DIESEL LEVEL DETECTOR WITH AUTOMATIC SWITCH OFF FOR A STATIC ENGINE

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Abstract: Diesel Tank level detector with an automatic "Switch OFF" is an electronic circuit used for continuous tank gauging or detecting the level of diesel in an engine tank, the level of diesel in tank is detected and converted into an electronic signal. The Experimental setup is divided into eight principal parts. These are; Integrated Circuit (IC), power supply, relay, sensor, ignition switch, buzzer, and Light Emitting Diode (LED). The system was designed to measure diesel level in tanks up to 80 cm in height with 0.01 mm resolution. The implementation of the prototype of experimental set up system which consists of the electronics sensor. Experimental prototype of the proposed sensor was constructed in order to evaluate its performance in diesel storage tanks of an engine. The lengths of these diesel level sensors were set at 4 and 6 m, respectively, such that they corresponded to the depth of the target diesel storage tanks where it would be installed. The diesel level detector with an automatic engine switch off for static engine was found to be effective in safeguarding the engine, monitoring fuel level, and making the use of engine more convenient for its users.

Keywords: Diesel tank, power supply, sensor, ignition switch

Introduction

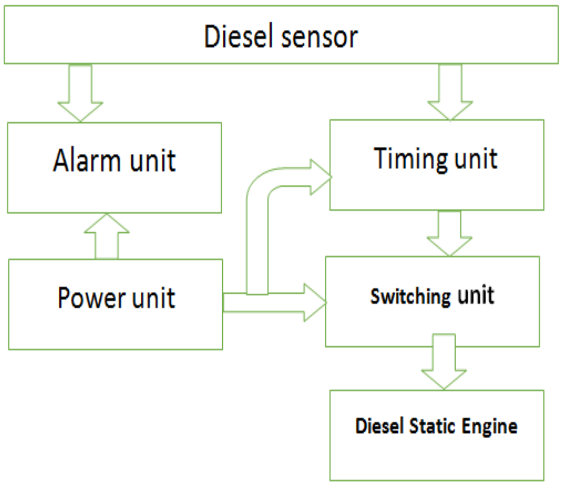
A conventional internal combustion diesel engine works on 'Diesel Cycle'. In a simple diesel engine, an injector injects diesel into the combustion chamber above the piston directly. Diesel engines are also commonly known as Compression-Ignition engines since the diesel is burned due to hot compressed air. The temperature of the air inside the combustion chamber rises above 400 to 800°C, which in turn, ignites the diesel which was injected into the combustion chamber. The 'Diesel Cycle' does not use an external mechanism such as a spark-plug to ignite the air-fuel mixture (Anonymous, 2017). There are many physical and applicable variables that affect the selection of the diesel level monitoring method for industrial and commercial processes. The selection criteria include the physical: phase (liquid), temperature, pressure , chemistry, dielectric constant of medium, mechanical shock, tank or bin size and shape. Also important are the application constraints: Ease of calibration, physical size and mounting of the instrument, monitoring or control of continuous or discrete (point) levels (Anonymous, 2016). More important is the ability to select an appropriate sensor type that best suit the need. In fact, level sensors are one of the very important sensors that play vital roles in variety of consumer/ industrial applications (Henggeler *et al.*, 2004). These sensitive parts of diesel engine are damaged as a result of emptiness of diesel in the diesel tank of an engine.

Diesel Tank level detector with an automatic "Switch OFF" is an electronic circuit used for continuous tank gauging or detecting the level of diesel in an engine tank, the level of diesel in tank is detected and converted into an electronic signal. The level signal is either displayed directly on site or incorporated into a process control or management system. In point level detection, a level switch detects when a certain predefined level in the tank is reached. Such a device is employed when it is not necessary to measure every possible intermediate level, as in the case with continuous tank gauging, however they are often combined with a diesel tank alarm that will let off a sound when a pre-set low level is hit (Bengtsson, 2013).

Materials and Method

The Experimental setup is divided into eight principal parts. These are; Integrated Circuit (IC), power supply, relay, Sensor, ignition switch, buzzer, and light emitting diode (LED). This study was, proposed to solve the problem of total diesel dryness in diesel engine tank.

Below is a Block Diagram of Diesel Level Detector with Automatic Engine Switch Off



Power supply

This is the circuit that supplies power to the full system. It obtains its power source from a 220 volt as ac power supply source, to deliver a 5 volts dc power output. The circuit diagram is shown in Fig. 1.

