MAT JOURNALS
Journal of Embedded Systems and Processing
Volume 4 Issue 1

Portable Fuel Adulteration Detection System

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DOI: https://doi.org/10.5281/zenodo.2537400

Abstract

In this paper a portable solution to the problem of adulteration in diesel is proposed. Techniques for checking adulteration in fuel are common. But, the biggest disadvantage of these is that these are lab based and hence require sophisticated testing and analysis in laboratories. The method that is proposed in this paper a portable apparatus that can be directly fitted in vehicles and adulteration can be checked on the go. The method employed uses polarimetry as the basis for sensing adulteration. The apparatus was designed after careful deliberation on various techniques that could be used for checking adulteration in diesel by kerosene. The proposed apparatus uses optical properties of the fuel samples to give the results.

Keywords: *Adulteration, Diesel, Crude oil, Polarimetry*

INTRODUCTION

Defining Adulteration in Diesel

Adulteration is defined as the illegal introduction of a lower in state, lesser distant substance into a higher-level, senior substance so as we get obtained mixture which does not contain the original specification or properties of real product. The distant substances are also called adulterants, which when presented degrade the nature of the item. Diesel is a significant transport fuel in India, which is typically tainted with lamp fuel. Adulteration can be recognized with the assistance of optical fiber sensor [1].

Causes of Adulteration

As the fuel prices are increases, people try to reduce the prices by mixing, combining cheaper hydrocarbons to highly taxed hydrocarbons. There are different products have having the comparable qualities and costumers are unable to differentiate because of lack of tools required for identification because different products having same properties. Self-seeking, selfish & corrupted people always try to utilize the conditions for illegal activities to earn profit which is called as black money. Illegal activities in the retail business are a global phenomenon and fuel adulteration is one of the major problems for the customers. In India, the adulteration of petroleum products is primarily done due to the majorcostdisparity between goods. The government has decided to fix the kerosene subsidy that the Union Budget would provide for in the current fiscal at Rs. 26/liter. To the contrary, Diesel costs Rs. 74 /liter and Petrol costs Rs. 85 /liter (as of 20/Nov/ 2018).Various method used to evaluate the fuel adulteration areSensor based technique [2], Computational techniques[3].

Problems Faced Due to Adulteration

a. When the adulterated diesel is used in vehicles it may produce harmful toxic gases which contain higher levels of HC, CO (as shown in Table 1). This decline the environment and ultimate

reason of air pollution.

b. High-level adulteration of low Sulfur diesel fuel with more elevated amount Sulfur lamp oil can make the fuel surpass the Sulfur greatest. Impetus can be deactivated because of huge centralization of lamp fuel and lower transformation of motor out toxins.
c. The adulteration in fuel may likewise cause change in octane number of the fuel being utilized, which thusly may result in harm to the Engine. Blending diesel with lamp oil can leave hurtful stores in motors. The adjustment in octane rating may enact an issue called motor thumping.
d. Avoiding fuel taxes reduces government revenue.

Table 1:*Potential Adulterants for Diesel.*

Sr. No.	Solvent/Chemical	Source
1	Aromex	Digboi
2	Iomex	NA
3	C9 Raffinate	Petrochemicals
4	MTO	Refineries
5	PDS Kerosene	Govt.
6	Free Kerosene	Parallel Marketers

BACKGROUND

Diesel Properties

After Invention of automotive the fuel used for vehicles are diesel and gasoline. These two products are uses as an energy source for vehicles (Table 2). There are many alternate fuels available like CNG, LPG, alcohol, di-methyl ether, biodiesel, methanol, etc. in the market. To produce transport fuels having desired specifications different fractions of crude oil are blended as shown in Figure 1. Depending upon the locality the composition of crude oil may vary, but the basic component alkanes, napthenes will remain in it. The low-boiling fractions of almost all petroleum products are composed of alkanes; it is the synthesis of the higher boiling portion, which contrasts as indicated by the supply of the oil. Hydrocarbons, mixes containing oxygen, nitrogen, Sulfur and metallic constituents are likewise present(as shown in Table 3). In this paper Diesel-Kerosene contaminated is proposed [4].

