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Approach of Adjusting Engine Parameters by Determination of Fuel Composition

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Abstract—*Ever increasing deterioration of air quality, global warming and oil prices hike have forced to reduce the fuel consumption and exhaust gas emission from the engines. As fuel consumption and emission of an engine are affected significantly by air/fuel ratio (AFR) ,ignition and injection timing and its duration so it needs to be controlled as it also improves energetic efficiency and power generation, with a reduction in the operating temperatures of an engine. An exact knowledge of the fuel composition is must in order to improve AFR and thus the drivability of the vehicle as Well as the cold starting capability and the degree of efficiency achieved by the adjustment of the parameters of the engine management system.*

Air/fuel ratio in internal combustion engine design is the ratio of mass flow rate of air to mass flow rate of fuel inducted by an internal combustion engine to achieve conversion of the fuel into completely oxidized products. The chemically correct ratio corresponding to complete oxidization of the products is called stoichiometric. Since the optimal AFR in the combustion chamber is a function of the fuel composition and is crucial for the smooth operation of the engine, the need to determine the fuel composition directly or indirectly became very important.In this paper, comparison between different approaches to determine fuel composition have been investigated and best method have been choosen which uses MEMS based technology and directly measure fluid density and temperature by using micro LDS sensor. This information is relayed to an engine controller and based on this information, dependant variables such as spark timing, fuel injection duration and AFR can be adjusted accordingly.

Keywords: *AFR,BDE,ECU,F/B,SRE*

1. INTRODUCTION

In the last decade, there has been a growing concern with regard to some important environmental aspects such as the vehicle-generated greenhouse gas emissions leading to air pollution. One of the crucial parameters that influence the formation of pollutant gases or emissions in internal combustion engines is the nature of the fuel and its additives in the fuel tank. The standards for fuels are usually regulated by governmental agencies. Unfortunately, in many countries, people intentionally add cheaper organic substances in an attempt to raise profit margins. This illicit practice is called adulteration. This may damage the engines and produce emissions that increase environmental pollution. For the purpose of overcoming fuel adulteration practices, it is necessary to develop novel, and reliable methods to monitor the fuel mixture.The comprehensive approach to reduce pollution requires the AFR stoichiometric to be calculated according to automotive fuel mixture/adulteration.

2. LITERATURE SURVEY

Various control strategies and approaches have been followed for Fuel composition determination which are given below.

2.1 Using Exhaust Gas Sensor

Fuel contamination can also be determined based on an output of exhaust gas sensor.In [2], the exhaust gas sensor was conFig. d for obtaining one of (a) an air-fuel ratio and (b) a combustion state for the internal combustion engine based on exhaust gas. Beside intake port injection engine ,it can be applied to cylinder injection engine or to a dual injection engine having a fuel injection valve for the intake port injection and a fuel injection valve for the cylinder injection.It can be applied to a diesel engine that uses light oil as fuel, and it may be determined whether gasoline contaminates light oil that is supplied to the engine based on the output by the exhaust gas sensor or can be applied to a bi-fuel engine that is able to use any fuel of gasoline, alcohol, and alcohol-mixed fuel having alcohol mixed into gasoline.

The operational state may be an air-fuel ratio of air-fuel mixture supplied to the engine , which ratio is estimated based on the detected oxygen in exhaust gas. When the other-type fuel, such as light oil, kerosene, heavy oil, contaminates gasoline supplied to the engine ,the air-fuel ratio of air fuel mixture is widely changed toward a leaner operation .Accordingly, the output by the exhaust gas sensor is widely changed toward the leaner operation. As a result, the output of the exhaust gas sensor falls beyond a normal range, within which the output of the exhaust gas sensor falls while normal fuel is supplied. Thus, the air-fuel ratio F/B correction amount for the air-fuel ratio F/B control is made larger toward a richer operation (richer combustion). Thus, the air-fuel ratio F/B correction amount also falls beyond a normal range,within which the air-fuel ratio F/B correction amount falls while normal fuel is supplied.Determination values(an upper limit determination value and a lower limit determination value) are changed in accordance with engine temperature. The temperature information may be coolant temperature or oil temperature.

