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FUEL PREHEATER FOR DIESEL ENGINE

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ABSTRACT

Petroleum energy resources are one of those major energy resources. Every automobiles uses petroleum based fuels. The causes of technical problems arising from the use of various biodiesel are the high surface tension and the high viscosity. In case of the CI engine, high surface tension and viscosity attains improper homogeneity in charge and fuel atomization. This reduces the overall efficiency of the engine. In order to overcome this, fuel preheating are adopted. Preheating is the technique to decrease viscosity of the fuel. The preheating of fuel can be done for various temperatures which reduces the viscosity and surface tension of the fuel which enhances better fuel injection and there by better fuel atomization. The various methods of fuel preheating available are, by using exhaust heat and by using heat from radiator. These methods are too heavy and containing complex circuits including heat exchangers. So we are trying to adopt direct heating of fuel through battery and using mechatronics approach. This paper shows that preheating of fuels effectively decreases the kinematic viscosity, density and surface tension properties which dominantly improves injection of biodiesel by contributing to better fuel atomization at the elevated temperature of the biodiesel.

Keywords: *Biodiesel, viscosity, atomization, battery, preheating, mechatronics*

INTRODUCTION

Industrial development and economy of any country mainly depends on its energy resources. Petroleum energy resources are one of those major energy resources. Every automobiles uses petroleum based fuels. The causes of technical problems arising from the use of various biodiesel are the high surface tension and the high viscosity. In case of the CI engine, high surface tension and viscosity attains improper homogeneity in charge and fuel atomization. This reduces the overall efficiency of the engine. Preheating is the technique to decrease viscosity of the fuel. The preheating of fuel can be done for various temperatures which reduces the viscosity and surface tension of the fuel which enhances better fuel injection and there by better fuel atomization. The preheating of fuel results in complete combustion of the fuel that results in complete utilization of fuel thus leading to the better efficiency. Presently we are using the fuels directly to engine and the viscosity of the fuel is more and thus results in the improper combustion of fuel. Hence to overcome this problem we are using preheating method with mechatronics approach.

In current scenario emissions from diesel engines seriously threaten the environment and are considered one of the major sources of air pollution. These pollutants lead to environmental problems and carry carcinogenic components that significantly endanger the ecological systems and the health of human beings. This situation needs to be overcome by switching from conventional fuels to alternative fuels. Use of biodiesel as fuel is better option for replacing the conventional fuel. As biodiesel is a clean and neat burning fuel and has an advantage on diesel fuel because of its biodegradable and less toxic nature, superior lubricity and better emission characteristics. The non-renewable nature and limited resources of petroleum fuels has become a matter of great concern. The economic and political factors are greatly associated with their Appropriation. The combustion of these fuels in CI engines causes pollution. All these aspects have drawn the consideration to conserve and stretch the oil resources by way of alternative fuel research.

Transesterification, pyrolysis is the processes generally performed in order to reduce the viscosity of biodiesel but still it is higher to that of the diesel. Thus preheating is the technique to decrease viscosity of the biodiesel. The preheating of diesel i.e, to the temperature just below the flash and fire points nearly about 60 °C and biodiesel at different temperature as at 60 °C, 90 °C, 120 °C, 150 °C reduces the viscosity and surface tension which enhances better fuel injection and there by better fuel atomization. To increase the fraction of biodiesel in blends, it is required to reduce the viscosity by preheating. The preheating of biodiesel results in complete combustion of the biodiesel or fuel that results in decreased in amount of carbon dioxide, carbon monoxide and particulate exhaust emission is also complete combustion of biodiesel and cleaner exhaust can be obtained while elevated temperature of the fuel increases NOx emissions. The use of the biodiesel is being restricted due to variation of its injection, ignition and emission characteristics from that of the diesel. The direct use of vegetable

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International Journal OF Engineering Sciences &Management Research

oils is generally considered to be unsatisfactory and impractical for diesel engines. The high viscosity, density of vegetable oil interferes with the injection process and leads to poor fuel atomization. This results in inefficient mixing of fuel with air contributes to incomplete combustion, carbonization of injector tip, poor cold engine start up, misfire and ignition delay period. It is therefore unsuitable to use straight vegetable oils in diesel engines. To overcome these problems caused by the high viscosity of vegetable oils, a number of techniques have been used. These include vegetable oil/diesel blends, preheating the vegetable oil.

