Improvement of Oil Engine Performance with Homogenous Mixture of Petrol Fuel Injection System

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Abstract: ***The oil (diesel) engines are operated at high compression ratios by using diesel as fuel with low amount of air i.e., rich mixture. In my design of engine, by using carburetor high amount of air with petrol as fuel i.e., lean mixture we can improve performance of the engine.***

Keywords: Compression ratios, rich mixture, carburator, lean mixture, performance

1. Introduction

Engines in which the combustion of the fuel takes place internally in the engine cylinder are known as internal combustion engine. In IC engines, the working agent is air which doesn't change its state in the working cycle strictly speaking the working substance is made up of air plus a small amount of fuel resulting in products of combustion, after the ignition of the air-mixture takes place.

Diesel engines:
The oil engines are very often referred to as the diesel engines after RUDOLPH DIESEL. The basic mechanical elements of the oil engines are the same as those of the petrol engines, these engines can be either two stroke (or) four stroke. These engines are known as CI engines. It will be noted that there is no ignition system. Thus the oil engine requires a fuel pump which will pump the fuel to high pressure. Secondly an injector nozzle is required protruding into the engine combustion space. Nozzle at the correct moment, fuel from the pump will be sprayed into the engine cylinder in form of mist i.e., atomization [1]. Charging of an engine classified as two types 1**)** Homogeneous mixture, 2) Heterogeneous mixture**.**

Homogeneous mixture is a mixture where the components that make up the mixture are uniformly distributed throughout the mixture. The composition of the mixture is the same throughout. There is only one phase mater observed in a homogenous mixture.

Homogeneous Mixture Examples: air, sugar water, rain water, vodka, vinegar, dishwashing detergent, steel. You can't pick out components of a homogeneous mixture or use a simple mechanical means to separate them. You can't see individual chemicals or ingredients in this type of mixture. Only one phase of matter is present in a homogeneous mixture. Actually in petrol engines will be charged as homogenous mixture i.e. Air + fuel mixture**.**

A heterogeneous mixture is a mixture where the components of the mixture are not uniform or have localized regions with different properties. Diesel will be charged as heterogeneous mixture in oil engines i.e. diesel engines [2].

2. Present Problems in Diesel Engines

Diesel-powered vehicles and equipment account for nearly half of all nitrogen oxides (NOx) and more than two-thirds of all particulate matter (PM) emissions.

Particulate matter or soot is created during the incomplete combustion of diesel fuel. Its composition often includes hundreds of chemical elements, including sulphates, ammonium, nitrates, elemental carbon, condensed organic compounds, and even carcinogenic compounds and heavy metals such as arsenic, selenium, cadmium and zinc. Through just a fraction of the width of human hair, particulate matter varies in size from coarse particulates (less than 10 microns in diameter) to fine particulates (less than 2.5 microns in diameter) to ultra-fine particulates (less than 0.1 microns in diameter). Ultrafine particulates, which are small enough to penetrate the cells of the lungs, make up 80-95% of diesel soot pollution.

Particulate matter irritates the eyes, nose, throat, and lungs, contributing to respiratory and cardiovascular illnesses and even premature death. Although everyone is susceptible to diesel soot pollution, children, the elderly, and individuals with pre-existing respiratory conditions are the most vulnerable. Researchers estimate that, nationwide, tens of thousands of people die prematurely each year as a result of particulate pollution. Diesel engines contribute to the problem by releasing particulates directly into the air and by emitting nitrogen oxides and sulphar oxides, which transform into "secondary" particulates in the atmosphere.

Diesel emissions of nitrogen oxides contribute to the formation of ground level ozone, which irritates the respiratory system, causing coughing, choking, and reduced lung capacity. Ground level ozone pollution, formed when nitrogen oxides and hydrocarbon emissions combine in the presence of sunlight, presents a hazard for both healthy adults and individuals suffering from respiratory problems. Urban ozone pollution has been linked to increased hospital admissions for respiratory problems such as asthma, even at levels below the federal standards for ozone.

Diesel exhaust has been classified a potential human carcinogen by the U.S. Environmental Protection Agency (EPA) and the International Agency for Research on Cancer. Exposure to high levels of diesel exhaust has been shown to cause lung tumors in rats, and studies of humans routinely exposed to diesel fumes indicate a greater risk of lung cancer. For example, occupational health studies of railroad, dock, trucking, and bus garage workers exposed to high levels of diesel exhaust over many years consistently demonstrate a 20 to 50 percent increase in the risk of lung cancer or mortality [3].