2.2 Using Knock Sensor

As Fuels with different percentages with respect to gasoline have a different octane number, this means that types of fuel and the mixtures produced from them have a significantly different knock behavior. The composition must be determined because the prevailing percentage of the fuel types determines not only the knock behavior but also the lambda value to be preset and additional operating parameters. In [4], the composition of the fuel mixture is determined from an absolute ignition angle. The absolute ignition angle is thereby a preset ignition angle minus an ignition retardation by the closed-loop knock control. Fuel composition determined from the closed-loop knock control is used for the plausibility of a value of the fuel composition previously determined in an engine management system.

2.3 Using Dielectric Properties or Optical Refraction Index Sensor

As known liquids possess substantially different dielectric properties the combined percentage of each of the known liquids in a mixture is directly proportional to the distributed capacitance of an insulated wire coil immersed in the mixture. One design that attempts to meet this demand is an optical refraction index sensor which utilizes the relationship between the percentage of alcohol in a fuel mixture and the angle of light refraction through the fuel mixture. In [5], the fuel mixture detection device uses the dielectric properties of fuel to detect the composition and consists of a coil which is immersed in the fuel mixture. A distributed capacitance is generated between the windings of the coil upon energization of the coil. The wire turns act as equivalent electrodes of a capacitor and the fuel mixture acts as a dielectric medium. This distributed capacitance of the coil is directly proportional to the dielectric constant of the mixture which, in turn, is directly proportional to the percentage of each fuel in the mixture.

This assumes that the sensor is dealing with known fluids as a base (each of which could be a mixture of other fluids) so long as the two known fluids have significantly different dielectric constants. The circuit of the subject invention includes a unique oscillator utilizing the submerged coil. A relationship exists between the resonant frequency and the capacitance of the coil whereby the resonant frequency decreases as the capacitance of the coil increases. The dielectric constant of the mixture is determined by using the coil as the resonant element in the oscillator, thereby generating an oscillation frequency which is inverse proportionally related to the dielectric constant of the liquid mixture. The circuit then provides a means whereby the frequency is converted to a voltage output and sent to a controller for processing.

2.4 Using Wide Range Oxygen Sensor

It is used to present output signals proportional to the exhaust gas fuel /air ratio level rather that just a rich/lean signal from a switching sensor. In [8], It then uses an algorithm such as Proportional/Integral/Derivative (PID) feedback algorithm to process an error signal in the fuel to air ratio and immediately correct the fuel delivery rate to provide the correct ratio and then to adjust the percent content proportional to an adjustment in the fueling rate.

3. SYSTEM DESIGN

A system equipped with microLDS sensor developed by ISSYS to determine the liquid density and based on that fuel composition/contamination is determined. A small, hollow silicon micro tube is used by this sensing approach. At a given frequency this small tube vibrates. The vibration frequency will change as the density or concentration of the liquid in the tube changes. By using the vibrational frequency of the micro tube the density of the fluid can be measured. The density output can be used by petrochemicals and biofuels to indicate the type of fuel, its purity and blend fuels together. The operation time taken is very less in micro seconds. Fuel composition determination provide new adaptation values of the altered stoichiometry of the new fuel filled in a fuel tank .

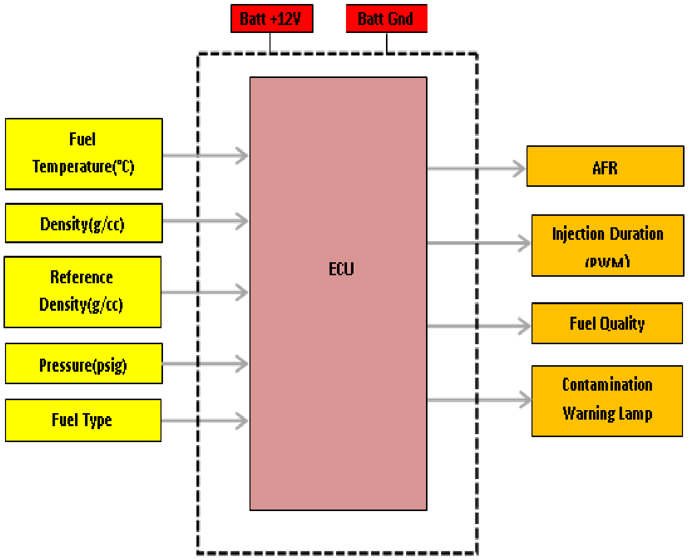

Fig. 1: Block Diagram of Model.

