTE to a small extent and increased the fuel consumption. MEWCO biodiesel has lower NOx emissions compared with neat diesel. The exhaust temperature decreased by 10% as a result of replacing diesel fuel with MEWCO. Increasing the blending ratio of MEWCO reported increase in the carbon emissions. The present work confirmed 20% MEWCO is the advisable mixing ratio that keeps the outcome of performance, reduces the emissions of NOx as well as a slight increment in the carbon emissions comparable with other examined blends.

**Ahmed Emara** In this paper the experiments are conducted inside a water cooled, cylindrical, combustor fitted with a coaxially mounted waste oil burner. The measurements include the inflame and exhaust mean gas temperatures and the dry volumetric species concentrations (CO, NOx,CxHy and O2) at the combustor exit. The present results indicate that the blending ratio should not exceed 20% to ensure acceptable combustor efficiency and lower emissions. WCO was considered as oxygenated fuel oil despite of its improper atomization. Exhaust gas emission measurements of CO and NOx showed a significant decrease through the mixing of the waste cooking oil with light diesel fuel oil. The slight rise of CxHy (in WCO blends) with the increase of U indicates increased rate of pyrolysis of the fuel to CxHy which would partly converted to CO. The reduction of CO with the increase of U indicates accelerated combustion and hence increased rates of conversion to CO2; leading to better combustion efficiency. Micro explosion phenomenon affected on both flame lengths and flame temperature distributions due to the waste cooking oil addition and it will shorten the flame in that case. Micro explosion reaction happened due to the difference in liquid flash point, surface tension, viscosity, and density. Light diesel oil tended to produce sooty flames more than that of waste cooking oil. The relatively poorer atomization of WCO relative to LDO which leads to slower rates of vaporization, mixing of the volatiles with the combustion air leading to deterioration of the reaction rate and the abundance of CxHy levels particularly at extremely lean conditions.

**Sanjaykumar Dalvi** concluded that due to high yield of oil from seeds Undi has a promising source of feedstock for making of biodiesel in India.  
Very little information is available about the production and optimization of biodiesel from Undi oil . As per literature survey, the in-situ transesterification of Undi seed crush is not reported before. The aim of this research is to study the in-situ transesterification reaction of Undi seed crush for the preparation of biodiesel in single step. This study also aims to characterize the obtained product by GC-MS techniques to detect the presence of various components of the  
transesterified product which should give the conformity that the product is transesterified and various ethyls, methyl esters are formed which can be used as biodiesel.The reaction time was finalized for optimum yield is 60 minutes. The reaction was carried out at different temperatures . The temperature 60ºC gives maximum yield whereas the oil as also separated at 80ºC by rotary evaporator. The water quantity also affects the rate of reaction considerably.The method to prepare the biodiesel is usually double or triple stage reaction but the  
method applied in this paper is a single stage reaction.The biodiesel  
fraction from oil content was found 74.5 % at 60ºC and 400 rpm oscillations for 60 minutes time and normal atmospheric pressure without addition of water in the reaction mixture. The harmful organic reagent like n-hexane was not at all used in this method. Hence this technique is environment friendly. The Biodiesel obtained has low cost. One can support the replacement of petrodiesel by biodiesel; as it is easily recovered. The catalyst used is KOH which is cheap and easily available. The esters obtained clearly indicates that the Undi plant seeds can be used directly without extraction of oil from seeds for the preparation of fatty acid methyl/ethyl esters (Biodiesel) which will be suitable for use as replacement of diesel without any change in engine.

5. **ACTION PLAN / SCHEME OF IMPLEMENTATION**

The proposed work concentrates on obtaining a perfect blend of diesel with undi oil and waste cooking oil with nominal emission parameters when used in diesel engine and experimental investigation of various engine parameters. The work regarding this will be dividing in following phases.

**Phase 1:** Information Gathering-Literature Survey.

**Phase 2:** Project Formulation.

**Phase 3:** Objective, problem statement definition.

**Phase 4:** Preparation of experimental set up.

**Phase 5:** Experimentation.

**Phase 6:** Result analysis and Discussion.

**Table 5.1 Month Wise Scheme of Implementation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Topics searching | Literature survey | Detail study | Report making | Experimentation |
| June 19 |  |  |  |  |  |
| July 19 |  |  |  |  |  |
| Aug 19 |  |  |  |  |  |
| Sept 19 |  |  |  |  |  |
| Oct 19 |  |  |  |  |  |
| Nov19 |  |  |  |  |  |
| Dec 19 |  |  |  |  |  |
| Jan 19 |  |  |  |  |  |

**6. PROPOSED SETUP LAYOUT**

The various components of experimental setup are described below. The important components of the system are

* Engine &
* Dynamometer

**6.1 The Engine**

The engine chosen to carry out experimentation is a single cylinder, four stroke, vertical and water cooled, direct injection computerized Kirloskar make CI engine. This engine can withstand higher pressures encountered and also is used extensively in agriculture and industrial sectors. Therefore this engine is selected for carrying experiments. The specifications of the engine shown in the given in the actual photos of the C.I. engine and its attachments are shown in figure.