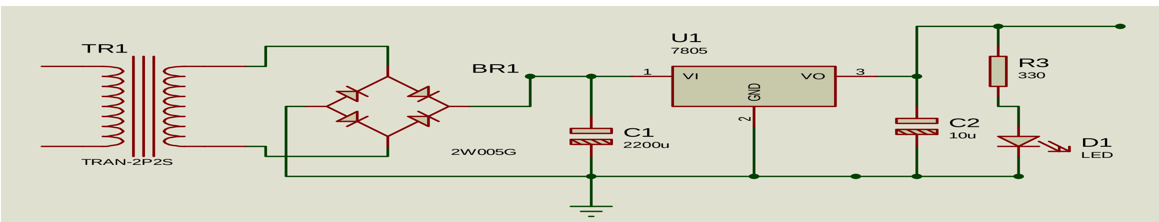


Fig. 1: The power supply unit

TRI: This is the step down transformer. A transformer voltage of 12Vac or above is required. The current should be enough to supply the requirement of the circuit.
The transformer (T1) chosen is 12Vac at 300 mA.
D1-D4: These are the rectifier circuit. The diodes chosen must have a peak inverse voltage (PIV) that must be able to withstand twice the peak voltage (V_p) of the transformers output and a forward current (D_c) of 1.5 times the output current of the transformer.
$V_p = \sqrt{2}V_{rms}$.............................. (1.1)
Where V_p is the peak voltage of the transformer output.
V_{rms} is the actual output voltage from the transformer = 12Vac
$D_{(piv)} = 2 \times V_p$ .... (1.2)
Where $D_{(piv)}$ is the PIV of the rectifier diode
C_1: This is the filters capacitor. Electrolytic capacitors come with a capacitance and a voltage rating.
Voltage Rating
The voltage of the capacitor (V_c) must be able to withstand 150% of the output voltage from the diode.
$V_C = 150\%$ of V_{DP} .... (1.3)
Where V_{DP} is the peak output voltage from the diodes
But V_{DP} is given as
$V_{DP} = V_p - V_D$.............................. (1.4)
Where V_p is the peak voltage of the transformer
V_D is the voltage drop of the diodes
Capacitance Rating:
The capacitance of the capacitor must be such that it could reduce the ripple voltage (V_R) to about 30% of the output peak voltage from the diodes.
$V_R = 30\%$ of V_{DP} .... (1.5)

From the ripple voltage equation (V_R), we could get the capacitance
$V_R = \frac{I_{max}}{2 \times f \times C1}$.............................. (1.6)
Where V_R is the ripple voltage
I_{max} is the maximum current from the diodes/ transformers (300mA)
F is the frequency of supply (50Hz)
C is the capacitance of the capacitor in Farads.
U1: This is the voltage regulator.
Regulator specifications:

i. Maximum input voltage = 30V
ii. Maximum output voltage = 5.5V
iii. Operating temperature = 0% - 150%

For effective Voltage regulation, the minimum input voltage should be:
$V_{min} = V_{out} + V_{ref}$ .... (1.7)
V_{min} – Minimum input voltage
V_{out} – required output voltage: 5V
V_{ref} – Datasheet Stipulated reference voltage; 3V
The regulator chosen is:
$U_1 = 7805$
C_2 is a transient capacitor. The rating is stipulated in the 7805 voltage regulator's data sheet as 0.1uF
Hence,
C_2=0.1uF

This capacitor helps for smoothening of the output from the voltage regulator. It is also to prevent spikes in the DC output voltage waveform in the event of transient disturbances. It is known as a buffer capacitor whose value is gotten from the data sheet of the regulator.

Current limiting resistor calculation:
$R_1 = (V_s - V_d)/ I_d$ .... (1.8)

Microcontroller unit

The microcontroller unit circuit is the heart of the project. This is where the program for the control part of the project is written and burned using assembly language and a universal programmer, respectively. The circuit diagram is as shown in Fig. 2.