Research work is carried out to perform the performance of engine and exhaust emissions using preheated vegetable oils. Barsic have indicated that it is essential to preheat the vegetable oil to 70–900 0C to resolve the fuel filter clogging problem.

SURVEY

Rafidah Rahim et.al., [2012], Study the effect of temperature using 5% biodiesel blended on diesel engine performance. The one-dimensional numerical analysis of power software is used to simulate the commercial four cylinder diesel engine. The standard fuel data base of power does not contain any biodiesel. Therefore, the authors have measured typical physical properties of the fuel before it can be installed into the power data base. The diesel engine is simulated to study the characteristic of engine performance when the engine is operating with fuel blend as an alternative fuel. The simulations are conducted at full load condition where the temperature are varies from 300 K to 500 K. The simulation results show that the brake power and brake torque reduced maximum of 1.39% and 1.13% respectively for the engine operating with fuel blend at different temperatures.

Murugu Mohan Kumar Kandasamy et.al., [2009], This paper discusses the performance characteristics of a single cylinder diesel engine using rice bran and pungam oil blended with diesel fuel. The experiments were carried out for the various blends i.e., B20, B40, B60, B80 and the results were compared with the neat diesel. The blended fuel is preheated before it is being injected to cylinder. The preheating ensures the enhancement of combustion efficiency and the overall performance of the engine.

Bhargav K Jaiswal et.al., [2015], Diesel engine play important role in field of power and energy. This paper deals with the fuel inlet temperature which is affected on engine parameter. It is observed that the BSFC for with and without preheating fuel can shown that the best BSFC can obtain at 400 oC temperature 1.53 to 0.31kg/Kwhr but the 500 oC temperature BSFC also nearly equal 1.51 to 0.27 kg/Kwhr. BTE increase with increase engine load for with and without preheating diesel fuel from the observation the BTE were 36.07%, 27.65%, 33.73%, 32.15% respectively. After the Pre heating the best BTE are at 450 oC temperature.

OVERVIEW OF EXISTING DEVICES

Air Pre-heater

The output of the engine exhaust gas is given to the input of the ignition system, so that the proper ignition is occurred. In this case, the efficiency of the engine is also increased. The exhaust gas is given to the heating chamber as shown in figure. The exhaust hot air is used to pre-heat the input air into the ignition system. Preheating is basically a volatile liquid fuel mixture of hydro carbons. As described already it is a by-product during the distillation of crude mineral oil and refining it further by other processes. It does not have a fine composition. The constituents vary depending upon the origin of the crude mineral oil. The high pressure gas exiting the cylinder initially flows in the form of a “wave front” as all disturbances in fluids do. The exhaust gas pushes its way into the pipe which is already occupied by gas from previous cycles, pushing that gas ahead and causing a wave front. Once the gas flow itself stops, the wave continues on bypassing the energy to the next gas downstream and so on to the end of the pipe. If this wave encounters any change in cross section or temperature it will reflect a portion of its strength in the opposite direction of its travel. The basic principle is described in wave dynamics. Fig:

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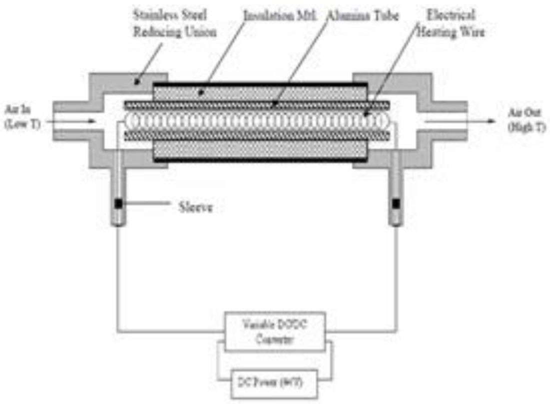


The problems associated with existing methods are,

- Heavy weight.
- Lower power output.
- Lower compression ratio.
- Complex and bulky.
- Maintenance is very difficult.
- Heat exchangers may require.
- It requires more space.

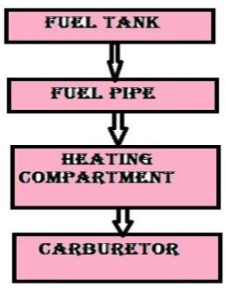
OBJECTIVES AND METHODOLOGY

1. Objectives

- To preheat the fuel to required temperature using closed loop control system
- To increase the atomization of fuel.
- To decrease the viscosity of fuel by increasing the temperature.
- To reduce the weight of preheaters of existing devices.