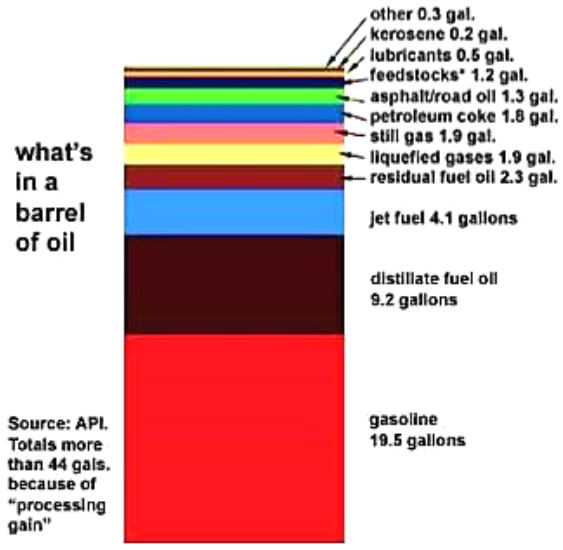

Figure 1:*Various Components of Crude Oil.*

Table 2: *Density and Kinematic Viscosity of Diesel Fuel and Adulterated Kerosene at Different Proportions.*

Parameter	Petrol	Diesel	Kerosene
Physical appearance	Coloured Dyes are added to change colour.	Greenish colour. Oily texture.	Thin, crystal clear liquid.
Density	0.71-0.77 g/cm3	0.832 g/cm3	0.78-0.81 g/cm3
Flash Point	-43º C	52-96º C	37-65º C
Heat of combustion	42.4 MJ/Kg	43.1 MJ/Kg	43.1-46.2 MJ/Kg
Obtained by fractional distillation at temperature:	140 - 175º C	200-350º C	150-275º C
Miscellaneous	Composed of carbon chains containing 4 and 12 carbon atoms.	Composed of Carbon chains containing 8-21 C atoms per molecule	Composed of Carbon chains containing 6-16 C atoms per molecule

Table 3: *Comparison of Various Parameters.*

Sr. No.	Diesel and Kerosene Proportions (v/v)	Density at 15ºC (in g/mL)	Kinematic Viscosity at 40ºC
1	Pure Diesel	0.8456	2.63
2	Prescribed Level	0.82-0.86	2 to 3
3	85:15	0.8400	2.33
4	75:25	0.8390	2.16
5	65:35	0.8321	1.89
6	50:50	0.8304	1.83
7	25:75	0.8234	1.5

METHODOLOGY

After reviewing the literature properly, it is observed that the following method can be used for making a portable fuel adulteration detection system.

Polarimetry

Polarimetry is utilized for the estimation and elucidation of energized transverse, most prominently electromagnetic waves, for example, radio or light waves. Normally, polarimetry is done on electromagnetic waves that have gone through or have been reflected, refracted, or diffracted by some material so as to describe that object.

An example is set in a basic polarimeter for estimation of revolution comprises of a long cylinder with glass put at each end. At each finish of the cylinder is a Nicol crystal or other polarizer. Light is shone through the cylinder, and the crystal at the opposite end, appended to an eye-piece, is turned to touch base at the locale of finish brilliance or that of half-dim, half-splendid or that of finish haziness. The edge of pivot is then perused from a scale. A similar marvel is seen after an edge of 180°. The explicit revolution of the example may then be determined. Temperature can influence the pivot of light, which ought to be represented in the estimations. Block diagram of polarimetry arrangement is shown in Figure 2.

$$[\alpha]_{\lambda}^{T} = 100\frac{\alpha}{l.\,p}$$

Where,

$[\alpha]_{\lambda}^{T}$ is the specific rotation
T is the temperature
λ is the wavelength of light
α is the angle of rotation
l is the length of the polarimeter tube
ρ is the mass concentration of solution

