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IoT/GSM Monitoring and Pollutant Detection of Heavy Equipment Fuel System

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Abstract*—This thesis presents an automation system that can be used in the monitoring process of diesel fuel, especially fuel from the beginning of heavy equipment with a tiered transportation process. This may cause pollutants in fuels, especially biodiesel/biofuel because of their solvency and hydroscopic properties that make it easy to absorb water to form mud and gel. Fuel available in heavy equipment sometimes has many impurities due to its complex distribution. The study began by scanning the properties of fuel ranging from B0 to B30 compared to water with a moisture sensor scanner and measuring pollutants using TDS sensors on clean B0, clean B30, and clean B100 compared to dirty fuel taken from a real job site. Using Arduino Mega, SIM 800, Nextion LCD, Relay, power supply, and Buzzer, it can be used to create an automatic system that can activate pumps and valves automatically if there are pollutants and water can be monitored. Using Blynk IoT, fuel conditions can be monitored online. Furthermore, if water or pollutants are in the fuel, then the developed tool can suck up using a valve and proceed to the filtering process with a filter to hold the pollutant and return the fuel to the tank. If there is water detected from the sensor, the pump will suck water and then continue to be accommodated in the reservoir. By using IoT, every sensing activity in the fuel tank, whether there is water or a pollutant, can be monitored in real time using Blynk. For commercial implementation, a robust design with powerful sensors and actuators is needed in accordance with the operational conditions of the fuel tank.

***Keywords*—biofuel, heavy equipment, pollutant, hydroscopic gel, mud, water in fuel.**

I. Introduction

The problem that often arises with heavy equipment with diesel engines is the supply of non-standard fuel [1]. especially with various fuels provided in various locations coming from illegal oil, oil mixed with water, and mismatches in fuel selection can cause serious damage to the engine [2]. In many cases, as shown in the following Fig. 1, a problem experienced by one of PT United Tractors' Tbk customers has been documented by mechanics, who found fuel mixed with water [3].

Fig. 1. Problem in the background

One of the damages that may arise is caused by the presence of water in the fuel tank and other damages, which ultimately cause the engine to not perform well. Engine lack of power is generally caused by ineffective air intake, insufficient supply of fuel, improper fuel injection, improper selection of fuel, engine overheating, or errors in the electrical system [4].

In terms of general causes alone, half are affected by fuel problems. In the picture below, it can also be seen that there are silt deposits caught in the water separator [5]. In Fig. 2, mud appears due to the unhandled content of pollutants contained in the fuel tank [6].

Fig. 2. Problem with fuel

II. Metodology

Every problem must have a root problem, so that it can be sorted out by looking for the root of the problem in people, tools, methods, and the environment to be examined in more detail the root of the problem at Fig. 3.

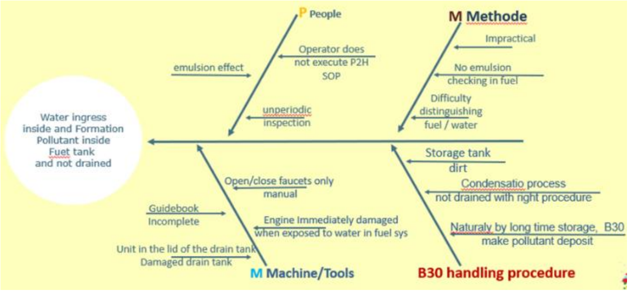

Fig. 3. Fish bone diagram

The research that will be carried out includes the evaluation of various kinds of liquid substances in various types of fuels and their pollutants, especially the capacitive value of the liquid fuel in various conditions such as pure diesel, biodiesel, biodiesel emulsified with water, sedimentary water, and so on [7]. With this data, the writers can determine the design of software and hardware to make decisions so that the water contained in the tank can be separated. The selection process to be used sequentially is as follows:

- Find out the value contained in various types of liquid substances that allow entry into the fuel tank, ranging from specific gravity capacitive or other appropriate to be used as a determinant of the fuel content.
- Create hardware and software designs to be able to separate water and pollutants contained in tanks or water separators.
- Make a prototype that is able to execute water intake when there is water and pollutants at the bottom of the tank [8].

