Implementation of a Automatic Dual Fuel Injection system in a CI Engine

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ABSTRACT

The paper investigates the result on the existing diesel engine that can suitably modified to operate on the diesel fuel mode to conserve diesel and also reduce environmental pollution. The conventional fuels, petrol's and diesel for internal combustion engines are exhausted at an alarming rate, due to increase of vehicle population and also these fuel causes environmental problems. Make these things in mind the diesel engine can be made to run on LPG as well. LPG carburetor is incorporated on the air intake side of the engine. The fuel injection system is also altered so that it injects only pilot fuel. The LPG will be automatically given to the air take of the engine and flow will be varied manually. At higher engine loads, the dual fuel mode is superior to the pure diesel mode of operation.

Keywords: Diesel, LPG, Emissions, Dual fuel engine, Performance

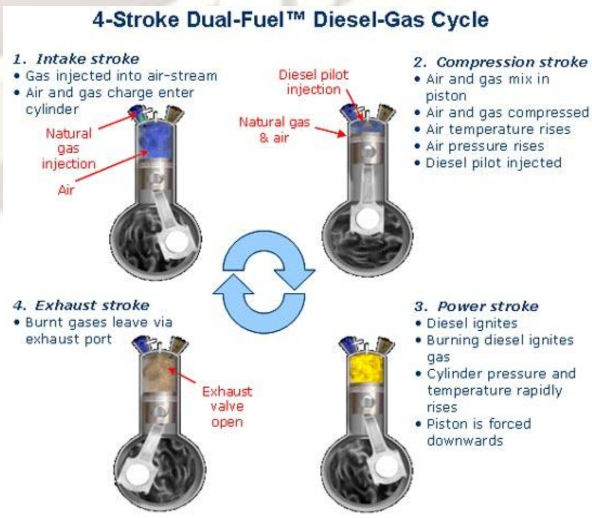
I. INTRODUCTION

There is an urgent need to conserve the conventional fuels, diesel and petrol, so as to reduce the oil import bills of an oil-dependent country and also to mitigate the menace of the environmental pollution. Automobiles can be made to run either on diesel or LPG or by both of them. Diesel is used as the primary fuel and LPG as the secondary fuel. This dual fuel operation enables to change from LPG to diesel or from diesel to LPG at his convenience by automatically when the engine speed reaches 1000 rpm. On the LPG line there is an electro-mechanical solenoid. The device closes the flow of LPG during the operation of diesel and opens the LPG line when the engine is running on LPG or by both. These fuels will have to be replaced by suitable alternative fuels like alcohols and various gaseous fuels. Among various gaseous fuels, CNG, LPG and hydrogen are prominent. Dual-fuel operation is found to be one of the prominent methods of conserving diesel and petrol. There is the importance of understanding combustion process in dual-fuel engines with regard to enhanced performance and reduced pollution.

II. OPERATION OF DUAL FUEL ENGINE

The main feature of dual fuel engine is simultaneous combustion of two types of fuel in its combustion chamber. The most typical combustion is diesel oil and Liquefied Petroleum Gases (LPG). Diesel oil combustion is decreased and missing energy input is covered by LPG. The decreased amount of diesel oil is called ignition portion and its main function is to provide ignition for LPG and air mixture.

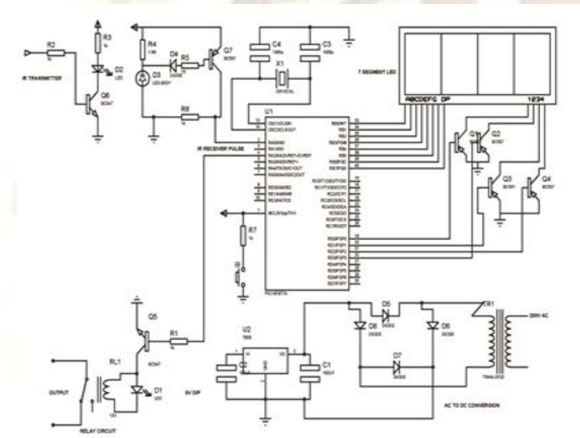
When the engine starts to run The RPM of the engine will be calculated by the contactless tachometer and the speed of the fly wheel is measured with the help of the microcontroller and displayed on the 7 segment LED. When the engine reaches 1000 RPM the microcontroller automatically switches on the solenoid valve which is connected with the LPG line. Initially the engine will start with diesel fuel as we cannot use LPG, as because LPG requires a very high temperature to burn which cannot be attained in the compression ignition engine. Once the engine starts with diesel the temperature inside the combustion chamber increases and when the engine reaches 1000 RPM it will automatically changes to LPG mode. When the engine reaches 1000 RPM the solenoid switch will be in ON position the solenoid valve gets energized as the current flows to the electric coil which in turn creates magnetic field and thus displace the metal actuator. The actuator is mechanically linked with valve. The valve than changes the state of position either opening or closing to allow the flow of gases to flow through the solenoid valve. A spring is also used to return the actuator in original position when current flow is removed.