1. Methodology

Fig:



In this paper we analysed equipment for direct fuel preheating. It contains a set of thermocouples, electric heating element, PID controller, fuel flow control valve etc. The fuel stored in the fuel tank is heated before entering to the engine inlet. The heating compartment contains an ordinary heating element placed on a chamber. The heating coil is connected to the PID controller which helps to control the temperature. A proportional integral derivative controller is a control loop feedback mechanism commonly used in industrial control systems. A PID controller continuously calculates an error value as the difference between a desired set point and a measured process variable.

In the process the fuel which will be in the upper tank is made to flow to the primary fuel pipe and then to the heating compartment. A thermometer is placed at the fuel inlet, it measures the inlet temperature of the fuel. When the electric power is switched on then the fuel starts heating inside the heating compartment, then the fuel

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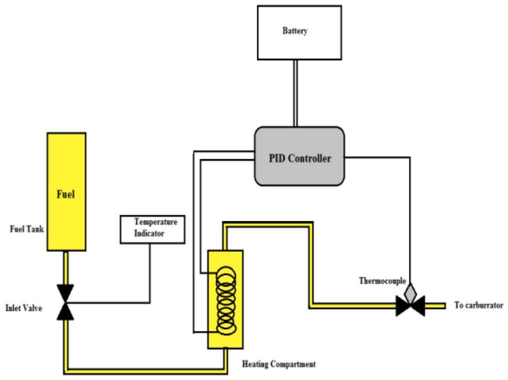
comes out of the heating compartment through secondary fuel pipe. A thermocouple is placed at the exit of the heating compartment. And the heating coil is connected to the PID controller which regulates the heating of fuel to present temperature. Hence the fuel is preheated before coming to the engine.

Fig:



The preheater works on the principle that by preheating the fuel, the fuel is more effectively vaporized, resulting in more efficient combustion. In ancient days, preheating is done by using exhaust heat and by using heat from radiator. In exhaust system the heating coil is wounded over the heating compartment and exhaust gas is made to pass through the coil so it results in the increases the weight and heating of the system was slow. So here we are using the electric heating coil to heat the fuel. By this equipment we can be able to heat any type of fuel such as petrol, diesel, biodiesels etc. The fuel flow arrangement is as shown in the Fig.

The circuit diagram of system is as shown in the Fig. In this system the fuel comes from main fuel tank and then it is passes on to the fuel pipe then is flows into the heating compartment. Then it is passes to the engine through carburetor.

2. Components

***Heating compartment**:* The heating compartment used in the experiment is as shown in the figure. It is a small tank made of plastic having a capacity of 300 ml. A heating coil is mounted on top of the tank and at the bottom a carburetor is fitted to control the flow into the tank.

Heating coli: A heating element converts electricity into heat through the process of resistive or Joule heating. Electric current passing through the element encounters resistance, resulting in heating of the element. For the heating of the coil it is connected to the 220 volts power supply.

Control valve: There will be a control valve which is placed at the end of secondary fuel pipe to control the flow going out of the heating compartment.

Thermocouples: A thermocouple is an electrical device consisting of two different conductors forming electrical junctions at differing temperatures. A thermocouple produces a temperature dependent voltage as a result of the thermoelectric effect and this voltage can be interpreted to measure temperature. Thermocouples are a widely used type of temperature sensor. Commercial thermocouples are inexpensive, interchangeable are supplied with standard connectors and can measure a wide range of temperatures. In contrast to most other methods of temperature measurement, thermocouples are self-powered and require no external form of excitation.

PID controller: A proportional–integral–derivative controller (PID controller) is a control loop feedback mechanism (controller) commonly used in industrial control systems. A PID controller continuously calculates an error value as the difference between a desired set point and a measured process variable. The controller attempts to minimize the error over time by adjustment of a control variable, such as the position of a control valve, a damper or the power supplied to a heating element, to a new value determined by a weighted sum.

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In PID controller

P accounts for present values of the error. For example, if the error is large and positive, the control output will also be large and positive.
I accounts for past values of the error. For example, if the current output is not sufficiently strong error will accumulate over time and the controller will respond by applying a stronger action.
D accounts for possible future values of the error, based on its current rate of change.

