

A Review: Concept of Diesel Vapor Combustion System

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ABSTRACT: This paper presents a concept of technique for delivery of heavy fuel oil (diesel fuel) in vapour form (gaseous state) to SI engine manifold and process of combustion of heavy fuel oil mixture (vapour and air) in light weight spark-ignition engines. If the diesel fuel is delivered to SI engine combustion chamber in vapour form (diesel fumes) through a technique of vaporization of diesel fuel and mixing of air-fuel, complete combustion of air-fuel mixture can be achieved, more improved mileage can be obtained with less emissions without compromising with engine performance aspects which is the must required criteria for any automobile.

Here the principle used in vaporization of diesel is a hot air vaporization technique, where hot air is supplied at the bottom diesel sub tank/ vaporizing container as a result of which these air bubbles extract the diesel vapours forming diesel fumes from liquid diesel and these diesel vapours when delivered to engine with appropriate mixing with air and when undergoes combustion gives the above expected results.

KEYWORDS: diesel fuel vapours, fuel vaporizer, air-fuel mixture, vapour combustion, reduced emission.

I. INTRODUCTION

The diesel engine (also known as a compression-ignition or CI engine) is an internal combustion engine in which ignition of the fuel that has been injected into the combustion chamber is initiated by the high temperature which a gas achieves when greatly compressed (adiabatic compression). This contrasts with spark-ignition engines such as a petrol engine (gasoline engine) or gas engine (using a gaseous fuel as opposed to petrol), which use a efficient replacement for stationary steam engines. The diesel internal combustion engine differs from the gasoline powered Otto cycle by using highly compressed hot air to ignite the fuel rather than using a spark plug. In the true diesel engine, only air is initially introduced into the combustion chamber. The air is then compressed with a compression ratio typically between 15:1 and 23:1. This high compression causes the temperature of the air to rise. At about the top of the compression stroke, fuel is injected directly into the compressed air in the combustion chamber. This may be into a void in the top of the piston or a pre-chamber depending upon the design of the engine. The fuel injector ensures that the fuel is broken down into small droplets, and that the fuel is distributed evenly. The heat of the compressed air vaporizes fuel from the surface of the droplets. The vapour is then ignited by the heat from the compressed air in the combustion chamber, the droplets continue to vaporise from their surfaces and burn, getting smaller, until all the fuel in the droplets has been burnt. Combustion occurs at a substantially constant pressure during the initial part of the power stroke. When combustion is complete the combustion gases expand as the piston descends further; the high pressure in the cylinder drives the piston downward, supplying power to the crankshaft.

As well as the high level of compression allowing combustion to take place without a separate ignition system, a high compression ratio greatly increases the engine's efficiency. Increasing the compression ratio in a spark-ignition engine where fuel and air are mixed before entry to the cylinder is limited by the need to prevent damaging pre-ignition. Since only air is compressed in a diesel engine, and fuel is not introduced into the cylinder until shortly before top dead centre (TDC), premature detonation is not a problem and compression ratios are much higher^[1].

Petrol engine, is a class of internal-combustion engines that generate power by burning a volatile liquid fuel (gasoline or a gasoline mixture such as ethanol) with ignition initiated by an electric spark. Gasoline engines can be

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built to meet the requirements of practically any conceivable power-plant application, the most important being passenger automobiles, small trucks and buses, general aviation aircraft, outboard and small inboard marine units, moderate-sized stationary pumping, lighting plants, machine tools, and power tools.^[3]

Of the different techniques for recovering the power from the combustion process, the most important so far has been the four-stroke cycle, a conception first developed in the late 19th century. With the inlet valve open, the piston first descends on the intake stroke. An ignitable mixture of gasoline vapour and air is drawn into the cylinder by the partial vacuum thus created. The mixture is compressed as the piston ascends on the compression stroke with both valves closed. As the end of the stroke is approached, the charge is ignited by an electric spark. The power stroke follows, with both valves still closed and the gas pressure, due to the expansion of the burned gas, pressing on the piston head or crown. During the exhaust stroke the ascending piston forces the spent products of combustion through the open exhaust valve. The cycle then repeats itself^{[3][4]}.

