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IDENTIFICATION TYPE OF GAS BASED ON *DISCHARGE TIME* MEASURING IN *LIGHT EMITTING DIODE* SERIES

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***Abstract*—Nowadays, gas or vapor detection to observe environment situation is very required in many fields. Spectrophotometer method is always used to analyze contain and gas concentrate based on the absorption intensity of light by the gas sample. This research used *Light Emitting Diode (LED)* series act as a transmitter and light receiver (detector). Above detector surface is layered by a chemical membrane that selective in to the type of gas according the polarization level. This vapor absorption in chemical membrane can cause shrinking the intensity of light that hit the detector. This light will be discarding the load in internal capacitor of the detector. Duration internal sudden discharge of the LED depends on light intensity that hit it. Detector LED series that layered by different chemical membrane is produce different an absorption phase that patterning different *discharge time*. In this experiment, alcoholic solution and gasoline are used as vapor samples. Identify types of gas using imitation nerve connection method to finding out every type of gas with 80% success.**

***Keywords*— Imitation nerve connection, LED, *discharge time* pattern, polymer**

I. Introduction

To observe environment situation in dangerous gas detection (pollutant) became headline in a few decades. Foreknown, effect of pollutant gas is extremely dangerous for human health, because of that human curious about good health either in environment aspect or body aspect. At this moment, there has been method to detect gas will take a long time to process and high cost. Therefore, research about making gas analyze instrumentation with the fast response rate, precise, and able to analyze on the site [1]

In this research, basic principle method of long wave absorption is used *Light Emitting Diode* (LED). Light that transmitted by LED will be received by the same LED light sensor until turning reverse current ray that cause sudden discharge detector of LED internal capacitor [2]

In this research, LED series is used to function as a transmitter and receiver of light. The light will be discarding the load in internal capacitor of the detector. To distinguish discharge time patterns, detector surface layered by a chemical membrane that type of polarized is different become a different light absorption phase.

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II. Research Methodology

Materials that used in this research is polymer *Apiezonem M, PED-20, Squalane,* for layering detector surface, as seen in Table 1. In behalf of gas sample that used is alcohol and gasoline. Equipment that used is microcontroller AT MEGA-16A and LED 5mm size. Sensor principal is based on Beer law where a ray is transmitted and passed into medium with c concentration and 1 path length with starting radiation I_0 and after through I_1 sample, as seen in Picture 1. The size of transmittance of T defined in equation 1. [3]

$$T = P / P_0 = 10^{-kb}$$

Table 1. Types of polymeric materials

Layer	Types of Polymers	Konstanta
Layer 1	PEG-20M	Polar
Layer 2	Apiezone M	Non-Polar
Layer 3	Squalane	Non-Polar

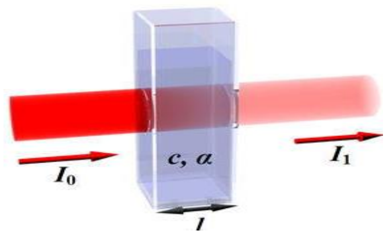

Figure 1. Ligh absorption by a sample [3]

1. Discharge Time is sudden discharge capacity internal LED time. At the moment charging capacitance, detector pin I/O make into 5 volt output until the voltage will recharge LED internal capacity. After capacitance is fully filled, detector pin I/O formerly output is made to input. To know discharge time so can be done by changing input emitter become 5 volt output so LED will on. The light transmitted in LED will irradiating detector which this process will turning reverse current ray, so capacitance in internal detector become

sudden discharge until pin I/O 1,7 volt valuable. Duration of sudden discharge capacitance starting from 5 volt to 1,7 volt is called *discharge time,* as seen in figure 2.

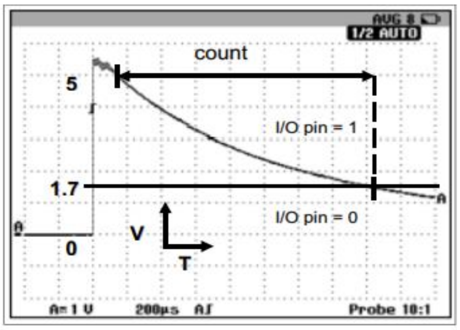

Figure 2. Discharge Time [2]