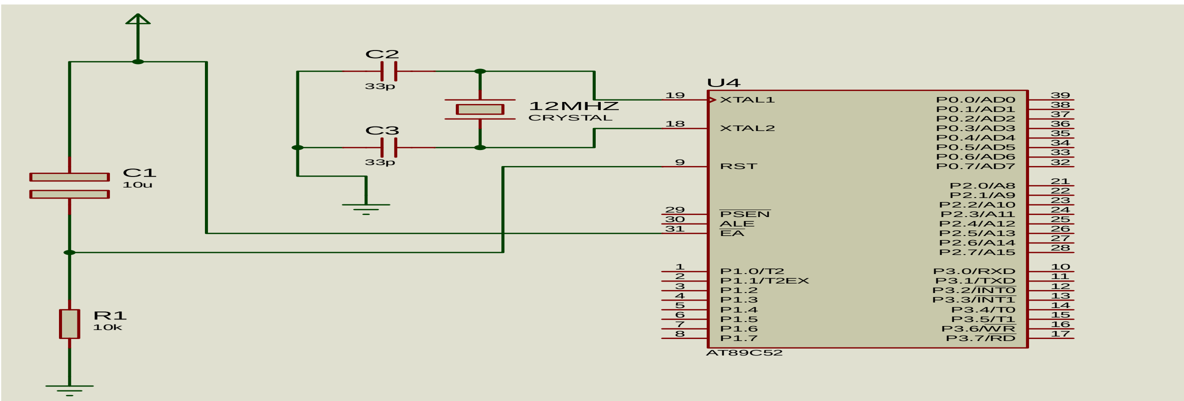


Fig. 2: Microcontroller unit

The 8052 microcontroller hardware circuit is usually a very flexible one and all the surrounding components are given a recommended range of values, by the datasheet but the actual values can be chosen by the programmer, which we successfully did.
The ranges of values given for the 8052 microcontroller hardware are as follows

Reset capacitor:	4.7µF	to	10µF
Reset resistor:	8.2KΩ	to	15 KΩ
Crystal oscillator:	4MHz	to	32MHz
Crystal capacitors:	27pF	to	47pF

For the programming of the microcontroller for the automatic fish feeding system, the chosen values are as follows;

Reset capacitor (C_1):	10µF
Reset resistor (R_1):	10 KΩ
Crystal oscillator (X_1):	12MHz
Crystal capacitors (C_2& C_3):	33pF

Results and Discussion

In order to demonstrate usability of the presented experimental set up, a virtual system for diesel level and measurement was developed. The system was designed to measure diesel level in tanks up to 80cm in height with 0.01

mm resolution. The implementation of the prototype of experimental set up system which consists of the electronics sensor. Experimental prototype of the proposed sensor was constructed in order to evaluate its performance in diesel storage tanks of an engine. The lengths of these diesel level sensors were set at 4m and 6m respectively, such that they corresponded to the depth of the target diesel storage tanks where it would be installed. In order for this device to be operated in these diesel tanks, the prototype of the proposed sensor had been attached on plastic base mounted on the wall of the corresponding tank. Due to the flexibility, the probe used here could be any metal rod with size and shape of your choice. If the tank is made of metal it should be properly grounded. For non-metal tanks a small metal is fixed at its bottom level to salve as the ground. The probe must be placed at the level you intend to monitor. The proposed diesel level sensor is light weight. This enables its easy transportation to remote locations, where the diesel storage tanks are located. Diesel tanks are often horizontal cylinders without graduated markings, so equation 2 can be used to calculate the gallons of diesel inside the tank based on tank length, diameter, and the depth to diesel surface. The value **$^a/_A$**in equation 2 represents the percentage that **a** (the submerged cross-sectional area) is relative to **A** (the total cross sectional area of the tank's side); c.f., embedded graphic in equation 2. The value **$^d/_D$**in equation 2 represents the percentage that **d** (the actual depth of diesel in the tank) is relative to D (tank diameter). To obtain the value of **$^a/_A$** draw a line vertically through the point **$^d/_D$** to where it transects the curved line; then draw a line back horizontally to find the value of **$^a/_A$**. For example, if the diameter of the tank (**D**) is 36 inches and the depth of diesel in the tank (**d**) is 7.2 inches then **$^d/_D$** is 0.20 and **$^a/_A$** is 0.15.3.

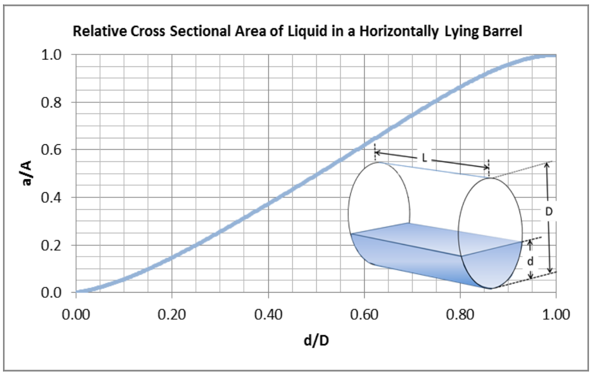


Fig. 1: The relative wetted cross sectional area to the total cross sectional area based on the diameter of the tank and liquid level inside

The quantity of diesel in gallons inside a horizontal tank at any alarm is given by equation 1.

$$Gals = {}^a/_A\ 181.4LD^2 \qquad \ldots\ldots\ldots\ldots\ldots\ 1$$

Where: The value of $^a/_A$ x 100 is the 5 the tank is full. Mathematically, the value of $^a/_A$ is given by:

$$^a/_A = 1.0038(^d/_D)^3 - 1.5621(^d/_D)^2 + 1.5366\,^d/_D$$

Gals = Volume of diesel in tank, gallons
L = Length of tank, inches
D = Diameter of tank, inches