When the solenoid switch is in ON position, the LPG will move out from the cylinder and moves in the flame trap through pressure gauge where we can measure the pressure of the LPG. After that the LPG will flow through the pressure reducing valve where we can adjust the pressure of the LPG as per the requirement of the system. Now the LPG will move to the aluminium gas mixture adaptor where the LPG will mix up with the air and thus penetrate to the combustion chamber where it combines with the atomized particles of the diesel which is feed by the injector.

The brake power of the engine was found to be about 15% more on the dual fuel operation, while the brake specific fuel consumption was found to be about 30% lower than diesel fuel mode of operation. This could be due to better mixing of air and LPG and hence improves combustion efficiency. Here LPG is used as a partial replacement of diesel in the dual fuel mode of operation.

III. ELECTRONICS IN FUEL INJECTOR

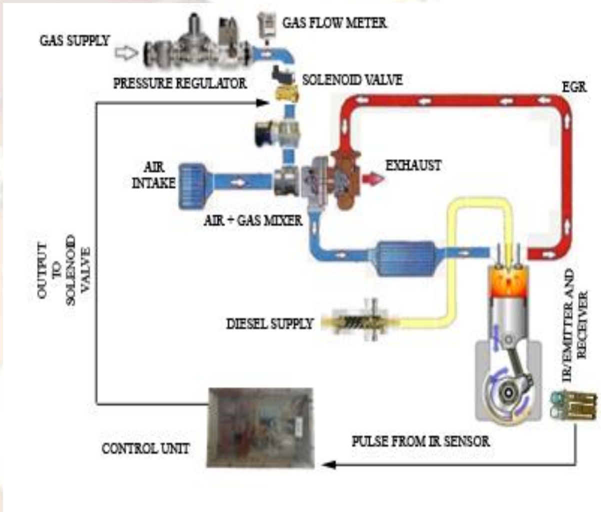


The contactless speed sensor is placed under the flywheel of the dual fuel engine. Whenever the engines start to run speed sensor counts the revolution of the engine flywheel and sends pulse as the input to the microcontroller unit, the microcontroller unit calculates the speed of the engine and displays on the 7 segment led screen. When the engine attains 1000 rpm of its speed the microcontroller will switch on the relay which is connected with the solenoid valve of the LPG line. The solenoid valve opens which causes the flow of lpg gas into air intake of the diesel engine.

IV. EXPERIMENTAL SET UP

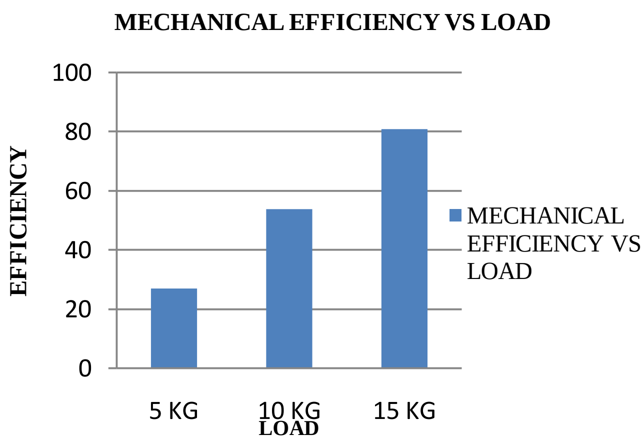
The test engine is a single cylinder, direct injection, four-stroke cycle diesel engine. The intake port system of diesel engine was modifies for LPG fuel injection. The premixed fuel injection system is composed of solenoid operated type fuel injector and injection controller. The specifications and dimension of the engine are listed in below. An infrared emitter and receiver were used to sense the position of the flywheel and gives senses to the electronic control unit. The start of the injection was controlled by electronic system.