LED that used is 5mm size as many 6pcs, where 3pcs as transmitter and 3pcs as a detector that set opposite. After detector LED layered by different polymer, next step LED is input inside of the chamber with sealed and lightproof, shown in picture 3. This case was made with purpose the light from outside are not able to through and influence discharge time process in LED. Two holes were made for circulation of inside and outside gas sample. Whole system design can be seen in picture 4. At picture 5 shown result of realization equipment design that used in this experiment

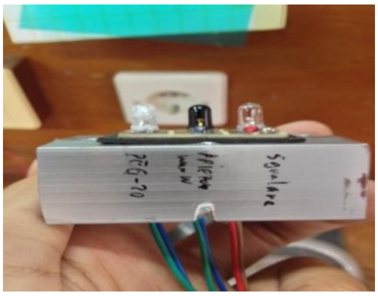

Figure 3. Polymer coated detector

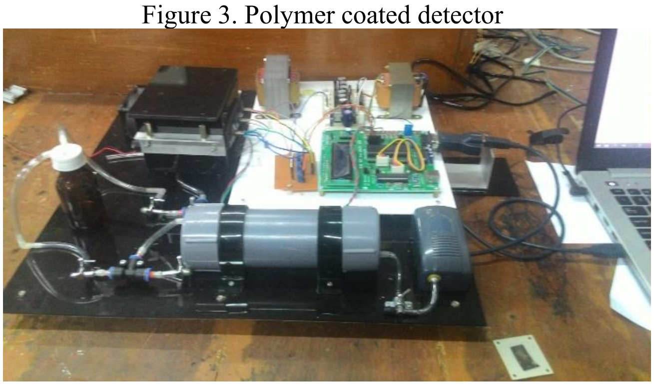

Figure 4. Overall system prototype

Procedure for collecting data on the initial state of pin A6 as a detector which is given a high logic to fill the voltage while pin A7 which is an emitter is given a low logic and is given a delay of a few moments and pin A6 is given a low logic. This is intended to create a high impedance state, while pin A7 as an emitter is given a high logic. Simultaneously the timer counter on the microcontroler will actively calculate the discharge time.

The backpropogation artificial neural network method is a method that is widely used to solve problems related to identification, prediction and pattern recognition. One application is to identify gases [1]. Backpropogation consists of two stages, namely the forward and backward stages [5], shown in Figure 5. For training this network, an input-target table is used as shown in Table 2.

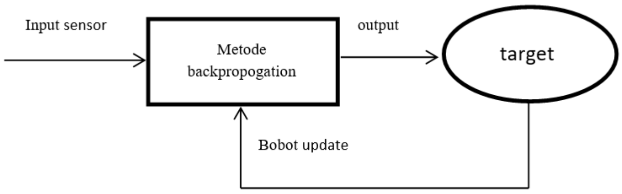

Figure 5. Backpropogation method model

Table 4. Target pattern of artificial neural network training

No	Jenis Sampel	Pola Target
1	Alkohol	10
2	Bensin	01

III. Results and Discussion

This research can be done by *discharge time* testing toward current intensity where the greater of current those given in then discharge time become more less, as pointed in figure 6. Furthermore, sample test is conducted as ten times, five data as imitation nerve connection to studying, and five data as testing. Every data consists of withdrawal seven hundred *discharge times*, two hundred sampling of fresh air. Then the distribution of vapor sample is doing during five second, and then fresh air is flowing until sevenhundred of data sampling. Zero until three hundred data sampling is *discharge time* condition as base line when without existence vapor sample. *Discharge time* alteration can be seen in table 2. for alcohol and gasoline sample. On behalf of gasoline sample, the sensor experiencing *discharge time* alteration in data sampling 271[th] while for gasoline sample experiencing *discharge time* alteration in data sampling 297[th].

