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Direct Electronic Fuel Injection and Mixing of Corrosion Inhibitor in System with Petrol/Fuel

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***Abstract*:- In the era of growing technology, growth of companies depends upon how efficient their products work in the market with an increase in competition, we are going to discuss on how a modern-day automatic direct fuel injection works as well as engine maintenance system to avoid corrosion in internal parts of an engine, EMS is one of the main components of modern-day I.C engine, how the magnitude of fuel taken according to the power of engine for getting more efficiency, the role of sensors**
in the whole process, mixing of fuel with additives in fuel injector (cranked) the flow mass calculation of fuel and by that calculating the efficiency of the engine by automatic direct fuel injection and further on making some assumptions about the after process, and some comments on the usage of the maximum amount of energy generated in a different form are added, and discussion on effect on properties of fuel on adding of additives and selection of additives is also included.

Keywords:- EMS, Direct Fuel Injection, I.C. engine, CVT.

I. INTRODUCTION:

In the era of Electric Transmission System with higher efficiency, we all are still interested in increasing efficiency of I.C Engines too, but with an increase in efficiency, we also have some unwanted results pollution in the environment, corrosion (rusting) of the cylinder inside I.C engine and error in the system such as incomplete combustion and Overheating, etc.

We are going to analyze about control system of blending of petrol with a corrosion inhibitor in cranked and direct electronic fuel injection system as for the reason to increase efficiency the of an engine with least wastage of energy and with less air pollution.

Corrosion in petrol/diesel engine is affected by the quality of fuel used, Sulphuric acid is formed due to Sulphur component present in fuels such as Petrol/Diesel when mixes with air in the cylinder the walls of the cylinder due to high temperature and pressure reacts and forms acid and results in the degradation of material used in a cylinder, Sometimes corrosion in the material is due to a low quality of material used in engine components, sometimes creep effect plays its role in degrading the material which results in corrosion of engine parts.
Exhaust Valves in an engine are subjected to different air medium and gas which sometimes reacts with valves in presence of high temperature and if liners are not fitted well which may also result in incomplete combustion of fuel and continuous failure in the system and the lifetime of engine decreases.

Lead is also one of the factors which get accumulated in the cylinder of the engine and may affect the efficiency of the engine as well as degrade the material, which on time being decreases engine's lifetime.
So to come up with this problem Scientists used corrosion inhibitors the process went through many iterations and failures, And nowadays at some parts in vehicle engine are having valves of corrosion inhibitors so that failures due to corrosion in the engine gets nullified, And in small-sized engines, corrosion inhibitors are used along with petrol(gasoline). In areas whit, cold weather Antifreeze is also used as a Corrosion inhibitor as at low-temperature water present inside engine cylinder freezes to ice so to overcome this problem antifreeze is used so that the freezing temperature of water molecules resulting combustion of fuel easily, Without any error or failure of the system.

As for automatic control system for direct fuel injection, valve control system and system maintenance are all interconnected with each other in the latest generation petrol/diesel engines. And for setting up and calibration of these systems we need to apply some basic principles of thermodynamics, fluid mechanics, material science and design of the engine compatible with all of this system and properties taken into consideration.

II. THE BASIC WORKING OF THE CONTROL SYSTEM:

As we know the transmission system of vehicles are different according to their use and on public demand such as CVT (continuous vehicle transmission), auto gear system and manual gear system, and for safety purpose, we also have ABS (antilock brake system) which is not connected to EMS (engine management system), EMS is the main component of the all automatic electric system which is connected with most of the sensors in a vehicle to reduce human effort and to minimize the loss of energy in a vehicle.

For direct fuel injection system and resistance to corrosion via petrol one mechanism is applied in the vehicle which is managed by EMS.

When a modern engine is operated it has components as well as sensors attached to it for the proper working of the engine, the components are listed in direction of flow of fuel 1) Fuel Tank, 2) Low-Pressure Fuel Pump, 3) Fuel Filter, 4) Pressure Control valve, 5) High-Pressure Fuel Pump, 6) Fuel

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Injector, and some sensors such as 1) Throttle Position Sensor (located near throttle valve), 2) Manifold Absolute Pressure Sensor, 3) Oxygen Sensor, 4) Crankshaft Position Sensor, 5) Fuel Temperature Sensor.

When the engine starts and the driver applies force on the accelerator the throttle position sensor determines the magnitude of acceleration needed by driver sends the signal to EMS, EMS compiles the signal and sends another signal to the sensor near pressure control valve and the amount of fuel which is to be used for the acceleration of the vehicle passes through High-Pressure Fuel Pump then the pressure sensor distributes the volume of the fuel equally into fuel injection via fuel rail and via pressure sensor, the remaining fuel is sent back to the tank after proper distribution of fuel in rail, then the strokes are completed and the residual in form of heat can be used for regenerating electricity for the vehicle (concept by AUDI) and the remaining gaseous residual is processed near carburettor and is thrown out after removal of excess of carbon component and other gases (this was the system followed by modern-day I.C engine vehicles).