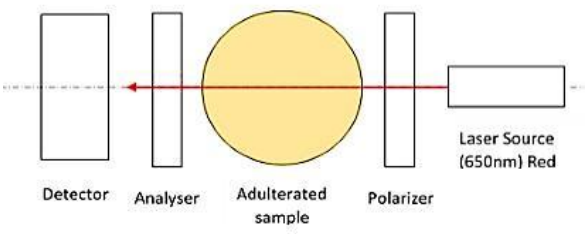

Figure 2: *Block Diagram of our Polarimetry Arrangement.*

WORKING

A cylindrical whole pipe or tube is used. At one end laser is placed and at other end photo diode is used which is a semiconductor device that converts light into an electrical current. It has pnjunction or P-I-N structure. As resultant current of photodiode is in mA, so for amplification purpose we use two stage differential amplifiers. Then it will be fed to signal level shifter which is used to shift the increased voltage swing downwards. It have emitter follower with voltage divider network. So first of all, we pour a pure fuel into tank. A laser shaft is gone through it ceaselessly which is gotten on photodiode territory at opposite end. Subsequently, current is created which getsamplified by amplifier and fed to level shifter. This value is stored as standard value in microcontroller. Same process is followed but this time adulterated fuel is poured into tank that may show changes in readings which are totally different from standard readings stored in microcontroller. As soon as microcontroller detects the difference between these two values it will send a signal to motor driver circuit which willcut off the power by breakdown contact of ignition coil and it will also send warning message to monitoring section through GSM and with the help of GPS we are able to detect the location. The following block diagram shows the arrangement of different components shown in Figure 3.

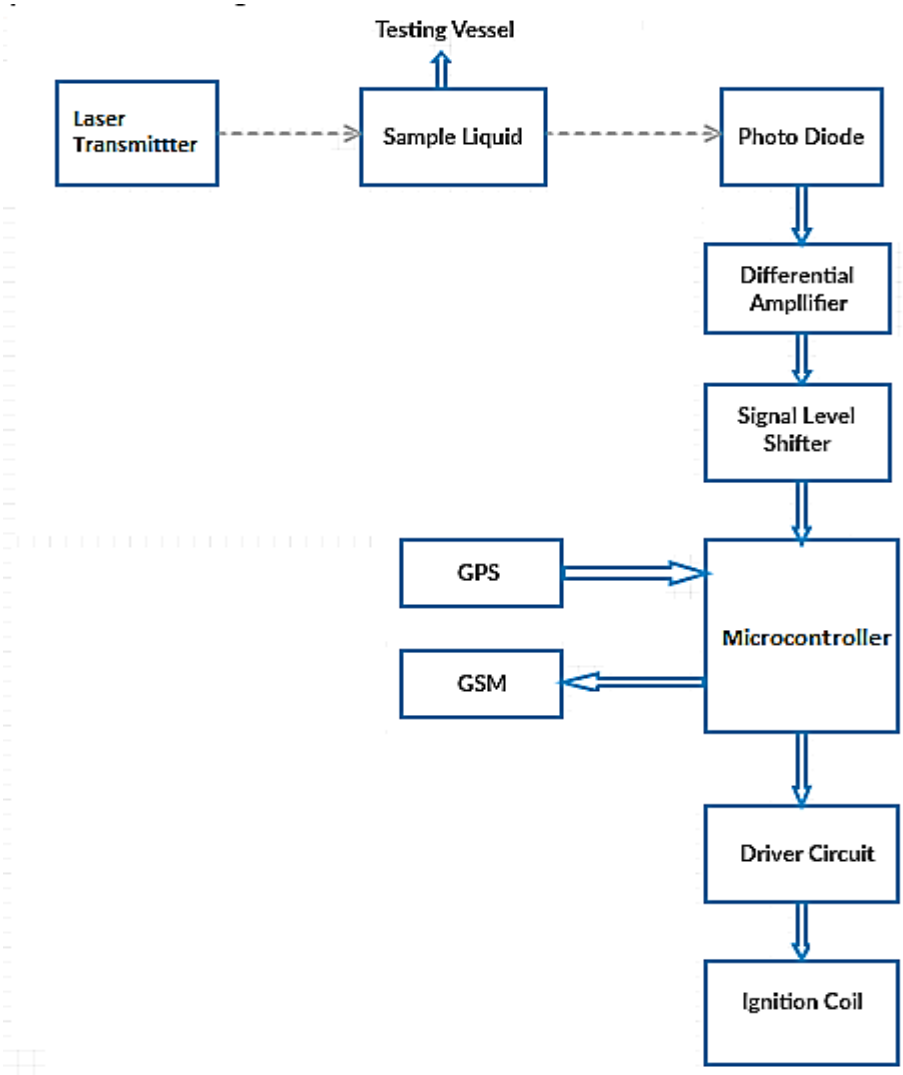

Figure 3:*Block Diagram of Different Component.*

APPARATUS DESIGN

Components of Apparatus

The following components in the apparatus used for experiment:

1. PVC pipes (Plasto)
2. Polarizer sheet
3. Analyzer sheet
4. Laser source (650 nm dot source)
5. Phototransistor (PT333-3c)
6. LM-324 Op-Amp IC
7. PVC Glue
8. Araldite
9. Circular thin glass sheet

PVC Pipes (Plasto)

There are many pipes available in the market but the strongest pipe is PVC. PVC pipes broadly categorized into two category 1) Rigid 2) Flexible. For Construction line the rigid type PVC pipe is suitable.

Polarizer and Analyzer Sheets

There are numerous channels accessible for signs like Low pass filter, Band pass filter, and so on. For light Polarizer are utilizes for separating application. Polarizer will pass light of needed polarizations and square the rest light. It is helpful for change of undefined blended polarization into a light emission polarization. Contingent on application straight polarizer and circular polarizer are utilized.

Laser Source (650 nm)

A laser is a gadget that emanates light through a procedure of optical enhancement dependent on the stimulated outflow of electromagnetic radiation.

Signal Conditioning Circuit

The signal conditioning circuit used in the system consists of two amplifier stages. LM324 IC is used as the op-amp IC for amplifiers. The first stage is a difference amplifier with a gain of 2. The second stage is a simple non-inverting amplifier with a gain of 3. Schematic diagram of apparatus is explain in Figure 4.The feedback loop of second stage is adjustable by the use of 50k pot in series with 10k resistor. The output of the signal conditioning circuit is so adjusted as to limit the output in the range of 0-5V.

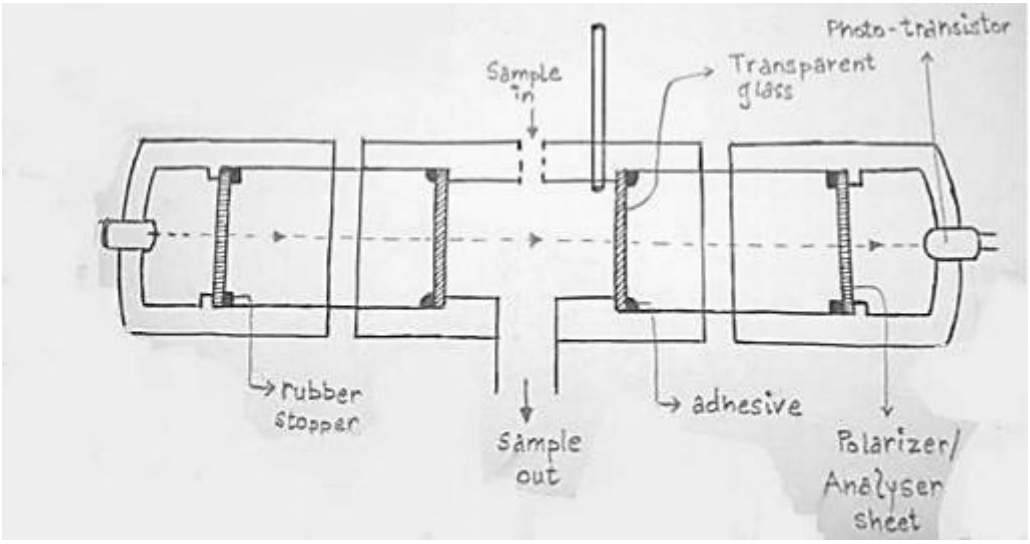

Figure 4:*Schematic Diagram of Apparatus.*

Photo Transistor (PT333-3C)

Transistor is device used for amplification purpose. Majority and Minority charge carrier will contribute to the output

current. The Input resistance of transistor is low as compared to the output resistance. A phototransistor depends upon the light. The light will used for generation of minority charge carrier. It is Light sensitive device.

Controller Circuit

The amplified output from signal conditioning circuit is contribution to the controller. This information voltage run is restricted in the scope of 0-5V by utilizing a 5V zenerdiode voltage controller circuit. This guarantees at no time the voltage of the flag sustained to controller surpasses the 5V esteem, consequently, preventing the controller from any sort of damage. This input is applied to the ADC channel of the microcontroller. The ADC module is used in 10-bit mode, so as to enhance precision of the sensing circuit. The controller converts the analog value to digital value which is then processed on the basis of pre-defined algorithm. As per the sensed adulteration level, combined with the parameters matched in the algorithm, the controller displays the approximate adulteration level on the LCD display.