Frequent diesel fuel filter changes and the expensive and time consuming task of cleaning diesel fuel tanks have become acceptable periodic maintenance instead of a warning signal for diesel engine failure. Diesel fuel filter elements should last a thousand hours or more and injectors some 15,000 hours. However, since diesel fuel is inherently unstable, solids begin to form and the accumulating tank sludge will eventually clog your diesel fuel filters, ruin your injectors and cause diesel engines to smoke [4]. All diesel fuel contains some percentage of dissolved water. The water molecules remain part of the fuel until there are too many of them. The point at which the fuel can hold no more water is called the saturation point. The quantity of water in fuel is measured in ppm (parts per million). As long as the water stays below the saturation point as dissolved water it is typically not too much of an issue. Significant problems start when water separates from diesel and becomes free or emulsified water. Emulsified water is another form of free water; the droplets are simply as small as so well mixed into the fuel that they remain suspended rather than dropping to the bottom. There are no "droplets" when water is fully dissolved in fuel [5].

Diesel Pollution and Public Health Solutions:

The public-health problems associated with diesel emissions have intensified efforts to develop viable solutions for reducing these emissions. Both federal and state governments have taken steps to reduce diesel emissions, but more work needs to be done.

Cleaner Fuels – The EPA has adopted more stringent fuel standards to reduce the amount of sulfur allowed in diesel fuel. These requirements went into effect in late 2006 for on-road diesel vehicles, while off-road diesel fuel used in construction equipment and trains will take effect over the next five years. Lower sulfur diesel fuel allows the use of advanced emission control technologies, which when combined, can reduce emissions more than 85 percent. The fuel used in ships visiting our port cities, however, is not subject to EPA's regulation and remains a significant source of diesel pollution.

New Engine Standards – New engine standards for diesel cars, trucks and heavy equipment have traditionally lagged far behind those for gasoline powered vehicles. For example, diesel construction equipment faced no emissions standards as late as 1996. With mounting pressure to clean-up diesel engines, the EPA has adopted standards for both heavy-duty trucks and off-road construction equipment and more recently for marine vessels and trains, which will phase in over the coming decade. Under current regulations, passenger cars and trucks are subject to the same emission standards regardless of the fuel they use.

Retrofitting – New engine standards only apply to the equipment in the dealer showrooms, not to the diesel engines that are already in operation. The combination of lagging emission standards and durability of diesel engines means there are many high polluting diesel trucks, buses, and off-road equipment that will continue to operate well in to the future. Retrofitting these diesel vehicles and equipment with advanced emission control devices can effectively reduce harmful tailpipe emissions.

3. Literature Review

Actually HCCI (homogeneous charge compression ignition) engines has raises density and temperature by compression until the entire mixture reacts spontaneously but, the difference is Gasoline can also be mixed with diesel to operate in HCCI mode [6]. In this case we are using only petrol as fuel and to get the perfect homogeneous mixture we can use carburetor. In combustion, a homogeneous mixture of air and fuel is compressed until auto-ignition occurs near the end of the compression stroke, followed by a combustion process that is significantly faster than either CI or SI combustion. SI engines have a spark plug to initiate combustion with a flame front propagating across the combustion chamber. CI engines have a fuel injector to inject the diesel and combustion takes place in a compressed hot air region. , in this engine no spark plug or fuel injector and the combustion starts spontaneously in multiple locations. High engine efficiency can be achieved with low NO_X and soot emissions. In this engine combustion, a homogeneous mixture of air and fuel is compressed until auto-ignition occurs near the end of the compression stroke, followed by a combustion process that is significantly faster than either CI or SI combustion.

The Epping [8] Christensen and Johansson [9] reported that HCCI technology, using iso-octane as a fuel and this model are also using iso-octane as fuel, which improved engine efficiency by as much as 37% given a high compression ratio (18:1) and maintains low emissions levels. The efficiency and compression ratio are in the range of CI engines. The technology can be implemented by modifying either SI or CI engines using any fuel or combination of fuels. The air/fuel mixture quality in this engines is normally lean, it auto-ignites in multiple locations and is then burned volumetrically without discernible flame propagation. Combustion takes place when the homogeneous fuel mixture has reached the chemical activation energy and is fully controlled by chemical kinetics rather than spark or injection timing [10]. 2, 2, 4-trimethylpentane is the correct name for iso-octane. Like octane, iso-octane has eight carbon atoms and is also used as a fuel. Iso-octane is an example of a branched chain hydrocarbon, and is a five carbon chain with three methyl groups at various points in the chain. Both octane and iso-octane are isomers; they have the same molecular formula but different structures.

