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STUDY ON AUTOMOBILE HIGH SPEED DIESEL INJECTION (HSDI)

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ABSTRACT

The efficiency of combustion in I.C. engines depends upon the atomization of the fuel and the thoroughness of mixing with the air. However, after the end of compression stroke, the fuel is injected into the combustion chamber and mixed with compressed air and burnt.

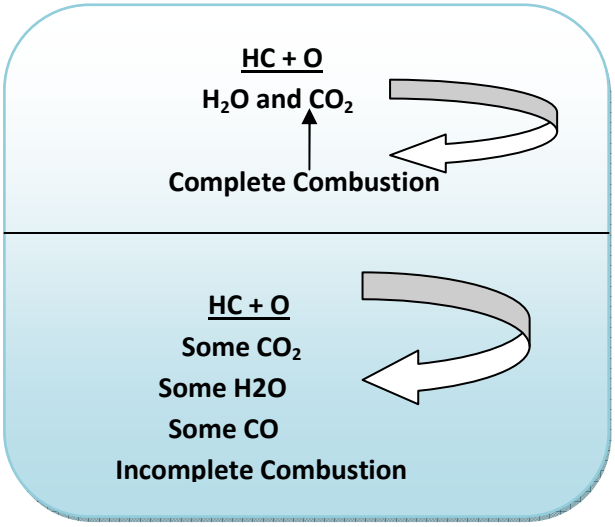
The present situation, the passenger cars with Direct Injection (DI) Diesel Engines have the lowest fuel consumption, but the greatest problems towards the emission legislation to the current lack of effective exhaust after treatment methods and increasing weight.

As per study it was notice that EURO-III, norms was achievable for all but the heaviest vehicles, where as EURO-IV is only feasible for the lightest vehicle. Therefore, overload capacity is a biggest question special reference to Heavy Commercial Vehicles.

KEYWORD: Atomization, Direct Injection, Exhaust Gas After Treatment, Overload.

INTRODUCTION

A report of Planning commission entitle, "India Vision 2020", that the percentage of CO_2 in the atmosphere will go up by over 22% by 2020, as a result CO and CO_2 respectively effect the human blood.



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In terms of method of ignition for diesel engine, that air compressed the combustion chamber by high temperature and pressure and fuel sprayed by nozzle in side of combustion chamber and burnt.

For example, determine for a four cylinder in four strokes I.C. Engine, the quantity of fuel to be injected per cycle, if it consumes o.2 kg/bhp per hour and develop 500 bhp at 200 rpm, Specific gravity of fuel being 0.9.

Solution

Fuel consumption /hr = $500 \times 0.2 = 100$ kg

And number of cycle per hour,

$= \frac{200}{2} \times 60 = 6000$ cycles

∴ Weight 1of fuel pee cylinder per cycle

$= \frac{100}{6000} \times \frac{1}{4} = 0.00416$ kg

Now, Specific Gravity of Fuel = 0.9

∴ Density of Fuel = $0.9 \times \frac{1}{1000}$ = kg/cc

∴Quantity of fuel injected per cylinder,

$= .0041 \times \frac{1000}{0.9}$

= 4.6 c.c.

However, the modern high speed diesel injection (HSDI) has demonstrated a tremendous emissions reduction potential over the recent two decades. European legislative limits required a reduction of gaseous and particulate emission down to and below 1-5 % of the 1970 levels. An additional challenge has now been raised by the ACEA/EU-parliament agreement to reduce CO_2 fleet average values, in new European Drive Cycle test.

In this connection, as per study it was notice in India that passenger (diesel) car is responsible for between 1 and 2 percent of global CO_2 output and ranked 8^{th} global CO_2 emission output.

LITERATURE REVIEW

European parliament have been amendments affect consumption of about 5,2 Liter/100 km for passengers cars with petrol engines and about 4.5 liter/100 km diesel engines. This equates to a CO_2 emission of 120 gm/km. The limits was proposed for 2010 are around 3.1/100 km. $CO_2 < 90$ g/km in July 1998, European Association of Automobile Manufactures (ACEA) undertook to ensure an average fuel consumption in new passengers cars of 6.1/100 km for petrol and 5.3 liter/100 km for diesel vehicle, CO_2 = 140 g/km. Not only has that CO_2 values of 165-170 g/km has been set in the year from 2003 to monitor whether the EU commission targets of 120 g/km stipulated up to 2012 .