Microcontroller (PIC 16F883)

PIC16F883 Microcontroller have 10 bit Analog to Digital convertor, one Pulse width modulator, Synchronous Serial port, Universal Asynchronous Receiver Transmitter, Two Comparator, 256 bytes of EEPROM information memory (Figure 5). Implementation of proposed solution is shown in Figure 6.The fundamental favorable position of this microcontroller is it is self-modified and effortlessly perfect with industry application.

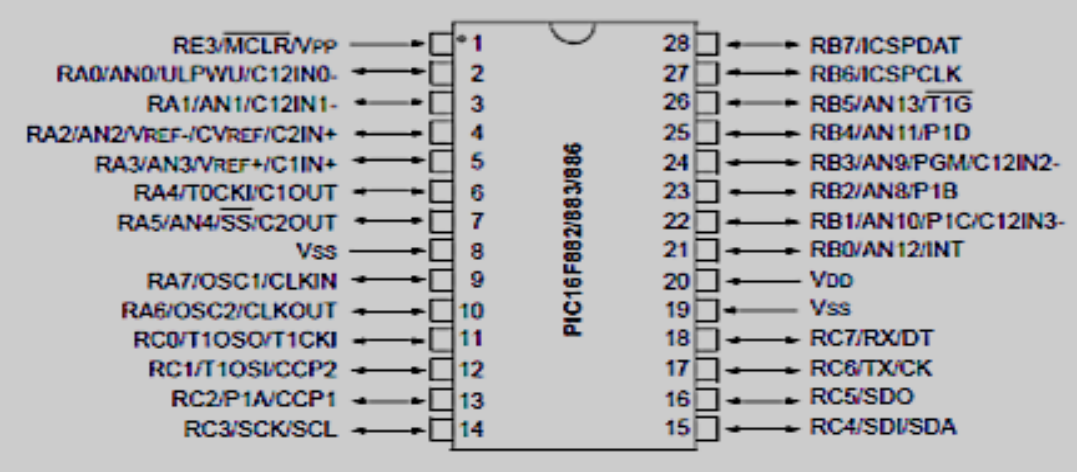

Figure 5:*Pin Diagram of PIC16F883 Microcontroller.*

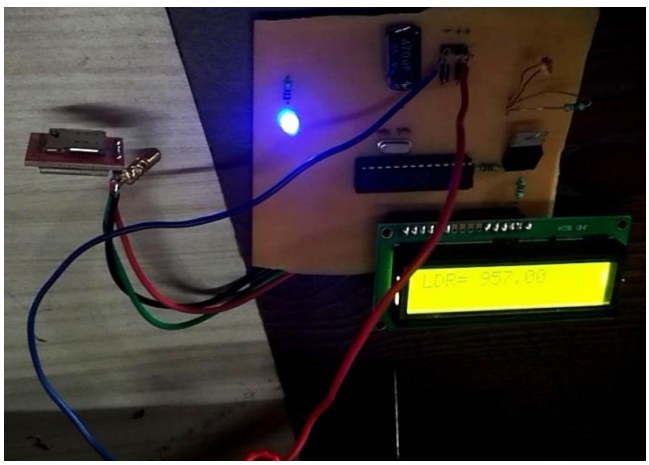

Figure 6: *Implementation of Proposed Solution*

CONCLUSION

1. With different samples from the same fuel station, the results are reproducible for different testing conditions, as in, different times and temperatures in a day.
2. With samples from different fuel stations the results are reproducible. Thus, this confirms that the method can be used universally.
3. The output results do not depend on the color of the sample.
4. Samples taken from various fuel stations and companies show similar characteristics when tested.
5. A vibration in the system does not affect the output of the system. By making some changes in design it can be used in vehicles as a portable system to detect adulteration.

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Cite as:
Minal Patil, Abhishek Madankar, & Vijay Chakole. (2019). Portable Fuel Adulteration Detection System. Journal of Embedded Systems and Processing, 4(1), 1–7.
http://doi.org/10.5281/zenodo.2537400