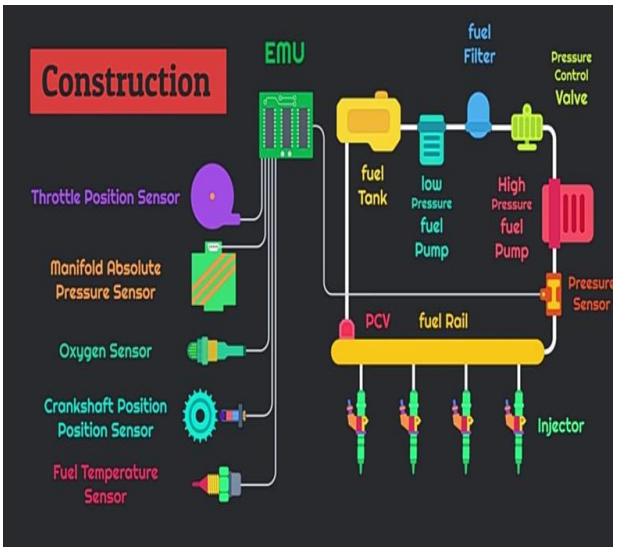

Figure 1 - Construction of the direct fuel injection system

In some type of engines, there is a special valve for corrosion inhibitors near fuel tank of a vehicle and also near oil tank too as after some time corrosion inhibitors mixed with petrol safeguards the internal layers of engine parts by forming a thin layer around them and in the case with oil system the path of oil and the inhibitor should also be the same to stop corrosion inside the lubricating valves and the coolant valves, so that the lifetime of an engine is not harmed and which may decrease the creep effect too.

III. SOME CALCULATIONS RELATED TO THE FLOW OF FUEL FROM THE FUEL INJECTION SYSTEM:

When the fuel is transferred via fuel rail to fuel injector with some additives such as antifreeze and corrosion resistor the volume of the fuel inside increases so that to prevent the error and loses possible due to increase in volume as well as pressure can be solved by some mathematical and thermodynamic approach for which a special sensor is connected to EMS which is directly connected to fuel tank and fuel rail so that the excess of fuel can be directly transferred to fuel tank so that the error or failure in the system can be prevented.

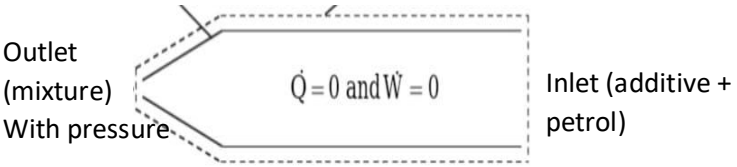

Figure 2

As shown in figure 2 petrol with some additives are inserted with pressure inside the control volume and then the mixture is compressed through injector nozzle and the highly pressurized mixture is thrown out inside the cylinder of the engine when the EMS sends a signal to the input valve so that power stroke receives the precise power so that it can generate acceleration accordingly required by the driver.

Likewise, the SFEE can be applied to this case to calculate the rate of flow of fuel mixture accordingly as the further calculations get complicated and due to lack of practical aspects and laboratory shut due to this pandemic would not be proposed.

IV. ASSUMPTIONS ON THE BLENDING PROCESS:

1) Due to the addition of some additives with petrol, there should not be any contact between the material layer inside the cylinder and valves due to a thin layer formed of additives formed between them.
2) The injector nozzle is the blending chamber.
3) For the mixing of additives and petrol, their densities must be equal and they should not form any compound by reacting with each other (chemically).
4) The mixing process should be perfectly adiabatic.
5) As there should not be any chemical reaction between them no extra mass should be added or removed from the constant volume at any temperature as it may affect the accuracy of our EMS.
6) The linearity of the input and output system in automatic fuel control system should remain intact.
7) As electronics systems are involved the reaction time should be negligibly small compared to that of completely mechanical systems.
8) The volume should not vary when some volume of additives are added to some volume of petrol i.e. V_T(total volume) = V_P+V_A (volume of petrol + volume of additives)
9) The input variables when blending is done should be known with the reason for their existence.

For proper understanding refer figure-2.

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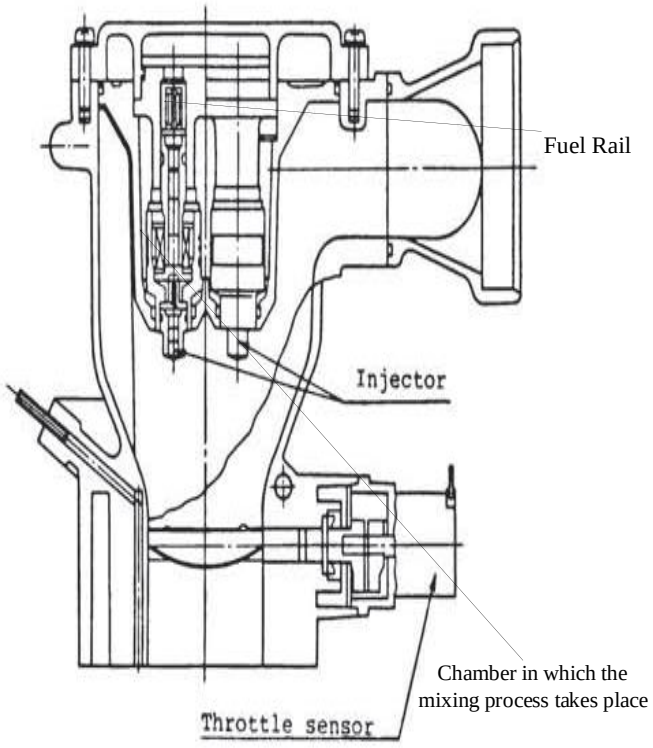