As a PID controller relies only on the measured process variable, not on knowledge of the underlying process, it is broadly applicable. By tuning the three parameters of the model, a PID controller can deal with specific process requirements. The response of the controller can be described in terms of its responsiveness to an error, the degree to which the system overshoots a set point and the degree of any system oscillation. The use of the PID algorithm does not guarantee optimal control of the system or even its stability. Some applications may require using only one or two terms to provide the appropriate system control. This is achieved by setting the other parameters to zero. A PID controller will be called a PI, PD, P or I controller in the absence of the respective control actions. PI controllers are fairly common, since derivative action is sensitive to measurement noise, whereas the absence of an integral term may prevent the system from reaching its target value.

RESULT & DISCUSSION

The major technical problem of higher viscosity, density can be effectively eliminated by heating fuels before injecting it into combustion chamber. The fuels thus with decreased viscosity can be successfully used with improved ignition and emission characteristics.
Preheating of fuels effectively decreases the kinematic viscosity, density and surface tension properties which dominantly improves injection of biodiesel by contributing to better fuel atomization at the elevated temperature of the biodiesel. Moreover preheating reduces the ignition problem by decreasing the ignition delay time during cold start of engine in cold countries. Preheating contributes to reduction in CO, CO_2 emissions.

Advantages

- Preheating of fuels effectively decreases the kinematic viscosity, density and surface tension properties which dominantly improves injection of fuel by contributing to better fuel atomization at the elevated temperature of the fuel.
- Moreover preheating reduces the ignition problem by decreasing the ignition delay time during cold start of engine in cold countries.
- Preheating contributes to reduction in CO ,CO_2 emissions of biodiesel than that of the pure diesel and non-preheated biodiesel while the NO_x emission increases with increase in preheating temperature due to increase in combustion temperature.
- Suitable for preheating any type of fuel such as Diesel, Biodiesel etc.
- Prevents clogged fuel filters due to fuel gelling in winter
- Increase in efficiency due to proper atomization
- Reduces exhaust emissions

FOR FULL FLOW OF FUELS

Table :1 For full flow of fuels

Temperature (^oC)	Time taken to reach 100 ml (sec)		
	Petrol	Diesel	Bio diesel
28	114	120	132
33	57	95	123
50	-	60	76

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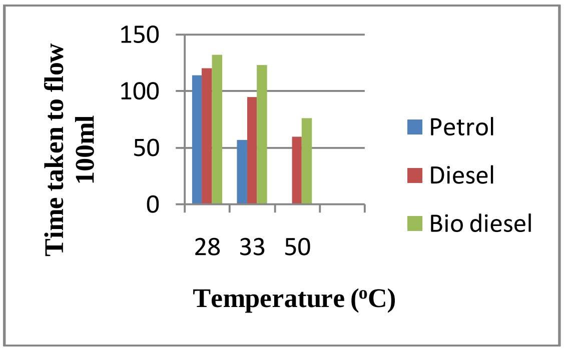
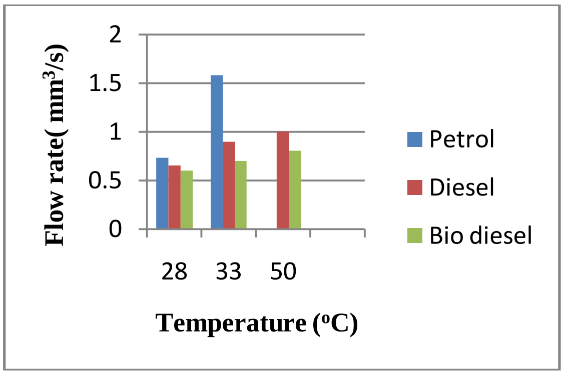


Graph:1 for full flow of fuels



Graph :2 flowrate

At 30°C before preheating

Table 2 Performance before preheating at 30°C

Load (kg)	Fuel flow (10 ml)	Heat input (kW)	Specific fuel consumption Kg/kW hr	BP (kW)	η_{bthe} (%)
5	36	10.15	0.63	1.46	12.87
10	27	12.9	0.73	2.92	19.9

After preheating 35 °C

Table 3 Performance after preheating at 35 °C

Load (kg)	Fuel flow (10 ml)	Heat input (kW)	Specific fuel consumption Kg/kW hr	BP (kW)	η_{bthe} (%)
5	32	11.34	0.582	1.52	14.38
10	25	14.62	0.64	3.12	22.6

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