From the above, the great economic growth in India, in the past three decades in an enormous increase in energy demand as well as green house gas emission and became the top emitter for CO_2 (Next China) in the world a decade ago and need to take of an immediate action to set up a diesel emission control programmed in the future.

The most fundamental question in everybody's mind today, can we not except to get clean air and water in this millennium. In India 50% to 60% of automobile exhaust, emission goes to the Air pollution. For the controlling of automobile, exhaust emission, the honorable Supreme Court of India rule that vehicular emission had to be reduced at a much quicker pace that planned so far. Engine manufactures were faced the challenging task to quickly find solutions, which are production feasible and technological explained with Euro-Norms.

In this regard, they have been changing the concept of I.e. engine design, multipoint fuel

injection system (MPFI), catalytic converter and incorporation of Exhaust Gas Recirculation (EGR) system.

In terms of modification of fuel, add tetraethyl lead to increase the Octane rating of gasoline. The fuel gets anti-knock quality and can be used in high Compression engines. High Octane caused increased CO2 emission. On the other hand, lead in the engine exhaust causes serious health problems because it is a poisonous substance. The concentration of lead is more where the traffic is heavy. Now a day's lead free alternative fuel is available in the market.

Last approach by catalytic converter and Exhaust Gas Re-circulation system, can control the automobile exhaust emission.

Catalytic Converter is converting to harmful gases to harmless gases. It is a muffler like device for use in an exhaust system. A catalyst is a material that causes a chemical without entering into the chemical reaction.

In effect, the catalysts encourage two chemicals to reach with each other. For example, in the HC/ CO catalyst converter the catalyst encourages the carbon monoxide (CO), change to CO_2. The catalyst in the NOx converter splits the Nitrogen from the Oxygen. The NOx therefore, becomes harmless Nitrogen and Oxygen. Instead of having, two separate catalytic converter in the exhaust system i.e. one for HC and CO and the other for NOx.

As India, prepare to make the use of catalytic converter compulsory with a view of drastically reducing of air pollution. However, Environmental Protection Agency (EPA) of USA was observed that the catalytic Converter has become a significant and growing cause of Global Warming.

Catalytic aconverter May Cause Global warming

Because, Automobile fitted catalytic converter produce nearly half the Nitrous Oxide that contributes to Global Warming. EPA of USA published a study that Nitrous Oxide is one of the few gases emissions of which are increasing with catalytic converter. So does the percentage of Nitrous Oxide in the atmosphere and Nitrogen mixed with Oxygen, produce Oxides of Nitrogen (NOx), which is harmful for human health.

As worldwide emission control regulation become more demanding, therefore, automobile Engineers are faced with challenging the new performance standards fir catalytic converter application that help protect our health and environment.

To control the Oxides of Nitrogen (NOx), only one method is available, which is called Exhaust Gas Re-Circulation.

Figure 1.High Speed Diesel Injector

NOx control system that recycles a small part of the inert exhaust gas back through the intake manifold to the combustion temperature and this system are called EGR system.

Figure 2.Metal Injector

Metal injector molding is a comparatively new method for mass producing complex shapes with small dimensions. Initially developed in the 1970s, metal injection molding has seen immense growth in popularity during the past decades.

METHODOLOGY

OBD-II DIAGNOSTIC

Individual fuel injectors located in the intake manifold activated plunger which is normally closed inhibiting fuel delivery when, Activated the valve opens and a predetermined quantity of fuel is sprayed into the air flowing into the cylinder and mixed with this air. This valve opening is timed relative to the intake stroke by the PCM controller.