Figure 3 – Fuel Injection

V. EFFICIENCY BY AUTO-FUEL INJECTION SYSTEM:

The efficiency of a vehicle engine is also known as volumetric efficiency which depends upon the volume of fuel used, it is denoted as NV which can be calculated by taking the ratio of actual volume intake V_i by theoretical volume intake V_{i*}.

This can be mathematically represented as,

$$n_v = \frac{V_i}{V_{i*}} \quad \dots (1)$$

As we know that volume of a substance is the ratio of its mass m_i by the density of that material without any impurities ρ_i.

Mathematically,

$$V_i = \frac{m_i}{\rho_i} \quad \dots (2)$$

As dynamometer measures the mass flow rate of air, the mass flow rate of fuel can be mathematically represented as,

$$m_i * = \frac{m_i}{n_r} N_e \quad \dots (3)$$

Where N_e is the engine speed, n_r is the number of crankshaft rotations for a complete engine cycle, now replacing the value of mass with mass flow rate and replacing the value of volume in equation 1 via equation 2. Therefore the volumetric efficiency of the engine can be written as,

$$N_v = \frac{m_i * n_r}{N_e \rho_i V_{i*}}$$

As per the engine efficiency, the calorific value of the fuel is also important.

As the calorific value petrol is 33.7 M J / litre which is less than that of diesel i.e. 36.9 M J / litre.

By this, we can conclude that the efficiency of the petrol engine is less than that of a diesel engine.

But the calorific value is not that much important as diesel undergoes incomplete combustion so it causes air pollution and also may lead to the greenhouse effect, and as there is less difference in calorific value of petrol and diesel, petrol is more preferred as petrol undergoes complete combustion inside the cylinder of an engine so it causes less air pollution to the environment.

In olden days diesel engines were used to carry heavy vehicles as they gave more torque compared to petrol engines, but in modern-day era fully electric transmission engines are used in place of a diesel engine which provides more torque compared to diesel engines and electric engine offers negligible pollution to the environment as electricity can be produced via renewable energy sources such as solar energy, tidal energy and geothermal energy.

In modern-day petrol/diesel engines efficiency as well as power transmitted is also high as a result we can generate higher speed in vehicles. And we can get higher efficiency in vehicle engine with automatic direct fuel injection system as air is heated inside and then fuel is injected in fewer amounts with high pressure and then spark plug ignites the whole mixture so that the volume is used more and fuel is used less and we get more power compared to olden days petrol engine.

VI. EFFECT ON CALORIFIC VALUE ON FUEL WITH THE ADDITION OF ADDITIVES:

Additives are used in an engine for preventing corrosion effect, creep and freezing effect as for lubricating they are used with the life support system.

Some assumptions related to this topic:

1) The calorific value of additives must be near to that of fuel.
2) The additives must be completely combustible in presence of high pressure.
3) No third product should be formed after combustion of fuels which can cause harm to the environment.
4) Additives should not change any property of fuel which may affect the performance of the engine.

Some thermodynamic and mathematical approach should be used to calculate the mixing effect of two substances by entropy change and 2nd law of thermodynamics should be taken into consideration.

An there is no relation between the speed gained due to gear shifting and piston speed, as piston speed remains constant and the produced energy too, the change in speed is the result of gear shifting, and for CVT it depends upon the rotor speed

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resulted due to rotation of accelerator directly or indirectly connected to clutch and input shaft.

VII. CONCLUSION:

Form this analysis we can conclude that with automatic direct fuel injection system we can attain less (not least) reaction time because electrical systems work more efficiently and fast with the least harm to the engine. But with this advancement we are still not able to increase the lifespan of vehicle engine from 3-4 years to 10-15 years, as semiconductors change their properties with increase in temperature, this may affect the accuracy of EMS as for some engines used on CNG/LPG proper coolant systems are not established to make out some useful work out of it. So the material used in designing and making EMS should be improved as with the sensors so that if any system in the engine fails then it gives signals to the owner of vehicle so proper servicing of that part is done well.

The idea of mixing of corrosion inhibitors along with petrol in cranked is a nice initiative but the proper maintenance for checking of inhibitor level is to be done on time, so some alternative method should be used so that inhibitor is not wasted and the engine's lifespan is also not harmed.

As the coin has two faces this system is also advantageous in terms of lower fuel consumption and for proper power generation inside the arrangement. And pressure control is also one of the factors in this direct fuel injection system, and to put all the components working properly EMS should be properly scripted with Matlab without any error so that the probability of failure in the system will be minimum.

Some factors are necessary for the selection of additives which are to be used along with petrol, which should be evolved under proper thermodynamic approach.

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