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Improving Pyrolysed Oil Efficiency by Distillation

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Abstract— The scarcity of crude oil price and increase in environmental pollution there is a necessity to search for alternative fuel for internal combustion engines. In this investigation, the pyrolysed oil was distilled using distillator to get better efficiency. The pyrolysed oil was extracted from various seeds like Velikathan (prosopis juliflora) and Coconut shell. The pyrolysed oil was then distilled using a distillation setup. The flash point, fire point, viscosity, density of the oil was observed. The results were compared with diesel and pyrolysed oil before distillation and are presented in this paper. Pyrolysis is the thermal degradation of carbonaceous materials at temperatures between 300^0C and 700^0C in the absence of oxygen. The process is endothermic and requires an external indirect input of energy typically through the walls of the reactor. The heat volatilizes and decomposes the organic matter to produce a pyrolysis gas, liquid and solid char in relative proportions depending on the process parameters of temperature and pressure. But many undesired impurities were found while extracting pyrolysed oil. These may occur due to: (i) Failure of condenser (ii) ageing of condenser and other apparatus (iii) deposition of carbon and char on the inner surfaces of apparatus (iv) fault of pyrolysis reactor. For such reasons many a times the efficiency of oil is reduced. Distillation can be used for removing excess water content from pyrolysed oil and in turn to increase its efficiency. Distillation is the process in which a liquid is vaporized (turned to steam), re-condensed (turned back into a liquid) and collected in a container. The main aim of this study is to use oil obtained from pyrolysis and distill it for improving its efficiency and properties. Our studies have shown a considerable decrease in the viscosity and density values of distilled oil when compared with normal pyrolysed oil which has a desirable result. The viscosity and density were calculated by using ultrasonic interferometer for getting more accurate results.

Keywords: distillation, pyrolysed oil, density, viscosity, pyrolysis, condenser.

I. INTRODUCTION

In concern with the environmental issues like global climate change, has stimulated research in to the development of more environmental friendly technologies and energy sources. There is a necessity to search for alternative fuels for internal combustion engines. Among the safer methods of waste disposal, pyrolysis is a technique in which the feedstock is thermally degraded in the absence of oxygen. The resulting products of pyrolysis were solid char, liquid pyrolytic oil and gases. Each of the products formed has potential usage such as energy carrier and chemical feed stocks further the processing.

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Experiments with bio-diesels have been carried out byJoel Blin, Ghisilinevolle and Philip Girad, "Experimental investigation ofpyrolysis oil with biodiesel in 2012.Many research works were carried out on the use of pyrolysed oil in the 1990's and 2000. Due to the energy crises in the late 1990's, it hasbeen a necessity to seek alternative energy sources to conventional sources of energy.India being anagriculture based country produces around $6.7x10^6$tons of non-edible oils such as Velikathan (prosopis juliflora), linseed, Neem (Azadirachtaindica), and Kusum (SchelcheraTrijuga).These oils can be used as alternative fuels in compression ignition engines after modifying the fuel structure or properties or modifying the engine. On the other hand edible oils such as groundnut oil, coconut oil, mustard seedoil are restricted IC engines oil as they areused in domestic purpose.The main hindrance to use thenon-edible oil as fuels incompression ignition engines cause problemslike carbon deposit, injector cokingand wear and tear in fuel injector. Viscosity of these oils and their structure are importantcharacters that result in such problems. Hence, theoil obtained from those seeds must be converted into engine adoptedfuel. There are various methods available to reducethe viscosity of such oils. They are (i) Blending (ii) Micro emulsification(iii) Preheating (iv) Transesterification (v) Pyrolysisand thermal cracking.

Among these different methods, pyrolysis is useful in deriving fuels from different kind of seeds.Pyrolysis is the thermal degradation of carbonaceous materials at temperatures between 300^oC and 700^oC in the absence of oxygen. The process is endothermic and requires an external indirect input of energy typically through the walls of the reactor. The heat volatilizes and decomposes the organic matter to produce a pyrolysis gas, liquid and solid char in relative proportions depending on different parameters of temperature and pressure. Many a time's undesired impurities are found while extracting pyrolysed oil. These may occur due to: (i) failure of condenser (ii) ageing of condenser and other apparatus (iii) deposition of carbon and char on the inner surfaces of apparatus (iv) fault of pyrolysis reactor. For these reasons the efficiency of oil used in the engine have less efficiency.

Distillation can be used for removing excess water content from pyrolysed oil and in turn increasing its efficiency.Distillation is the process in which a liquid is vaporized (turned to steam), re-condensed (turned back into a liquid) and collected in a container.The main aim of the present study is to use oil obtained from pyrolysis and distill it for improving its efficiency.