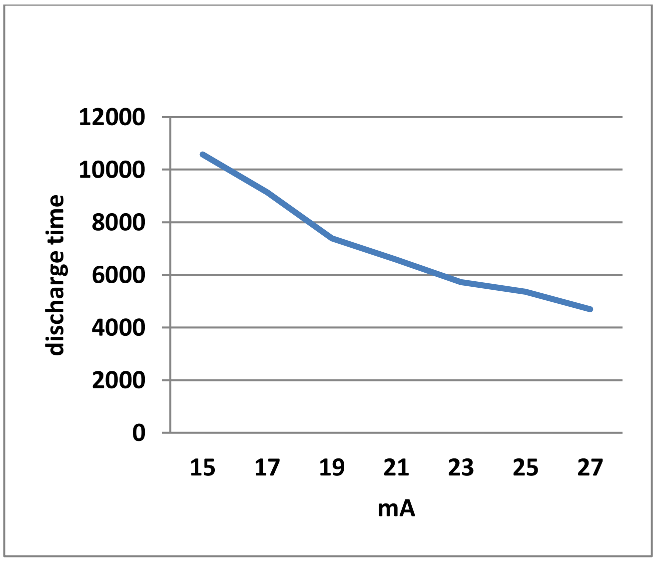

Figure 6 Discharge time testing

In this test, the LED on the emitter is gradually given different currents. When a large current is applied, the LED emitter gives a high light intensity. This change in light intensity will cause the discharge time to change according to the light intensity received.

The second test is to test the LED series sensor on colored mica plastic, where in this test it is designed to find out the difference in *discharge time* between different colors, so that it can produce *a discharge* pattern. In the test using mica plastic, it was formed according to the size *of the sensor chamber*. A process with mica plastic is placed between the LED detector and the LED emitter as a barrier so that the emitter light is absorbed, which then captures *the discharge time* data for each color can be found. The results of this test show that the use of mica plastic in yellow and green colors shows a difference in *discharge time*, where the results of mica plastic with yellow color produce a value of 10600 ms and green color produce a *discharge time* of 8600 ms. This result shows that the test using mica plastic that is yellow absorbs more light than green color. So that making *the dischange time* will last a long time.

The third stage of testing is using airflow testing, which is expected to detect airway leaks. Testing the airflow in the air unit by providing a predetermined air pressure and checking the leakage at each connection point. To be able to check the airflow, a flow meter with a measurement system block model is used. Air pressure measurement is obtained in three measurement patterns seen in the table below:

Table 2. Pressure measurement experiment table

Measurement Point	Pressure from the air pump	Measurement Results
A	0.1	0.1
B	0.1	0.1
C	0.1	0.1

Testing with air pressure measurement, which if there is no decrease in air pressure so that it can be carried out for the next data collection process. Temperature testing on discharge *time patterns* aims to determine the effect of temperature on discharge time patterns on each polymer layer. Where the test procedure will be given a temperature with the initial step of cleaning *the sensor chamber* with a process flowed by clean air, which is then given a room temperature where the room is given a gradual increase in heating temperature and observed charges in *the discharge time* pattern.

As a result of this observation, a charge in temperature was obtained, where the initial temperature was shown at a temperature of 27 °C, indicating that each *dischange time* in the polymer layer was between 11,000 µs and 1300 µs, where there was an increase in temperature of 35 °C. And the test if the temperature is increased by 50°C, then there is an increase in *the discharge* time in each layer which is at 20,000 µs to 22,000 µs, so it can be interpreted that the discharge time pattern test is greatly influenced by temperature changes.

The next test is using gas samples against polymer-coated LED sensors, which is expected from this test to be able to determine how the *discharge time* pattern and the response of discharge patterns change when given different gas samples. The testing procedure is carried out with a sample test as the first step by providing *a chamber* with a clean air temperature starting with sampling data of 0 to data at 200 sampling. Next, the sample gas flow is given by opening the valve for 5 seconds, which will be circulated again clean air until the sampling data reaches 700, this stage process is carried out with other gas samples, so that the *discharge time* pattern of each gas is obtained.

The test found in sampling data from zero to 200 is a discharge *time condition* that acts as a baseline, where when there is a sign of sample gas. The change in *discharge time* for alcohol samples changed in the 271st sampling, while for gasoline samples there was a change in discharge time in the sampling data 297 and for the acetone gas sample there was a change *in the discharge time* in the sampling data 341. Based on these results, it shows that for gas and alcohol samples, sensors show a faster response than gasoline samples, seen in the figure 7 & 8 below:

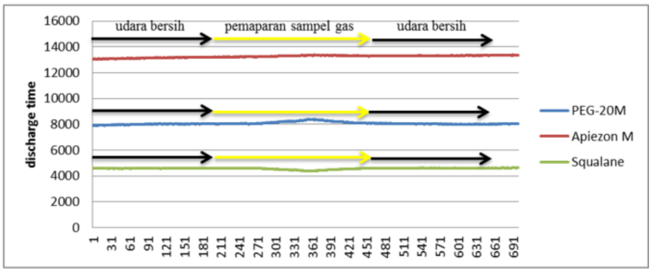

Figure 7. Sensory response to alcohol vapor

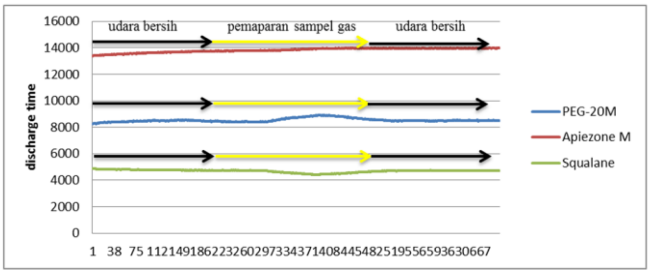

Figure 7. Sensor response to gasoline vapor

Tests related to the temperature sensor aim to find out if temperature affects the *discharge time pattern* on the LED series sensor so that it can know at the temperature when the sensor does not detect. The results of testing and analysis on the response of the LED series sensor when exposed to alcohol gas so that there is a very small change *in discharge time*. Each polymer is insensitive when exposed to the gas. In addition, the sensor experiences an acceleration *of discharge time* in the Apiezone layer when the gas sample is exposed. The Apiezon layer experiences an accelerated discharge time when exposed to acetone. From the overall results of this test, the sensor experienced a reduced sensitivity at 35oC, but the *discharge time pattern* on the polymer layer showed that each layer had a different pattern after exposure to the gas sample. The discharge time pattern in the alcohol and acetone gas samples is almost the same.

Table 2. Discharge time of each polymer

Sample		PEG-20M	Apiezone M	Squalane
Alcohol	1	7929	13137	4438
	2	8024	13120	4459
	3	7964	13085	4407
	4	8144	13216	4414
	5	7666	13504	4500
Gasolin	1	8799	14490	4472
	2	8620	13994	4390
	3	8522	14247	4570
	4	8581	14245	4465
	5	8534	14678	4467

Table 2 shows the discharge time in every polymer layer. For efficiently training time in imitation nerve connection held by normalization data from 0 to 1. The difference pattern response situation between alcohol and gasoline sample become parameter for imitation nerve connection study. A parameter that had got can be used for introduction testing of next gas. Error point is given as 0,001. In imitation nerve connection training, total iteration to reach error point is 245456. Imitation nerve connection testing was done by 10 data that was tested. There are two data that cannot be noticed, as shown in Table 3. The success level to identify every type of vapor is 80%.

Testing the LED array sensor using artificial neural networks to recognize the type of gas from the discharge time pattern. The gas samples tested were taken for a total of 10 data from two gas samples. The entire testing process was carried out at a temperature of 27°C. Training error is determined to be 0.001. After reaching the error value, the weight value is obtained for the gas type recognition process.

Table 3. Result of testing all gases

No	Sample type	Testing	Status	% Result
1	Alcohol	1	Appropriate	100%
2		2	Appropriate	
3		3	Appropriate	
4		4	Appropriate	
5		5	Appropriate	
6	Gasoline	1	Fail	60%
7		2	Appropriate	
8		3	Fail	
9		4	Appropriate	
10		5	Appropriate	

Testing on led series sensors using artificial neural networks is the introduction of the type of gas from the *discharge time pattern*. The gas samples tested were alcohol, gasoline, and acetone. The gas data tested was taken as many as 20 data from each gas sample. Overall, the testing process was carried out at a temperature of ±27 °C. The training error is specified 0.001. After reaching the error value, a weight value is obtained for the process of recognizing the type of gas, where the test process or procedure is initially the sensor is flowed with clean air sourced from the pump, which will then be given gas for 5 seconds and then clean air is flowed again. Data on changes in *discharge time* patterns and their responses are observed and stored. The test was taken 10 times from each gas sample, found in the results of testing and analysis in the learning process of artificial neural networks, the number of iterations to achieve the error value was 745456. Testing of artificial neural networks was carried out as many as 15 data. There are 4 data that cannot be recognized. The success rate for recognizing each type of vapor is 73.33%

IV. Conclusion

1. In the research, vapor detection device was made by using Light Emitting Diode series taking as a transmitter and receiver of light**.**
2. On detector surface is layered by polymer Apiezone M, PEG-20 and Squalane LED Series detector that layered by a different chemical membrane that produce an absorption different level that patterning different discharge time
3. Identity types of vapor using imitation nerve connection method can be trained to know every type of sample vapor with success level 80%

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