EXPERIMENTAL INVESTIGATION OF PERFORMANCE AND EMISSION CHARACTERISTICS OF CI ENGINE USING GHRAPHENE NANOPARTICLES AS AN ADDITIVE IN BIODIESEL

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Abstract : Whenever we think of fuel, fossil fuels like petroleum and diesel fuels were first comes in our mind. As we know that the fossil fuels are destroyed day by day due to the increased population and increased energy requirement sectors. The diesel engines have their own advantages like reliability, durability and fuel economy etc, but also have disadvantages such as excess emissions of harmful emission like unburned hydrocarbons, carbon monoxides, particulate matter and nitric oxides. The harmful emissions from engines may cause many hazardous effects on environment as well as human beings like greenhouse effect, acid rain, global warming, smog, climatic change, ozone layer depletion, green and reduced air quality in environment. These emissions will also effects on living beings as eye irritation, breathing problem, and lung cancer and skin diseases. So for all the above mentioned problems effects on environment as well as living being, to reduce these effects many researchers have adopted many methods as engine modification, fuel alteration instead of fossil fuels and exhaust gas treatment. In this way biodiesel is an alternative fuel for diesel engines because of their advantageous properties. A renewable fuel such as biodiesel, with lesser exhaust emissions, is the best available sources to fulfil the energy demand of the world. Hence, the scientists are looking for alternative fuels. India is importing more than 80% of its fuel demand and spending a huge amount of foreign currency on fuel. Biodiesel is gaining more and more importance as an attractive fuel due to the depleting nature of fossil fuel resources. Hence, researchers and scientific community worldwide have focused on development of biodiesel and the optimization of the processes to meet the standards and specifications needed for the fuel to be used commercially without compromising on the durability of engine parts. The interest in the use of renewable fuel started with the direct use of vegetable oils as a substitute for diesel. Biodiesel is derived from vegetable oils such as soybean, peanut, sunflower, rape, coconut, karanja, neem, cotton, mustard, jatropha, linseed and coster have been evaluated in many parts of the world in comparison with other non-edible oils.

1.1. Fuel alteration

1.1.1 Plant oils used for Biodiesel

The interest in vegetable oils originated in the late 70's and came from the agrarian sector, which is still one of its main drivers. Initially, it was believed to be possible to use these oils directly with a low processing level. Extensive testing by the engine industry has shown that unmodified engines, while operating satisfactorily, would quickly develop durability problems, due to problems with fuel injectors, piston rings and lubrication oil stability. For this reason the engine must be modified. Such modifications can at present be made by a number of facilities mainly in Germany. More than 5000 vehicles are presently using pure vegetable oil in Germany. Nevertheless one can still find examples of claims that PVO can be used in any unmodified engine. A variety of bio-liquids can be used to produce biodiesel. The main plants whose oils have been considered as feed stocks for bio fuel are soya bean oil, rapeseed oil, palm oil, sunflower oil, honge oil and jatropha oil. Others in contention are mustard, hemp, castor oil, waste vegetable oil, and in some cases even algae. There is going on research into finding more suitable crops. A list of oils that appear to have the potential for biodiesel is provided below:

1) Algae 2) honge oil 3) Canola oil 4)Castor oil 5) Coconut oil 6) Corn oil 7) Cottonseed oil 8) Flax oil 9) Hemp oil 10) Jatropha oil 11) Jojoba oil 12) Karanj oil 13) Kukui nut oil 14) Milk bush shrub 15) Mustard oil 16) Neem oil 17) Olive oil 18) Palm oil 19) Peanut oil 20) Radish oil 21) Rapeseed oil 22) Rice bran oil 23) Safflower oil 24) Tung oil 25) Sunflower oil 26) Soyabean oil 27) Waste vegetable oil

The major advantages of natural vegetable oil

High calorific value: high energy density

Liquid in form and thus easily to be handled

When burned it emits less soot

When burned it has high energy efficiency

It is neither harmful nor toxic to humans, animals, soil or water. It is neither flammable nor explosive, and does not release toxic gases.

It is easy to store, transport and handle

It does not cause damage if accidentally spilt

Its handling does not require special care to be taken

It is produced directly by nature: it does not have to be transformed

It is a recyclable form of energy

It does not have adverse ecological effects when used

It does not contain sulphur it does not cause acid rain when used

Does not need to modify the engine when they are used in engines.

1.1.2 Problems in using vegetable oils in CI engines

It has been found that neat vegetable oil can be used as diesel fuel in conventional diesel engines, which leads to the following problems: The injection, atomization and combustion characteristics of vegetable oils in diesel engine are significantly different from those of the diesel fuel. High viscosity of vegetable oil interferes with the injection process and leads to poor fuel atomization. The inefficient mixing of oil with air contributes to incomplete combustion, leading to heavy smoke emission. The high flash point attributes to lower volatility characteristics. Both cloud and pour point are significantly higher than that of diesel fuel. These high values may cause problems during cold weather. High carbon deposits. Ring sticking. Injection nozzle failure. These problems can be solved, if the vegetable oils are chemically modified to bio-diesel.