The fuel injector consists of a spray nozzle and a solenoid operated plunger. Whenever the plunger is lifted from the nozzle, fuel flows at a fixed rate through the nozzle into the air scream going to the intake manifold. The plunger acts as a fuel injection on-off valve. The plunger position is controlled by a solenoid and a spring. When no current is applied to the solenoid the plunger is tightly held against the nozzle by a spring. The plunger pulled away from the nozzle when the solenoid is activated, causing fuel to flow which is under pressure. The solenoid plunger and nozzle act as an electrically switched valve, which is closed or open, depending on whether the control current is off or on respectively. The fuel flow rate is regulated by fuel pressure and nozzle geometry. The amount of fuel is proportional to the time the valve is open. The control current that operates the fuel injector is pulsed on and off and the Air/Fuel ratio is proportional to the duty cycle of the pulse train from the PCM controller.

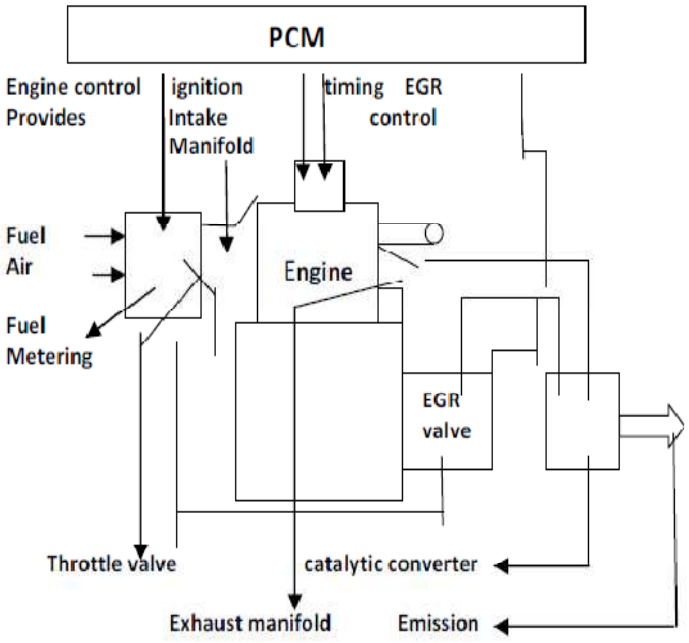

Figure 3.Major Controller out-put to Engine

P0251 CODE

However, from the other point of view, P0251 code definition of injector pump fuel metering control means, P0251 is a generic fault code which will relate to one or more of the following components:

- Optical Sensor,
- Crankshaft position sensor,
- Accelerator pedal position sensor,
- Intake air temperature sensor

These each provide input to the Engine Control Module (ECM), which results into an output from the ECM that adjusts fuel supply and ignition timing.

The main cause the P0251 code: contaminated, incorrect or bad gasoline, dirty optical sensor, clogged fuel pump, fuel filter or fuel injector, faulty intake air temperature sensor, crankshaft position sensor or accelerator pedal position sensor. Faulty fuel control actuator etc.

For example, idle air control (IAC) valve, the main principal of operation that the valve is an electronically controlled throttle bypass valve which allows air t flow around the throttle plate (which is closed due to low engine RPM and vehicle being stationary) and produces the same effect as if the throttle is slightly opened. A stepper motor opens the pintle (valve), allowing a limited amount of air to bypass the closed throttle plate. The stepper motor controls the pintle movement accurately thus controlling the amount of bypass opening into the intake manifold. The duty cycle of the stepper motor is controlled by the PCM which monitors the pintle position and commands the steeper motor to move back the pintle to open the bypass by the calculated amount and move the pintle forward to close the bypass at the end of the duty.

RESULT AND DISCUSSION

DIAMETER OF ORIFICE

The purpose of a nozzle is to atomize and direct the spray of the fuel droplets into the combustion space in such a manner that proper penetration and distribution are obtained.

Let diameter of the injector orifice to spray a fuel quantity "Q" per cycle per cylinder is d_f. The

injector pressure is p_1 combustion chamber pressure is P_2, density of fuel is p_f and period of injection is t- second.

Pressure differences causing the fuel flow through the orifice =

(p_1-p_2) kg/cm^2

Pressure head causing the fuel flow

$= h_f = \frac{(p1-p2)}{pf}$ cm of fuel.