A. Hardware Design

The hardware components are designed into three major parts namely input devices, processing devices, and output devices. There is a component description of the three assembly devices:

1. Input device: Soil Moisture Sensor, TDS Sensor.
2. Processing devices: Arduino Mega, GSM module
3. Output device: LCD [9], Buzzer, relay pump, valve [1]

The hardware design is shown in Fig. 4.

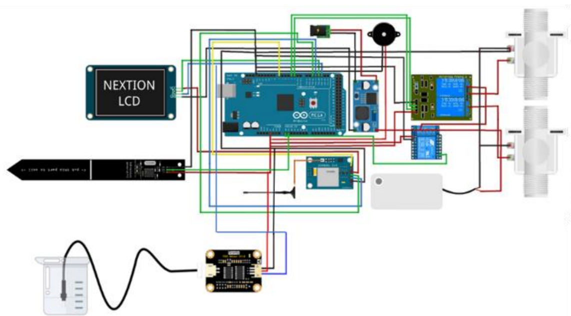

Fig. 4. Wiring diagram

B. Connected Hardware, Sensor and IoT

This device design is able to do five things:

1. Read if there is any water in the fuel tank.
2. Read if there is any pollutant in the fuel tank.
3. Pump the water contained in the fuel tank and transfer it to the holding tank.
4. Pump the pollutants contained in the fuel tank, filter the pollutants, and channel them back to the tank.
5. Monitor fuel conditions via Blynk.

Design the prototype sensors and actuators inside as shown Fig. 5.

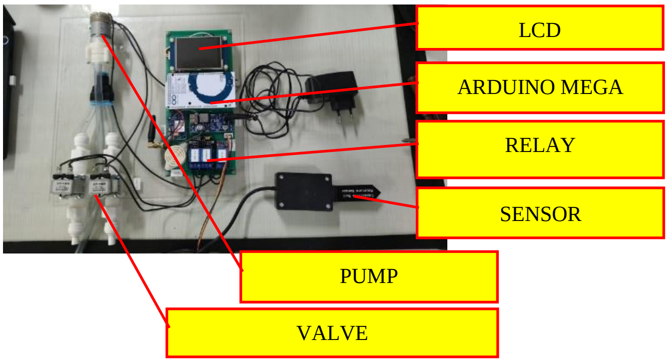

Fig. 5. Prototype design

The design process can be done through the website or through a direct application. When creating a new template, an authentication code will be sent via email and this code will be entered into the sketch Arduino IDE [10]. Before being added to the sketch, the Arduino IDE must add the latest blynk.edgent library. The example of creating a new project in Blynk is shown in Fig. 6.

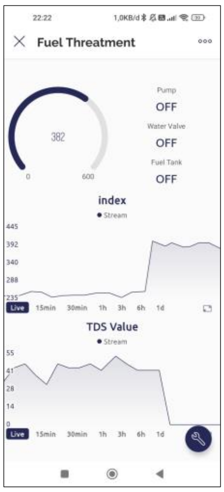

Fig. 6. Create new project in Blynk application

C. Experiments with capacitive soil moisture sensors

In the first experiment we used thermo gun, Arduino uno and capacitive moisture sensor, with water material and

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industrial diesel [3]. Fig. 7 is documentation When Capacitive measurements are carried out at normal temperatures in Jakarta.

Fig. 7. Experiment with capacitive soil moisture sensor

The results obtained are significant enough to distinguish between water with fuel and fuel mixed with pollutants, as shown in Table 1 below.