1.1.3 Honge Oil

Honge oil is derived from the seeds of the Pongamia tree. However the is a much ignored tree now. It grows on regardless, waiting for its virtues to be re- discovered. It is a hardy tree that mines water for its needs from 10 meter depths without competing with other crops. It grows all over the country, from the coastline to the hill slopes. It needs very little care and cattle don't browse it. It has rich leathery evergreen foliage, which is wonderful manure. From, year-3 it yields pods and production is a mature average of 160 kg per year from year-10, through to its life of 100 years. Ten trees can yield 400 litres of oil, 1200 kg of fertilizer grade oil cake and 2500kg of biomass as green manure per year.

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1.1.4 Biodiesel

Biodiesel is a diesel replacement fuel that is manufactured from vegetable oils and animal fats. Because plants produce oils from sunlight and air, and can do so year after year on cropland, these oils are renewable. Animal fats are produced when the animal consumes plant oils and other fats, and they too are renewable.

The biodiesel manufacturing process converts oils and fats into chemicals called long chain mono alkyl esters, or biodiesel. These chemicals are also referred to as fatty acid methyl esters or FAME. In the manufacturing process, oils or fats are reacted with a short chain alcohol (usually methanol) in the presence of a catalyst (usually sodium or potassium hydroxide) to form biodiesel and glycerine. Glycerine is a sugar, and is a co- product of the biodiesel process.

1.1.5 Benefits of Biodiesel

The following are the benefits that are derived on the usage of biodiesel:

- Biodiesel reduces the dependence on diesel and checks the growing demand for diesel by being a suitable alternative.
- Biodiesel reduces emissions of carbon monoxide (CO) by approximately 50% and carbon dioxide by 78 % on a net lifecycle basis because the carbon in biodiesel emissions is recycled from carbon that was already in the atmosphere, rather than being new carbon from petroleum that was sequestered in the earth's crust.
- Biodiesel is biodegradable and non-toxic. Biodiesel has higher cetane rating than petro diesel, and therefore ignites more rapidly when injected into the engine.
- Biodiesel has a higher calorific value of around 41860 kJ/kg on etherification suiting it as an alternate fuel.
- Biodiesel reduces by as much as 65 % the emission of particulates, small particles of solid combustion products. This reduces cancer risks by up to 94%.
- Biodiesel has lesser sulphur content which reduces sulphur oxides emissions and also improves lubricity in the engine.
- Biodiesel is easy to use and requires no or very little engine modifications

II. LITERATURE SURVEY

2.1 Biodiesels

As the fossil fuels are depleting day by day, there is a need to find out an alternative fuel to fulfil the energy demand of the world. Biodiesel is one of the best available sources to fulfil the energy demand of the world More than 350 oil-bearing crops identified, among which some only considered as potential alternative fuels for diesel engines. Even though 350 oil bearing crops are identified, only few are potential biodiesel like sunflower, rapeseed, palm and jatropha. It is observed that biodiesel has similar combustion characteristics as diesel and also found that the base catalyst performs better than acid catalyst and enzymes. Ahn et al. [1] followed a two-step reaction process to produce biodiesel. Using this method canola methyl ester (CME), rapeseed methyl ester (RME), linseed methyl ester (LME), beef tallow ester (BTE) and sunflower methyl ester (SME), synthesized in a batch reactor using sodium hydroxide, potassium hydroxide and sodium meth oxide as catalysts. Cvengro and Povaz et al. [2] described biodiesel production by using two-stage low-temperature transesterification of cold pressed rapeseed oil with methanol at temperatures up to 708C. A new enzymatic method of synthesizing methyl esters from plant oil and methanol in a solvent-free reaction system was developed by Masaru et al. [3]. Demirbas et al. [4] studied a non-catalytic biodiesel production with supercritical methanol, which allows a simple process and high yield because of the simultaneous transesterification of triglycerides and methyl esterification of fatty acids. Zhang and Van Gerpen et al [5] investigated the use of blends of methyl esters of soybean oil and diesel in a turbo-charged, four cylinders, direct injection diesel engine modified with bowl in piston and medium swirl type. They found that the blends gave a shorter ignition delay and similar combustion characteristics as diesel. Sinha and Agarwal et al. [6] investigated the combustion characteristics of rice bran oil in transport diesel engines. Murayama et al. [7] reported that vegetable oils and methyl ester of rapeseed oil offered lower smoke and oxides of nitrogen (NOX) emissions. Scholl and Sorenson et al. [8] reported that carbon monoxide, oxides of nitrogen (NOX) and smoke emissions were slightly lower for soybean ester than diesel, whereas HC emission showed 50% reduction compared to diesel. Nwafor and Rice et al. [9] Reported that unburnt hydrocarbon emission was lower when operated with rapeseed methyl ester. A heavy-duty engine exhaust emission by using methyl ester soybean oil/diesel fuel blends was tested by Schumacher et al. [10]. The use of methyl esters of sunflower oil, cottonseed oil, soybean oil and corn oil as fuel in a single cylinder direct injection diesel engine had been tested by Altin et al. [11]. Bari et al. [12] discussed the effects of preheating of crude palm oil on emissions of diesel engine. Senthil Kumar et al. [13] observed reduction in smoke, hydrocarbon and carbon monoxide emissions with the induction of hydrogen. However, the NOX emissions increased due to higher combustion rates. Labeckas and Slavinskas et al. [14] analyzed the emission characteristics of four stroke, four- cylinder, direct injection, unmodified, naturally aspirated diesel engine when operating on neat rapeseed methyl ester (RPE) and its 5%, 10%, 20% and 35% blends with diesel fuel. They found that carbon monoxide, hydrocarbon and visible emissions had decreased while an oxide of nitrogen emissions increased for methyl ester compared to diesel. Lin et al. [15] compared the trace formation from the exhaust gas of a diesel engine when operated using the different fuel types of fuel such as neat biodiesel (waste cooking oil), biodiesel/diesel blends, and normal diesel fuels. The use of sunflower, safflower and rapeseed oils as liquid fuels was investigated by Bettis et al. [16]. They found that engine power output to be equivalent to that of diesel fuel, but long-term durability tests indicated severe problems due to carbonization. Ryan et al. [17] investigated the injection and combustion properties of several vegetable oils namely peanut oil, cottonseed oil, sunflower oil and soybean oil.