Velocity of fuel through the orifice =

$V = \sqrt{2g.hf}$

$= \sqrt{2g\ (\frac{p1-p2}{pf})}$ cm/sec

Let, Cd = Coefficient of discharge of the orifice

∴ Q = Cd × Area of the orifice × velocity of flow × duration of flow.

$= Cd \times \frac{\pi}{4} \times d_f^2 \times V \times t$

Area of orifice $= \frac{\pi}{4} d_f^2 = \frac{Q}{Cd.V.t}$

$= \frac{Q}{Cd.t.\sqrt{2g\frac{p1-p2}{pf}}}$ cm^2

$= dt = \sqrt{\frac{4Q}{\pi .Cd.V.t.}}$ cm

Attention has been drawn into the gasoline direct injection (GDI) engine due to various potential advantages. GDI engine provide various advantages, including precise control of fuel injection to each cylinder in each cycle and the capability of producing stratified charge lean-burn combustion with fully un-throttled operation. Especially, viable one GDI engines that have been introduced since 1996, which have overcome problems of earlier GDI system based on diesel-injection systems will advanced-computer-controlled fuel injection system. In cylinder direct injection of fuel allows two different combustion strategies to be used: The simplest method is to produce a homogenous charge by injecting the fuel during the intake stroke to allow enough time for fuel vaporization and mixing. Load Control is achieved via throttling.

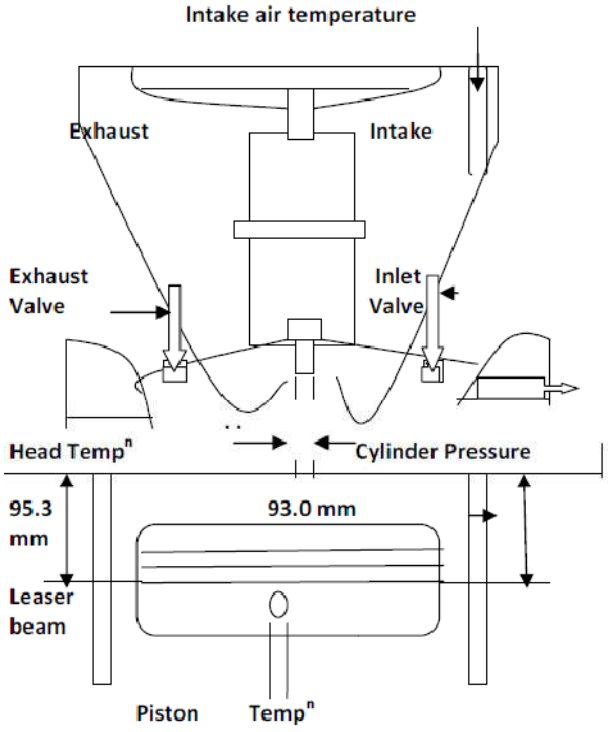

Figure 4.Combustion Chamber with DI System

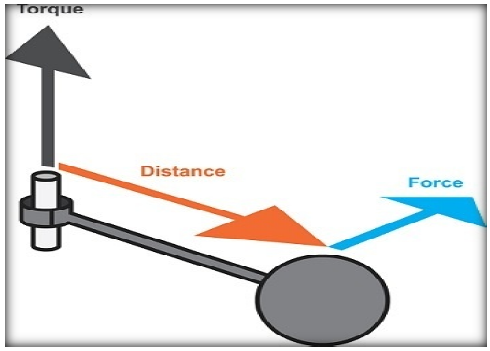

Figure 5.The Newton meter is the unit for torque

Direct injection stratified charge (DISC) engines, in which compact fuel rich clouds is formed around the spark plug in an overall lean mixture. Spark ignition is used to intake combustion both GDI strategies and can be adjusted for various engine speeds and loads by a computer based control system. The full potential of the GDI combustion systems requires use of both GDI strategies.

The current emission legislation i.e. OBD-II, tests all sensors, actuators (valves), switches and wiring for proper connectivity and checks the inputs and output of each are within allowed range of value. Each sensor circuit consists of mainly three parts, i.e. sensor, signal processor and a display device.