**6.2 DYNAMOMETER**

The engine has a DC electrical dynamometer to measure its output. The dynamometer is calibrated statistically before use. The dynamometer is reversible le, it works as monitoring as well as an absorbing device. Load is controlled by changing the field current. Eddy-current dynamometer theory is based on eddy current (Fleming's right hand law). The construction of eddy-current dynamometer has a notched disc (rotor) which is driven by a prime mover (such as engine, etc.) and magnetic poles (stators) are located outside with a gap. The coil which excites the magnetic pole is wound in circumferential direction. When current runs through exciting coil, a magnetic flux loop is formed around the exciting coil through stators and a rotor. The rotation of rotor produces density difference, then eddy-current goes to stator. The electromagnetic force is applied opposite to the rotational direction by the product of these eddy current shows in Fig:

****

**Figure 6.1. VCR Engine Setup**

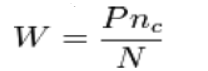
**6.3 Engine Specification**

|  |  |
| --- | --- |
| No of Cylinders | 1 |
| Fuel | Diesel |
| Rated power | 3.5 Kw |
| Rpm | 1500 Rpm |
| Cylinder diameter | 87.5 mm |
| Stroke length | 110 mm |
| Connecting rod length | 334 mm |
| Compression ratio | 12 to 18.1 |
| Orifice diameter | 20 mm |
| Dynamometer arm length | 185 mm |
| No of strokes | 4 |

**6.4 Proposed Calculations**

**6.4.1. Brake Mean Effective Pressure (BMEP):**

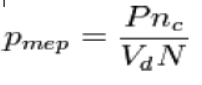
It is an important parameter for comparing the performance of different fuels and defined as the average pressure the engine can exert on the piston through one complete operating cycle. It is the average pressure of the gas in the fuel mixture inside the engine cylinder based on net power. BMEP is independent of the RPM and size of the engine. If N is the number of revolutions per second, and nc the number of revolutions per cycle, the number of cycles per second is just their ratio (W) which can be expressed by



By definition:

***W* = *pmep* \* *Vd***

So that:



**6.4.2. Brake Horsepower (BHP):**

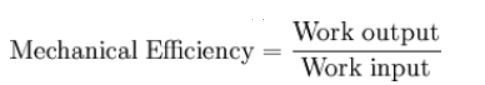
It is the measure of an engine's horsepower before the loss in power caused by the gearbox, alternator, water pump, and other auxiliary components like power steering pump, muffled exhaust system, etc. Brake refers to a device used to load an engine and hold it at a desired RPM. During testing, the output torque and rotational speed can be measured to determine the brake horsepower which is the actual shaft horsepower and is measured by the dynamometer by :

**BHP = IHP-FP**

Where BHP is brake horse power and IHP is indicated horse power while FP is frictional power The indicated power is produced from the fuel inside the engine while some power is lost due to friction the remaining power available at the shaft of the engine is brake horse power.

***6.4.3. Mechanical Efficiency :***

Part of the indicated work per cycle is used to expel exhaust gases, induct fresh air, and also overcome the friction of the bearings, pistons, and other mechanical parts of the engine. The mechanical efficiency is the measure of the ability of the engine to overcome the frictional power loss and can be defined as



The work output is also defined as brake horse power and input is indicated horse power and the ratio of BHP to IHP is defined as mechanical efficiency.

**6.4.4. Brake Specific Fuel Consumption (BSFC):**

The BSFC defined as the fuel flow rate per unit of power output is a measure of the efficiency of the engine in using the fuel supplied to produce work. It is desirable to obtain a lower value of BSFC meaning that the engine used less fuel to produce the same amount of work. It can be calculated by:

**BSFC (g/kWh) =Wf /Pb**

Where,

Wf = fuel consumed (g/h) ,

Pb = brake power (kW)

which can be calculated by:

**Pb = Pg/g**

Where,

Pg = load (kW) at generator end

g = efficiency of the generator

**6.4.5**. **Brake Thermal Efficiency (BTE):**

It is the ratio of the thermal energy in the fuel to the energy delivered by the engine at the crankshaft. It greatly depends on the manner in which the energy is converted as the efficiency is normalized respect to the fuel heating value. It can be expressed by:

**BTE (b ) = Pb/(mf x NCV)**

Where,

Pb = brake power (kW) ,

mf = fuel consumption (kg/sec) ,

NCV = net calorific value (kJ/kg)

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