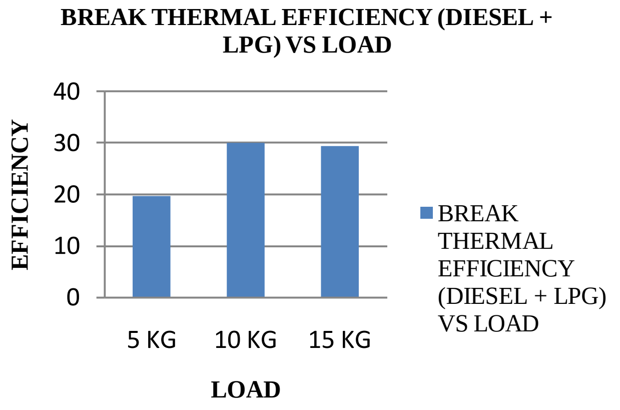
Description	Specification
Engine	: 4 stroke single cylinder
BP	: 5hp
RPM	: 1500
Fuel	: diesel
No. of cylinders	: one
Bore	: 80mm
Stroke length	: 110mm
Starting	: Cranking
Working Cycle	: four stroke
Method of cooling	: water cooled
Compression Rati:	16:1
Method of Ignitio:	compression ignition

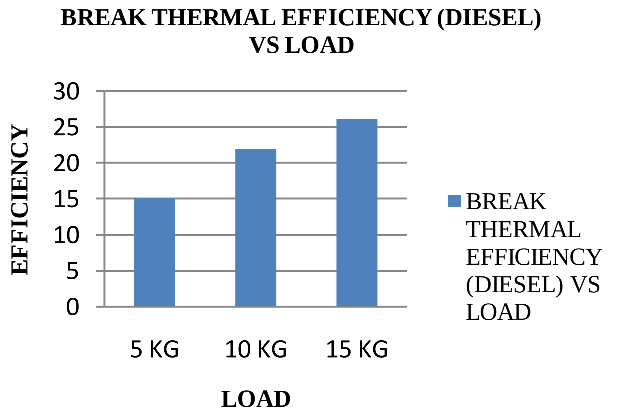


EXPERIMENTAL LAYOUT

V. GRAPHICAL REPRESENTATION FOR THE PERFORMANCE OF THE DUAL FUEL ENGINE







Advantages:

- Fuel cost savings
- Significantly reduced emissions, in both diesel and gas modes
- Fully rated horsepower
- Lower maintenance costs & improved longevity due to cleaner fuel
- Retains diesel only versatility
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- Fully rated horsepower
- Retrofit system - expands capability and adds value to your present investment
- Lower maintenance costs & improved longevity due to cleaner fuel
- Retains diesel only versatility

Limitations:

- Unable to operate at 100% in gaseous fuel
- Skilled operators are needed for this operation.
- Periodic maintenance is necessary due to use of dual fuels in operations
- Compare to diesel mode noise is more in dual fuel mode.

VI. SYSTEM COMPONENTS

CONTACTLESS TACHOMETER

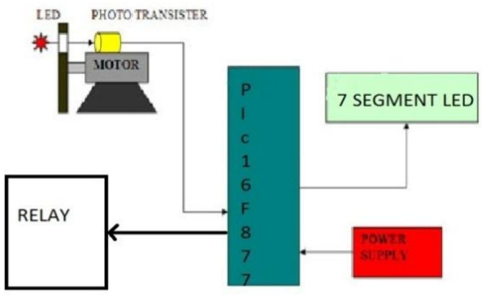
The tachometer also called revolution counter is an instrument that measure the speed of rotating machinery. Generally these measurements are rated in round per minute (R.P.M) Rotating machine could be any prime mover like an electric motor, diesel engine, petrol or gas driven engine, gas turbine, water turbine, steam turbine, and numerous industrial equipment's which are driven by any of the above engines. It is desirous to know and control the speed of the engine to a safer limit in order to avoid the damage to the engine. We have used its derivative PIC16F877A. As the name, we accurately measure the speed of the rotating shaft without touching the shaft.

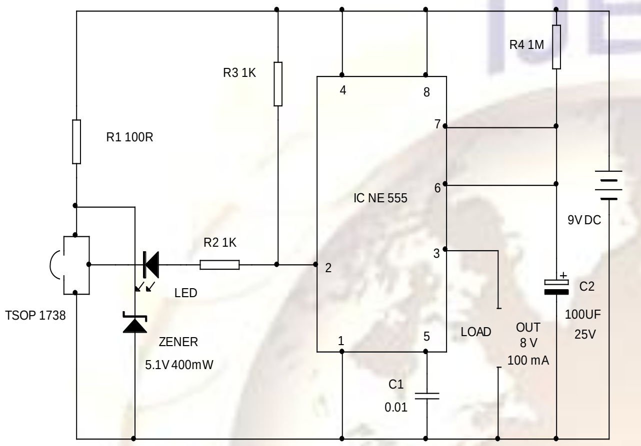
In order to know the speed of the machine we need to pick up pulse every round of the engine there are many ways to pick up the pulse from the engine shaft. We can use magnetic sensor and Hall Effect device. Proximity type of sensors, we can also pick up the pulses from the ignition coil from the petrol engines. Due to the absence of spark plug it's not possible this method with diesel engine.