III.METHODOLOGY

3.1. Piston modification for Swirl effect

Swirl is useful for proper mixing of air and fuel in combustion chamber. Swirl motion of air will be produced by providing 4 tangential grooves on the hemispherical piston crown; this will be produced during suction as well as compression strokes of engine operation. But swirl motion is decreases as piston moves towards the top dead centre due to the decrease of angular momentum air as in normal operation. So for this purpose on the top of piston slots (grooves) are made with different widths of 5.5mm, 6.5mm and 7.5mm and depth of 2mm. At the end of compression these grooves enhances the angular momentum air. For complete combustion of air-fuel mixture in cylinder we must provide an optimum swirl effect. For minimum swirl effect leads to incomplete combustion and for maximum swirl effect cause incomplete combustion due to the air will escapes away from fuel so mixture does not mix properly.

3.2. Experimental setup

Experiments will be conducted on a four stroke single cylinder direct injection CI engine as shown in Fig.1.

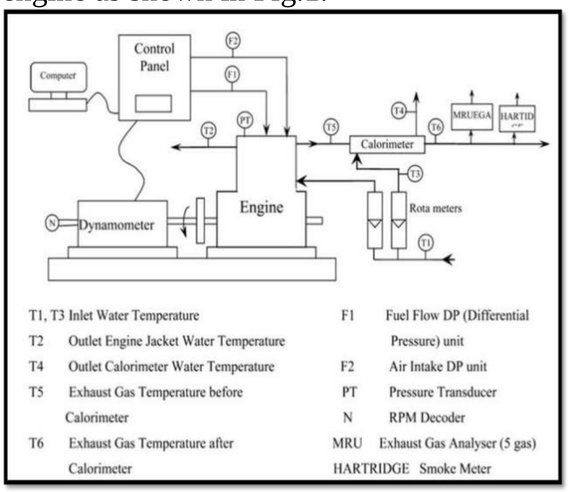

Fig 1 Experimental set up

All experiments will be carried out at rated speed of 1500RPM for different load conditions. Readings will be taken after the engine attained stability of engine operation. Exhaust gas analyzer for measurement of emissions such as HC, CO, NOx and smoke meter for measuring smoke capacity will be switched ON and allowed to stabilize before measurements. Instruments will be periodically calibrated.

IV.CONCLUSION

In the project work phase-I, I have referred the research papers regarding Bio- diesels usage, importance and availability, preparation of biodiesel, trans-esterification process, Honge oil, Piston modification for Swirl effect, nanoparticle. After referring all the papers I have selected Honge Oil as a Biodiesel for carrying out this project and for preparation of Biodiesel I have selected transesterification process. After the survey of research papers regarding Piston modification for Swirl effect, nanoparticle CI engines I have found some disadvantages, hence I am going to carry out the tests of performance, combustion and emission characteristics of Piston modification for Swirl effect, Low heat rejection engines, nanoparticle and Low heat rejection engine. Hence I conclude to select the title "Experimental Investigation of performance and emission Characteristics of CI engine using Graphene Nanoparticles as additive in biodiesel".

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