Branched chain hydrocarbons are more desirable than straight chain hydrocarbons in petrol. The straight chain hydrocarbons cause "*knocking*"; Undesirable small explosions that cause power loss. Branched chain hydrocarbons burn smoothly. The ability to burn smoothly or the quality of the petrol is indicated by its octane number. This is the percentage by volume of iso-octane in a mixture of iso-octane and heptane (a straight chain hydrocarbon), which gives the same knocking characteristics as petrol under test. A poor fuel has a zero octane number, whereas a good fuel has an octane number of 100 [11].

4. Results and Discussions

By reviewing this hybrid engine we are discuss some of the properties like engine performance i.e. fuel efficiency, efficiency of the engine.

Engine Thermal Efficiency (n_{th}):

$$n_{th} = \frac{brake\ power}{fuel\ power}$$

$$n_{th} = \frac{3600 * P_b}{FC * CV}$$

Where:

n_{th}= thermal efficiency.

P = brake power [kW].

FC = fuel consumption [kg/h = (fuel consumption in L/h) x (ρ in kg/L)].

CV = calorific value of kilogram fuel [kJ/kg].

ρ = relative density of fuel [kg/L]

Brake specific fuel consumption: It is a measure of the fuel efficiency of any prime mover that burns fuel and produces rotational, or shaft, power. It is typically used for comparing the efficiency of internal combustion engine with a shaft output.

It is the rate of fuel consumption divided by the power produced. It may also be thought of as power-specific fuel consumption, for this reason. BSFC allows the fuel efficiency of different engines to be directly compared.

The BSFC calculation (in metric units)

To calculate BSFC, use the formula

$$BSFC = \frac{r}{P}$$

Where:

r is the fuel consumption rate in grams per second (kg/hr)

P is the power produced in watts is $\frac{2\pi NT}{3600}$ where

N is the engine speed in rotation per minute (r.p.m)

T is the engine torque in newton - meter (N·m)

The above values of N and T may be readily measured by instrumentation with an engine mounted in a test stand and a load applied to the running engine. The resulting units of BSFC are grams per joule (g/J).

Commonly BSFC is expressed in units of grams per kilowatt-hour {g/ (kW·h)}. The conversion factor is as follows:

BSFC {g/ (kW·h)} = BSFC [g/J] × (3.6×10^6)

The conversion between metric and imperial units is:

BSFC [g / (kW·h)] = BSFC [lb. / (hp·h)] × 608.277

BSFC [lb. / (hp·h)] = BSFC [g / (kW·h)] × 0.001644

Table 1: Characteristics of petrol and diesel fuels [12]

properties	Petrol	Diesel
Octane number	98	-
Cetane number	-	54
Higher heating value (KJ/Kg)	47300	44800
lower heating value (KJ/Kg)	44000	42500
Boiling point (K)	468	553
Density (Kg/m^3)	750	814
Stoichiometric air-fuel ratio	14.6	14.5

The advantages of hybrid engine over traditional diesel engine are

Since Hybrid engines are fuel-lean, they can operate at diesel-like compression ratios just like HCCI engines (>15), thus achieving 30% higher efficiencies than conventional SI gasoline engines. Homogeneous mixing of fuel and air leads to cleaner combustion and lower emissions. Because peak temperatures are significantly lower than in typical SI engines, NOx levels are almost negligible. Additionally, the technique does not produce soot. This avoids throttle losses, which further improves efficiency.

The disadvantages of this engine are

High heat release and pressure rise rates contribute to engine wear and some cases explosion may occurs. Auto ignition is difficult to control, unlike the ignition event in SI and diesel engines, which are controlled by spark plugs and in-cylinder fuel injectors, respectively. This engine has a small power range, constrained at low loads by lean flammability limits and high loads by in-cylinder pressure restrictions. Carbon monoxide (CO) and hydrocarbons (HC) pre-catalyst emissions are higher than a typical spark ignition engine, caused by incomplete oxidation (due to the rapid combustion event and low in-cylinder temperatures) and trapped crevice gases, respectively.

5. Future and Further Work

This is a theoretical paper. The practical experiment based on above theory may be done in future and may determine the various parameters depending on the performance of the engine and also we need to change the design of carburetor for giving lean mixture in all times.

6. Conclusion

Final conclusion is the HCCI engine is already used but the problem in this engine is that, it pumps petrol as pilot & diesel as secondary fuel during combustion process, but in this engine only petrol is used as fuel during the combustion process. We are using carburetor for preparing a homogeneous mixture and the above discussion states that the break power may increase or decrease because of its practical value and it can't be determined theoretically. If may the break specific fuel consumption (BSFC) decrease the fuel efficiency will be high [it can't be predicted or determined theoretically] this values will be determined by conducting an experiment.

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