II. Properties Of Oil

The comparison of fuel properties of pyrolysed oil, distilled oil and diesel fuel are given in Table 1 and Table 2.

Table 1 Comparison of pyrolysed oil with diesel

Properties	Diesel	Velikathan seed	Coconut shell
Densityat 40°C(kg/m^3)	841.5	999.81	1072.42
Flash point(°C)	52	112	88
Fire point(°C)	58	117	92
Viscosity at 40°C (centistoke)	3.42	3.11	3.99
Specific gravity	0.842	0.999	1.072

Table 2 Comparison of distilled pyrolysed oil with diesel

Properties	Diesel	Velikathan seed	Coconut shell
Density at 40°C (kg/m^3)	841.5	1015.52	1085.21
Flash point(°C)	52	82	68
Fire point(°C)	58	88	72
Viscosity at 40°C (centistoke)	3.42	4.2	4.78
Specific gravity	0.842	1.016	1.085

It is observed from the table that the properties ofdistilled pyrolysed oil is closer to diesel fuel. The properties like Viscosity, Density, Flash point, Fire point were reduced after distillation.

III. Experimental Setup

The schematic diagram of the experimental setup is given in figure 1.

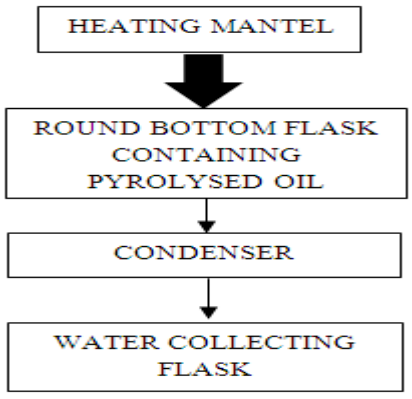

Fig 1 Block diagram of experimental setup

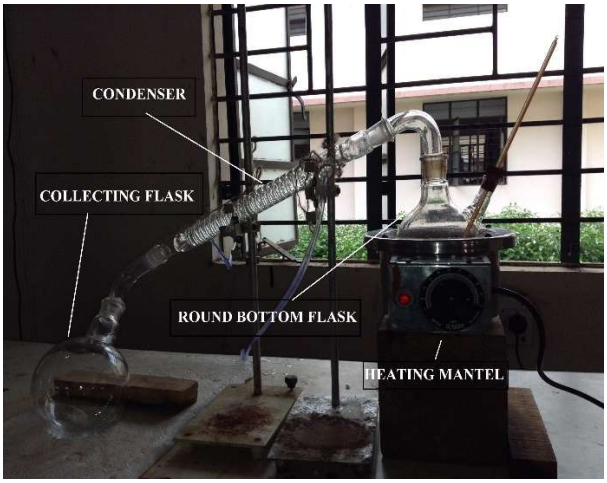

Fig 2. Pictorial representation of distillation.

The apparatus required for the experiment are:

Round bottom flask, condenser, collecting flask and heating mantel.

- The heating mantel heats the oil upto a maximum temperature of 100°C.
- Double neck round bottom flask of 500 ml capacity is attached with a mercury thermometer (300 °C).
- The coil type condenser is used for condensing the steam generated.
- The condensed water is collected by a flask of 500ml capacity.

IV. Results and Discussion

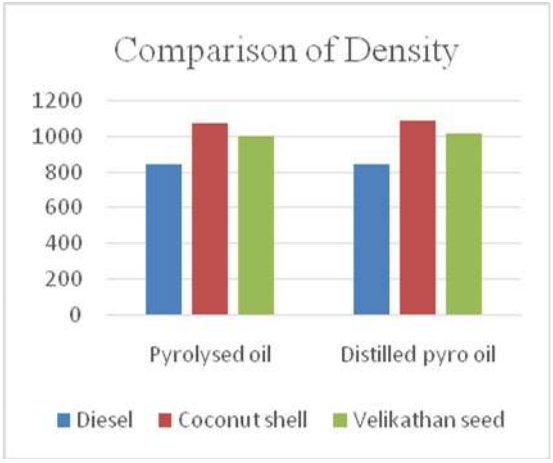

Fig 3 Comparison of Density

Fig 3 illustrates the relationship between the densities of bio fuel and diesel. At a certain temperature (40°C) it is observed that the density of distilled pyrolysed oil is higher than compared to pyrolysed oil.