II. RELATED WORK

Related to the present concept, few related projects were carried earlier, such as. In 1920's vaporisation of petrol fuel was achieved by applying heat both externally and internally to the fuel in the vaporizer tank so that faster vaporisation would occur and more efficient combustion would occur but drawbacks were that with constant heating more fuel was vaporised and the flow control was inefficient resulting in varying fuel consumption.

Then in 1960's energy saving technique was introduced where, the fuel was heated to its boiling by an auxiliary heating unit where the vapours occurring were transferred to the engine combustion chamber through a carburettor, as the fuel is heated to certain temperature the thermostat switch-off the heating unit and heat in the exhaust was utilized for further heating of the fuel .all these methods were implemented for petrol vaporization.

Further in 1980's diesel vaporization was introduced and diesel fuel was heated using a heat exchanger technique in which the intake manifold of the system was in heat exchanger relationship with the exhaust manifold, here the fuel was initially sprayed in the intake manifold, the exhaust manifold transfers heat in the exhaust gases to the fuel in the intake manifold so that due to this heat transfer the fuel is vaporized and this diesel vapours were mixed with proportion of air and transferred to the cylinder. These vapour-air mixture were suitable for combustion in low compression ratio engines with satisfactory combustion efficiency. Then since only few concepts of diesel vapour combustion were developed. This paper presents a new technique for vaporization of diesel fuel and combustion in SI engines which have low compression ratio and is described below in principle of working with detailed diagram of the conceptual designs.

III. COMPARISION BETWEEN CI AND SI ENGINES

1. Basically SI engines work on Otto Cycle and CI engines on Diesel cycle
- 2.SI engines use gasoline as fuel and CI engines use diesel as fuel.
3. SI engines use spark plugs and CI engines don't this is because the compression ratio of SI engines is small and the temperature developed is not high enough to start the combustion and so spark plug is used to initiate the combustion once the initial spark is generated the flame front takes care of the rest, whereas in a CI engine the temperature generated is higher than the ignition temperature of diesel due to high compression ratio and so spark plug is not needed.
4. The torque generated by CI engines are very high when compared to their counterpart SI engines this is because the CI engines at high compression ratio and so the piston travels far more distance into the cylinder and so the radius of crank also increases ,since torque is cross product of force and radius therefore this increase in radius causes an increase in, and this is the reason why almost all the trucks and heavy vehicles use CI engines.
5. CI engines are heavy when compared to SI engines because of the need to withstand the high pressure developed, the walls of the engine are made thicker to increase their strength and this one of the reason why Diesel engines are not

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usually preferred as they increase the weight of the bike and the vibrations make the ride wearisome. 6. Thermal efficiency of CI engines are higher when compared with SI engines because of the difference in compression ratio adding to this ,poor oxidation of fuel and Diesel engines more fuel efficient than petrol engines. 7. Carburettors are used in SI to prepare the air - fuel mixture which is combusted and in case of CI engines fuel at high pressure is injected at the end of compression stroke^[8].

IV. WORKING PRINCIPLE IN BRIEF

The main reason for selecting SI engine-diesel fuel combination is that, diesel vapours ignite much faster than diesel in liquid form and completely combustion can be achieved .less amount of diesel vapour produces relatively more horse power and relative torque in light weight engines .As a result of which lower fuel consumption, lesser emission and improved performance of the engine can be achieved. This covers few drawbacks of a diesel system.