TABLE I
SOIL MOISTURE SENSORS ON TEST MATERIALS

Material	value Moisture at ambient temperature Indonesia area* unit heavy equipment operation does not include freeport			
	Moisture Value temperature 25-30° Celsius	%	Moisture value cold 18° Celsius	%
Clean Fuel B35	428	23,23%	426	23,87%
Fuel with Pollutant	423	24,84%	423	24,84%
B35 extreme pollutant	433	21,61%	430	22,58%
B100 Clean after touch B0	434	21,29%	432	21,94%
B100 After use extreme	429	22,90%	427	23,55%
B100 After use extreme	431	22,26%	430	22,58%
B100 After use extreme	430	22,58%	429	22,90%
Clean Fuel After touch dirt B100	432	21,94%	430	22,58%
B35 extreme pollutant sensor at top position	431	22,26%	427	23,55%
Bio fuel with pollutant other hevy Eqp	432	21,94%	432	21,94%
material bio fuel with extreme contaminant	431	22,26%	427	23,55%
B35 extreme pollutant sensor at top position sensor on Top	430	22,58%	428	23,23%
B100 clean	431	22,26%	427	23,55%
water After sensor touch fuel	280	70,97%	187	100,97%
B0	432	21,94%	425	24,19%

D. Experiment with TDS sensors

In Fig. 8 of the next experiment, the writers will use a TDS sensor. In this experiment, the writers will measure how much the TDS value is [11].

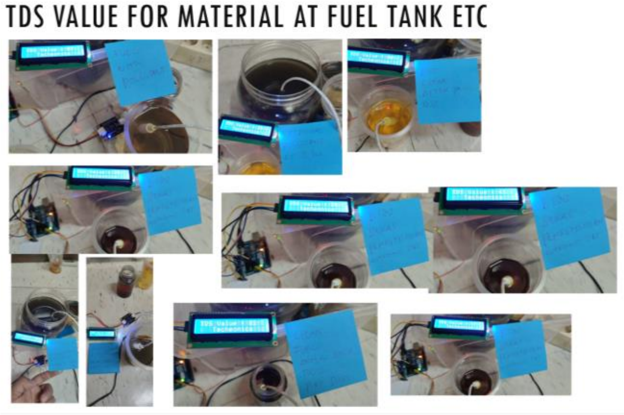


Fig. 8. Experimental using TDS sensor

Using a TDS sensor, the following data can be obtained in accordance with Table 2. The TDS sensor value is measured on several types of materials that may be contained in the fuel, as shown in Table 2 below.

TABLE II
TDS VALUES IN EACH MATERIAL IN THE FUEL TANK

Material	**value TDS at ambient temperature 25-30 celcius**
	TDS VALUE *ppm
Clean Fuel B35	0
Fuel with Pollutant	7
B35 extreme pollutant	35
B100 Clean after touch B0	0
B100 After use extreme	25
B100 After use extreme	29
B100 After use extreme	43
B35 extreme pollutant sensor at top position	5
Biofuel with pollutant other heavy Eqp	10
material biofuel with extreme contaminant	20
B100 clean	0
material biofuel with extreme contaminant	60
B35 extreme pollutant sensor at top position sensor on Top	23

E. Calibration Results Sensor Moisture

In Table 3, the writers find the calibration results that have been concluded to be executed when the pump will be on and off according to the moisture value appropriate in Table 3. If water is detected, the system will be turned on automatically [12]. In Table 3, it is shown when the pump and water valve will be on, so that there are no errors in decision-making based on the results. The pumping results will be accommodated in a transparent reservoir, which will be observed by the operator. If it is true, then the water will be discharged.