Oxygen sensor and Heater, monitoring for the performance of oxygen sensor, while it's operating temperature maintained within a specific range above 260° C. For this reason a heater is used to keep the oxygen sensor temperature at the desire value However, fuel injection system plays an important part in supplying the required air fuel mixture to a spark ignition engine for improving mixture preparation contributes to an enhanced power and fuel economy. The engine port injection mode performance at here different throttles openings over a wide range of engine speed. At 50% and 20% open throttle position as compared to wide open throttle position there is s fall in engine performance and increase in CO and HC emissions.

TYPE OF DATA

Idle, full load at rated speed and acceleration at rack are the three modes of operation which have found to significantly the emission levels in diesel exhaust as can be seen from the following table:

Figure 6.Photo courtesy DaimlerChrysler Atego Six cylinder diesel engine

Influence of operational modes on emission control				
Engine Constituent	**Concentration of values as measure Exhaust in Exhausts gas**			
	Idle	acceleration	Partial Load	full Load
FC Medium Size Engine ,				
HC	180	330	210	150
No_xm	330	920	590	780
CO, %	0.02	0.08	0.04	0.26
CO_2. %	256	3.40	5.33	6.68
RCHO	7.9	7.5	4.9	1.6
Smoke (HU)	4	44	4	10
Odour (DI)	3.6	4.1	3.4	5.5

Figure 7.Influence of operational modes on emission Control

During the idle mode the concentration of HC, Nox and aldehyde emissions lower other modes. The emission at idle are less significant than during any other mode.

CONCLUSION

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Therefore, exists a significant improvement in engine performance and emissions characteristics operating automatic control as compared to the manual control of the systems throughout the range of engine operating parameters.

Therefore, OBD-II diagnostic requires that the heater of the oxygen sensor must be monitored periodically for its normal operation. The circuit continuously checked, the voltage across the heater is checked; the normal carried by the heater element is checked (Max. 20 A) as well as, the temperature of the oxygen sensor. If the heater found defective on any of three accounts, the PCM sets a fault code. The PCM has a special circuit for detecting short circuit (break) of the sensor wiring and monitoring the switching frequency.

Under various injection timings with 156° spray angle, it is shown based on the experimental results that peak value of combustion pressure decreased when injection timing of 30° BTDC (before top dead center) was advanced. Regarding emission characteristics, the use of narrow spray angle injector is advantages in case of an early injection combustion strategy because it yields low ISHC (indicated specific hydrocarbon), ISCO (indicated specific carbon monoxide), and $ISNO_x$ (indicated specific nitrogen oxides) emissions. In addition, the IMEP (indicated mean effective pressure) in a

narrow spray angle injector is higher than that in conventional spray angle injector.

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DEFINITION/ ACRONYMS/ ABBREVIATION

VOLUMETRIC EFFICIENCY: Ratio of the volume discharged from a pump to the piston displacement of the pump. In diesel engines a term often used instead of the correct term 'charge efficiency'.

ACRONYMS

IDLE AIR CONTROL VALVE (IACV): The valve is an electronically controlled throttle by pass valve which allows air to flow around throttle plate (which is closed due to low engine rpm and vehicle being stationery) and produces the same effect as if the throttle slightly opened.

SOLENOID: A type of electro-magnet often used to operate the starter motor switch.

ABBREVIATION

CARB = California Air Resource Board.
CCR = California Code of Regulations.
DTC = Diagnostic Trouble Code.
FTP = Federal test Procedure.
I.C. ENGINE = Internal Combustion Engine.
MIL = Malfunction Indicator Light.
MAP = Manifold Absolute Pressure.

DEFINITION

AIR INJECTOR: This system of injecting fuel, into the combustion chamber of a diesel engine using a blast of compressed air.

PINTLE: A small extension of the needle valve tip projecting through the discharge nozzle. When the needle lifts, the oil passes through the opening between the circumstance of the orifice and that of the pintle.

SMOG: A term coined from the words, "Smoke" and "fog", first applied to the froglike layer that hangs in the air under certain atmosphere conditions. Now, generally used to describe any a condition of dirty air and or fumes or smoke.

THROTTLE VALVE: The butterfly valve of a petrol engine.

THRUST: axial force acting on a shaft.