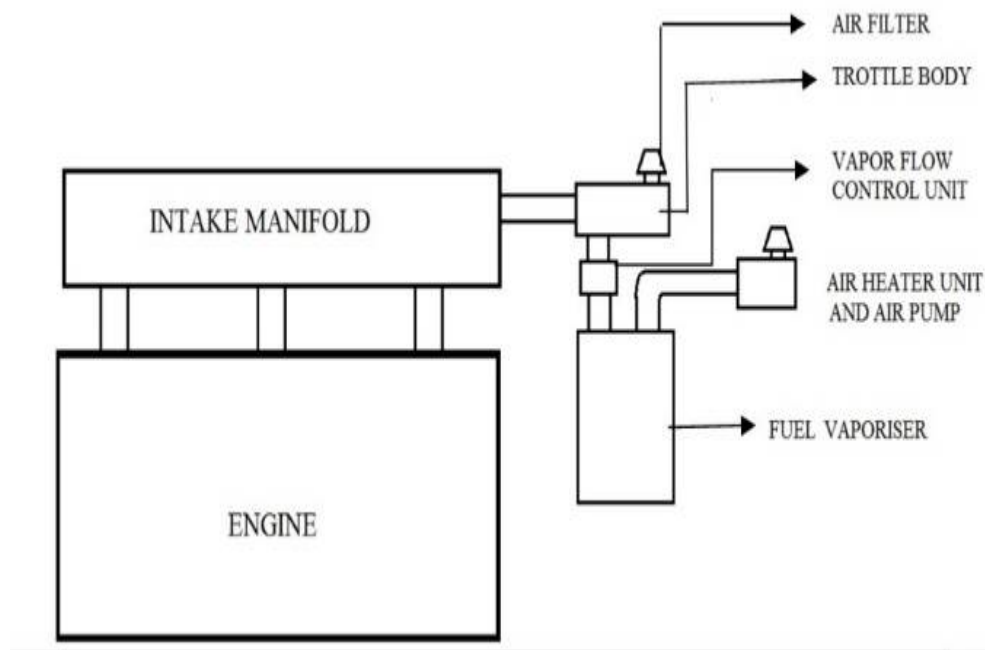


Fig.01: Simple Block Diagram Of The Concept, the system consists of main components such as air filters, throttle body, heating unit, air pump, inlet and outlet pipe, fuel vaporiser, flow control value, intake manifold and engine.

Atmospheric air is drawn by an supercharger like component which creates suction at the filter and sucked air is preheated by a round coil heater or series fins heater which rises the temperature of the air (say 100-200°C), at which the diesel fuel vaporization occurs. This hot air is transferred to the bottom of the vaporizer tank (say 0.75-1 lit) through the flow pipe where hot bubbles are formed. As these bubbles reach the surface of the fuel, they extract the diesel in vapor form and escape from the fuel surface as shown in the fig.2.

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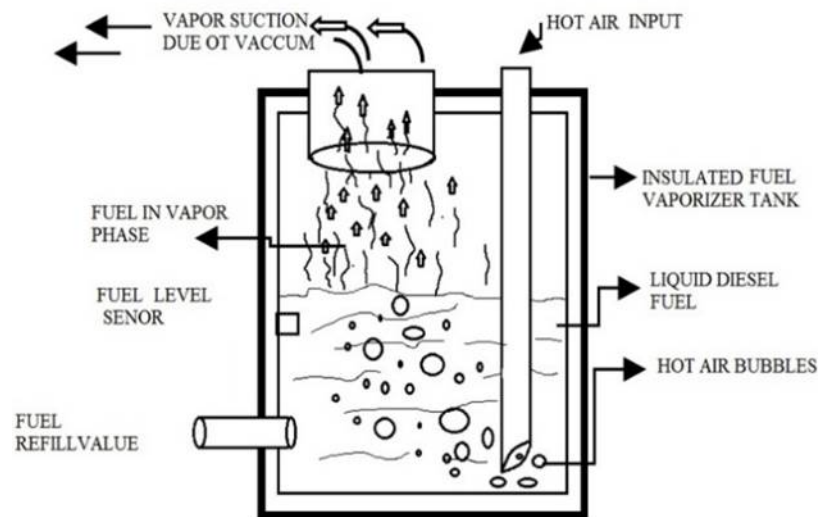


Fig.02: Fuelvaporizer Concept, this fig shows conceptual design of insulated vaporizer where hot air is introduced at the bottom of tank as a result of which vapours formation occurs.

now as the engine piston moves from TDC to BDC suction pressure occurs causing vacuum in intake manifold, due to this vacuum the diesel vapours in vaporizer are sucked towards the throttle body through flow control value.