In this work a unique sensor, a LED as light source and a photo transistor to pick up the pulse are used. An arrangement has been made to make a small black patch about 5mm near to the outer surface of the wheel. LED or any light source is fixed to the one side of the rotating wheel and photo transistor to the other side of the wheel. Light will fall on the phototransistor when the black patch on the rotating wheel comes in line with the photo transistor and light source or led .This way a pulse is picked up every revolution . These pulses are applied to the microcontroller. The general principal involved in this work is to count the pulse for two seconds and. And calculate the rpm. Display is refreshed every two seconds. 7 segment LED has been used here for display purpose.

IR RECEIVER

This circuituses the IR sensor module TSOP 1738 which operates in 38 KHz Infrared pulses.The circuit is a Short duration Monostable using 555 timer IC. Its trigger pin 2 is connected to the output of the IR sensor through R2 and LED. Normally the output of IR sensor is low. But the timer IC will not be triggered because its trigger pin remains high through R3. When the remote hand set is focused on to the IR sensor and any obstacle is near the ir sensor, out put of IR sensor goes low and triggers the 555 IC. With the given values of the timing elements R4 and C2, output of the timer isin high till the ir not receives its singal.





VII. CHALLENGES IDENTIFIED IN DUAL FUEL ENGINES

- Ignition timing control: research is needed to develop control methods for dual fuel engines in order to overcome the challenge of maintaining proper ignition timing as load and speed are varied.
- Needed to develop a fast response control system to overcome the challenge of maintaining proper ignition timing duration rapid variations in engine speed and load
- Research is needed to develop a methodology for feedback and closed-loop control of the fuel and air systems to keep the combustion optimized over the load speed range in a production vehicle. New sensors may be needed to achieve this level of control.

VIII. RESULTS

The variations in the length of the ignition delay in compression ignition engines have a profound and controlling effect on the subsequent combustion process and hence on almost every feature of engine performance. With constant injection timing and calculation was used to represent the ignition delay variations. The engine was operated in the dual fuel engine mode on commercial LPG having an average LPG concentration of more than 96% by volume. Pilot fuels as diesel fuels were initially employed. The amount of gaseous fuel is increased under dual fuel operation, producing a higher total equivalence ratio, the ignition delay increases markedly to reach a maximum value. The delay begins to decrease later on with the continued addition of the gaseous fuel. For the case of minimum pilot, the ignition delay decreases markedly all the time. These changes in the delay period depend very strongly on the pilot quantity being used. Larger pilots tend to display smaller changes to the delay while relatively small pilots bring about a large extension to the ignition delay. With a continued decrease in the pilot fuel size, the ignition delay period increases to such an extent that regular ignition cannot be maintained below a certain level of pilot quantity.

IX. CONCLUSION

With the cost of diesel fuel rising, and dual-fuel engines considerably reducing diesel fuel usage, converting an engine to operate primarily on a cheaper gaseous fuel is economically attractive. In addition, spark plugs and an ignition system are not required, eliminating the costly spark plug maintenance associated with traditional natural gas engines, which helps to further reduce overall cost of operation. Depending on the expected number of running hours and the cost of diesel and gaseous fuels, the up-front installation cost of retrofitting an existing diesel engine to dual-fuel operation can be recovered quickly.

Gaseous fuels—and natural gas in particular—are much cleaner than diesel. Diesel engines that have been converted to dual-fuel operation have exhibited significant reduction in NOX and CO2 over their original diesel operation. This is even more important in areas with increasingly tough emissions regulations. In addition, on-site diesel storage capacity can be reduced.

Retrofit systems can be installed in the field quickly, minimizing engine downtime. No modifications are required to the core engine or to the factory fuel management system. With the engine's main fuel becoming gaseous fuel rather than diesel and the electronic control system maximizing fuel efficiency, installing an alternative fuel system enables the on-site diesel supply to last much longer, extending engine uptime without compromising performance.

Replacing diesel fuel with natural gas typically extends engine maintenance intervals and overall engine life. For example, life expectancy of cylinder-head valve seats is improved due to the cleaner combustion that gaseous fuel exhibits over diesel. Benefits of the factory diesel engine, including hardware ruggedness and operational efficiency, are maintained. Returning to operation on 100% diesel fuel is possible at any time.

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