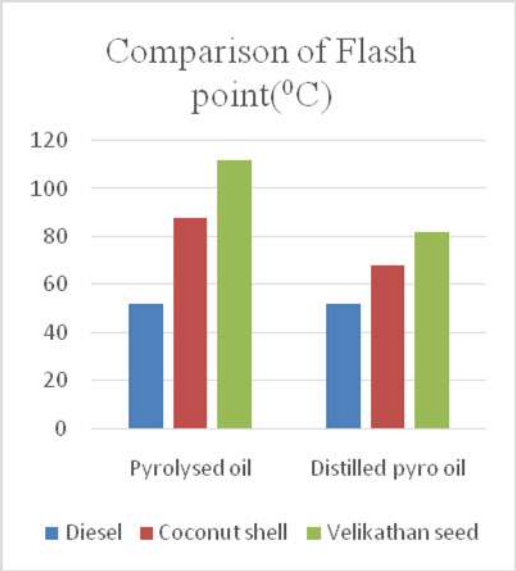

Fig 4 Comparison of Flash point

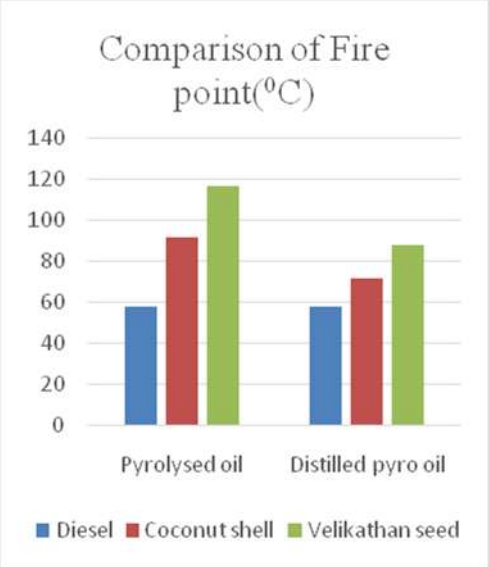

Fig 5Comparison of Fire point

Fig 4 and Fig 5 represents the relationship of flash and fire point between diesel and the bio fuel. It is observed that the flash and fire point of the distilled pyrolysed oil is low as compared to the pyrolysed oil. Hence this decrease in flash and fire point may be due to reduced content of moisture.

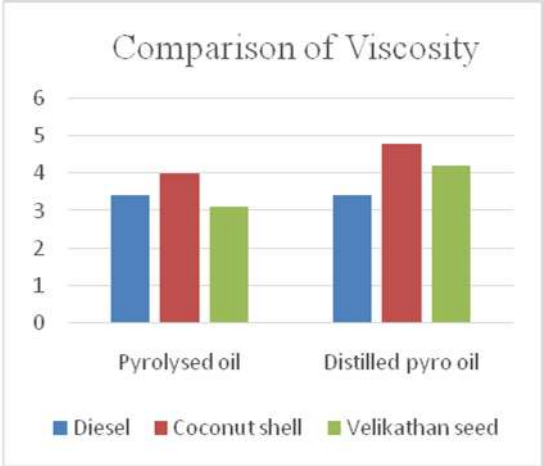

Fig 6 Comparison of Viscosity

Fig 6 depicts the variation of viscosity at 40^{o}C for various bio fuel. The fig shows that the viscosity of the distilled pyrolysed oil is increased as compared to the pyrolysed oil. The probable reason for the increase in viscosity may be due to increase in density.

Fig 7 Pyrolysed

oil

Fig 8 DistilledPyrolysed oil

Fig 9 Water removed from oil

V. CONCLUSION

The following conclusions were made on the observations of various properties of the distilled pyrolysed oil.

- The flash point of the distilled pyrolysed oil is comparatively low than the pyrolysed oil which is closer to the diesel.
- The fire point at which the fuel burns is also reduced as compared to pyrolysed oil which is more desirable.
- In contrary density of oil increased which may be due to the reduction of moisture content in pyrolysed oil.
- The viscous nature of the distilled pyrolysed oil is increased due to increase in viscosity. The less viscous fuel is desirable for smooth engine functioning.
- As the flash and fire point of distilled pyrolysed oil is low, the combustion can take place at a low temperature, which in turn increases the efficiency of the oil.
- On other hand, the density and viscosity of distilled pyrolysed oil is increased compared to pyrolysed oil, which makes the oil denser, viscous and changes the properties of pyrolysed oil.
- The distillation process results in the removal of unwanted moisture content.
- Thus this study shows that the pyrolysed oil has improved its properties due to the removal of water content by distillation process. Hence the distilled pyrolysed oil has greater efficiency than normal pyrolysed oil.

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