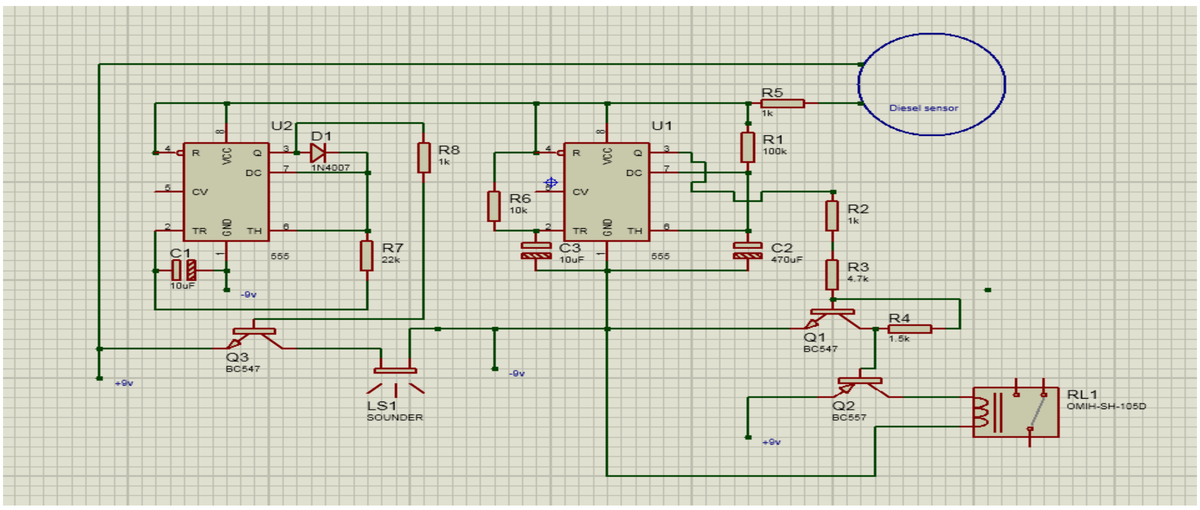
The quantity of diesel used during the time period (Δ Gals) is then the difference in tank as determined by equation (1) calculated at the end of the period against what it was at the start of the period. To turn these volumetric amounts into ***DR*** merely divide the Δ Gals by the additional clocked hours on the gauge since you first penciled down the original amount. Equation (2) calculates the diesel use rate (**DR**) for this period.

$$D_R = \frac{181.4LD^2\left(\left[{}^a/_A\right]_E - \left[{}^a/_A\right]\right)}{T_E - T} \ldots\ldots\ldots..2$$

$[^a/_A]_E$ = the value of a/A at the end.
$[^a/_A]_S$ = the value of a/A at the start.
T_E = the hours on the gauge at the end, hrs.
T_S= the hours on the gauge at the start, hrs. [3].

The complete circuit diagram of the Diesel Level Detector with Automatic Engine Switch Off.

Calibration of system



The calibration of system is very important for determining the accurate characteristic of the sensor, this one is obtained by hooking high precision Masses as prescribe by the operator and we note the voltage values corresponding to the predetermined value with a voltmeter of precision 0.01 mV.

Diesel level measurement with the experimental setup

In order to demonstrate usability of the presented experimental set up, a virtual system for diesel level and measurement is developed. The system is designed to measure level in tanks up to 80 cm in height with 0.01 mm resolution. The implementation of the prototype of experimental set up system which consists of the electronics sensor. Experimental prototypes of the proposed sensor were constructed in order to evaluate its performance in diesel storage tanks of an engine. The lengths of these diesel level sensors were set at 4 m and 6m respectively, such that they correspond to the depth of the target diesel storage tanks where it will be installed. In order to operate in these diesel tanks, the prototypes of the proposed sensor have been attached on plastic bases mounted on the wall of the corresponding tank. Due to the flexibility the probe used here can be any metal rod with size and shape of your choice. If the tank is made of metal it should be properly grounded. For non-metal tanks a small metal is fixed contactor at its bottom level and ground it. The probe must be placed at the level you want to monitor.

The proposed diesel level sensor is light weight. This enables its easy transportation to remote locations, where the diesel storage Tanks are located.

Conclusion

During the cause of this project, diesel level detector with an automatic engine switch off for static engine was found to be effective in safeguarding the engine, monitoring fuel level, and making the use of engine more convenient for its users. In spite of the simplicity of the designed prototype, the characteristics of the sensor showed acceptable results such as sensitivity and linearity. Finally, this work provides a complete solution for direct and complete dryness of diesel in the tank that always cause engine damage.

Conflict of Interest

The authors declare that there is no conflict of interest related to this study.

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