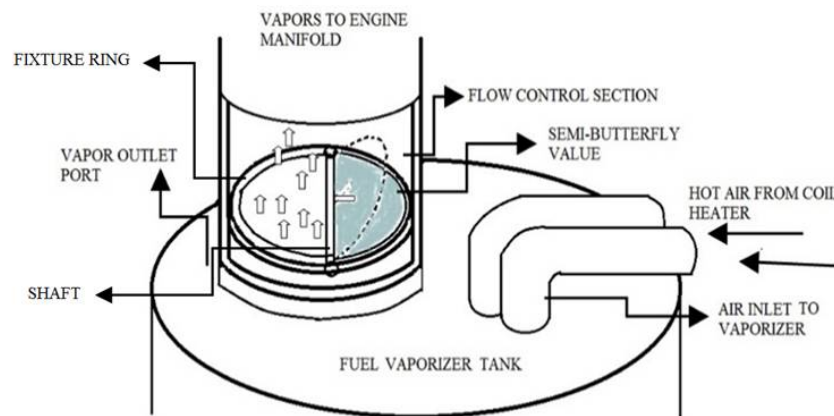


Fig.03: Flow Control Section (section where the flow of diesel vapours are controlled with respect to engine demand), mainly consists of fixture ring, semi-throttle plate/semi-butterfly value, shaft for solenoid actuation of value, solenoid. A conceptual flow control value shown in fig.3 is to be designed such that primary value open section matches with the combustion requirement i.e. flow quantity of vapours through the primary value is the sufficient air-fuel mixture for stable combustion at standard conditions. In some conditions like more load or cold engine start more fuel-air mixture is necessary for combustion to overcome such conditions, in such cases secondary value helps in supplying more vapours to stabilizer the combustion, hence to overcome the situation.

The secondary value or semi-butterfly value functions depending on parameters such as crankshaft speed, load, throttle opening and engine temperature. A control unit considers all the parameters, and depending on variations of the

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parameters a solenoid operates the secondary valve opening such that the vapor flow is increased to provide more fuel vapor-air mixture to stabilize the combustion. The mixture coming to the throttle section are mixed with the filtered air depending on the throttle butterfly valve opening and transferred to the engine intake manifold through which the mixture is a divided flow for individual cylinders.

Vapour combustion technique, results in complete combustion of mixture without compromising with performance aspects of the engine Because diesel vapours can match the combustion standards and engine design specifications of a petrol engine and mainly advantages very less fuel consumption because vapours phase fuel consumption is less compared to liquid phase consumption, thus provides more mileage and also produces near zero emissions because vapours undergo complete combustion than in liquid or mist phase, which is the must required criteria for the present environmental conditions. Utilizing this technique with very less modifications to the engine, satisfactory performance and results can be achieved.

VI. ADVANTAGES

1. Since diesel fuel in vapours form are combustible in petrol engines and combustion characteristics match with petrol combustion characteristics, if implemented in auto industries engine build is reduced in terms of weight , build material , fuel supply system and relative parts and since engine build is reduced , the cost of designing and manufacturing is reduced .
2. Since cost of design and manufacturing is less, the overall cost of the vehicle to market is reduced making it cost competeable with petrol vehicles.
3. Less fuel consumption without sacrificing the performance.
4. Reduced emission from vapour combustion system.
5. Applicable for wide range of automobile.

V. CONCLUSION

By implementing this concept very less fuel consumption in vapor form can be achieved and vapor combustion advantages in reduced emission, which are the must required for any automobile.

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