It is determined and stored, and can thus accordingly be taken into account. In this way,fuel quality, the fuel injection and ignition mode of operation, the fuel injection and ignition characteristic diagrams, can be adapted to the new fuel-mixture ratio. Thus, an optimal closed-loop control is also possible when altered fuel characteristics exist.The block diagram is shown in Fig. 1. Different inputs required are identified keeping in mind the requirement and operating parameters of the engine ,vehicle and fuel property. The fuel sensor uses a microcontroller to measure the fuel content percentage and fuel temperature, which it uses to produce an output signal.

Fuel composition sensor can also be placed inside the fuel tank and AFR is tuned according to the composition or the sensor can be installed between the fuel pressure regulator and the fuel tank, where it monitors the content of the fuel returning to the tank. The schematic is shown in Fig. 2.

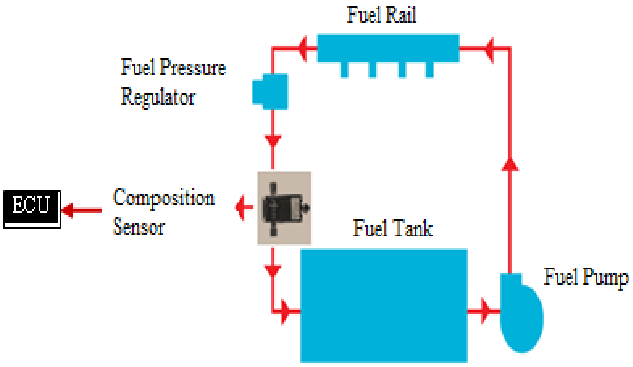

Fig. 2: Schematic of Fuel Composition Sensor Placement.

4. RESULTS AND DISCUSSION

As most of the vehicles are equipped with lambda sensors or universal exhaust gas oxygen (UEGO) sensors(Regitz & Collings, 2008) which do not directly determine the real fuel composition, but the amount of oxygen present in the exhaust gases. Besides, they are exposed to high temperatures (upto 1000 °C) and high vibrations (up to 50 g), which may lead to fast degradation of the sensor. A system equipped without an fuel composition sensor, and with only a switching oxygen sensor, indicates only a rich or lean exhaust gas fuel to air mixture, without identifying the magnitude of the error. The oxygen sensor feedback term must increment or ramp until a switch in the oxygen sensor state is obtained, indicating that a stoichiometric condition has been reached. A varying amount of time is required, due to this ramping, to adjust the fuel rate to the appropriate level, particularly with an abrupt change in the fuel's percent content. During this time the engine could be operating in a range that is significantly rich or lean of stoichiometric. Both conditions are unwanted. Additionally, significantly lean operation accompanied by high engine load could cause improper engine operation.

So due to inaccurate fuel composition and varying amount of time taken by the lambda sensor a system equipped with fuel composition sensor is used. It can be used moreover in normally rich of stoichiometric "open loop" operation, such as during wide open throttle (WOT) , and for cold start time and exhaust reduction.

5. CONCLUSION

This paper presents the development of technique to determine fuel composition in a very less operation time compared to Lambda or oxygen sensor. As fuel composition can be measured through various techniques like optical refractive index sensor, sensor based on capacitance change, dielectric properties of mixture, electrical conductivity change, Liquid density measurement sensor, microLDS is used as density is the most best proven accurate method to check the change in fuel composition as it shows large change in the signal output over a narrow concentration range.Further research will focus in designing the fuzzy-neuro control techniques to deal with learning the impreciseness and uncertainties of this system.

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