TABLE III
CAPACITIVE VALUE AND VALVE DECISION

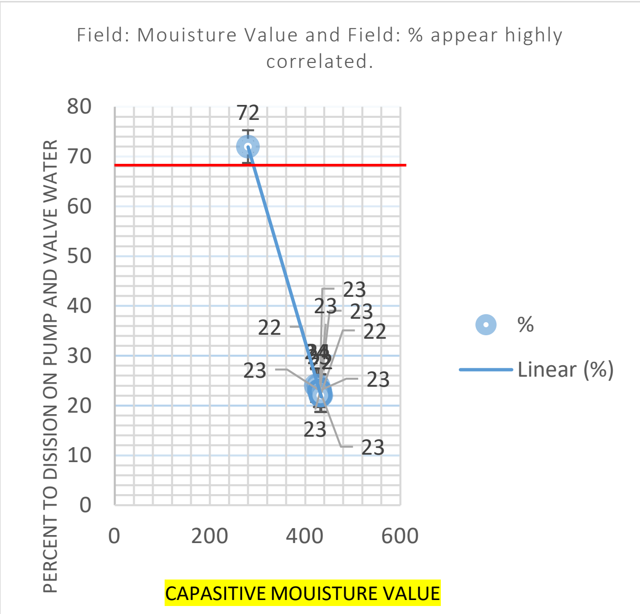


TABLE V
TDS VALUE PPM* AND VALVE DECISION

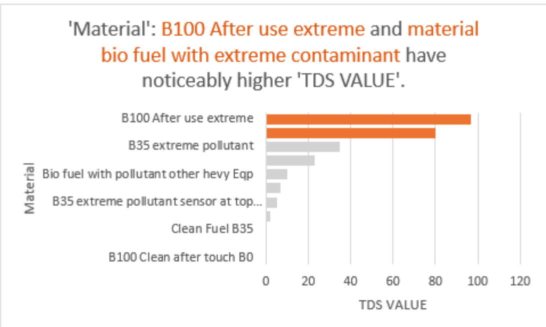
Material	value TDS at ambient temperature 25-30 Celsius			
	TDS VALUE	Pump Decision	to water tank	to fuel filter
Clean Fuel B35	0	OFF	OFF	OFF
Fuel with Pollutant	7	ON	OFF	ON
B35 extreme pollutant	35	ON	OFF	ON
B100 Clean after touch B0	0	OFF	OFF	
B100 After use extreme	25	ON	OFF	ON
Clean Fuel After touch dirt B100	2	OFF	OFF	OFF
B100 clean	0	OFF	OFF	OFF

Technical specifications of the portable TDS meter used are given on the attachment.
This portable TDS meter has not been calibrated using a calibrated and certified ppm measuring instrument.

F. Calibration Results TDS Sensor

The TDS sensor precision level functions to distinguish pollutants from fuel. In the table below, it can also be seen the condition of the pollutants contained in the fuel. Clean fuel has particle levels read by the TDS sensor at several of the several TDS values. Compared to portable TDS sensors, there is a slight difference [7]. This condition is not a problem because the fuel will be returned to the original tank after passing through the filter. The level of pollutants with several smaller TDS values in the fuel tank will continue to decrease until the fuel tank becomes clean, as shown in Table 4 below.

TABLE IV
TDS VALUES LISTED ON TDS SENSORS



At the end of this sensor, it is quite easy to determine because the fuel will be returned to the tank. If a little pollutant is found (determined below 2 ppm *), then the pump and the filter valve will be on. Filtering is done continuously until the fuel is completely clean, as shown in Table 5 below.

In Table 6 below, the writers can decide that, if the TDS value in the fuel is listed, a filtration process will be carried out in which the fuel will be pumped up and the fuel valve is on while the valve water off valve filter is on [13]. The logic taken is as shown in Table 6 below.

TABLE VI
ON-OFF PUMP AND VALVE LOGIC

TDS Value	**Logic**	**moisture**	**Pump**	**Water Valve**	**Fuel Valve (Filter)**
< 2	or	<70	OFF	OFF	OFF
> 2	or	<70	ON	OFF	ON
<2	or	>70	ON	ON	OFF
>2	and	>70	ON	ON	OFF

III. Conclusions And Recomendations

A. Conclusions

Based on the results of data analysis from a series of experiments carried out, the conclusions of this study are as follows:

- Fuel containing water can be sensed by the moisture sensor so that it can be used to transfer water from the fuel tank to the shelter.
- Fuel containing pollutants can be detected so that decisions can be made to pump up and filter, then lower the fuel tank again.
- Using IoT, every sensing activity in the fuel tank, whether there is water or a pollutant, can be monitored in real time using the Blynk.

B. Recommendations

With these experiments already done, some still need more patent data accuracy:

- The use of more precise sensors to detect the presence of pollutants will sharpen the fuel content analysis.
- The use of filter pumps is more appropriate for actual vehicles.
- More study of design in order to extend the life of the tools used.
- Further research can be continued by detecting pollutants with more precise values in accordance with actual PPM values.
- For commercial implementation, a robust design is needed that is in accordance with the operational conditions of the fuel tank.

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