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Implementation of Blynk Internet of Things Platform for Benzene Gas Monitoring System on Density Laboratory

Fitria Hidayanti

Abstract: Density Laboratory using benzene as a solvent for hydrometer calibration activities. This study aims to monitor the gas content levels of benzene with platform Internet of Things (IoT) as a monitoring and notification system on Android smartphone devices. MQ-135 sensor module as a benzene gas detector sends the input signal to be processed by a microcontroller NodeMCU. Wifi module contained in NodeMCU transmits the values read by the sensors to Platform IoT Blynk to be displayed in graphical form. The reading from the sensor is processed according to the program and if it meets the specified setpoint value, the system provides notification to the user through Blynk apps on android smartphone devices, as well as activates the buzzer and the exhaust fan in the lab space density. From the results of the implementation of the benzene gas monitoring system obtained the average value of the gas content of the benzene di laboratory density room is 0.42 ppm which is below the value threshold set by Indonesian Ministry of Manpower Regulation No. 5 Yera 2018 on Workplace Safety Health and Environment.

Keywords : Blynk, Internet of Things, Monitoring Gas, Benzene, MQ-135,

I. INTRODUCTION

In carrying out its functions, business units Metrology Jakarta require installation space and laboratories to support the inspection, testing and calibration of measuring tools. One such laboratory basement density which is located in the office building as a place to perform calibration, in particular, a hydrometer where liquid benzene is used as the test medium. Benzene is a chemical that is classified in B3 (toxic and hazardous materials). It is because benzene is a carcinogen for the human body. In laboratory space density, there has been no monitoring system that can provide information to the laboratory staff in the event of changes in the gas content of benzene. The monitoring system is required for 20% of the factors causes of accidents is the lack of oversight/supervision weak.

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Density Laboratory has a function as a place of execution of calibration of measuring instruments hydrometer. In laboratories, there are many kinds of chemicals that are used as the test medium in the implementation of calibration, one of the chemicals widely used is benzene.

Benzene is a chemical compound with chemical formula C_6H_6 and is one component in petroleum as materials petrochemicals The most basic and solvent which is important in the industrial world. benzene has the properties - i.e. the general nature liquid that is colourless, volatile, flammable, and explosive. In addition to benzene slightly soluble in water but soluble in organic solvents (chloroform, ether, alcohol, carbon sulfide, acetone, oil, acetic acid, carbon tetrachloride, and glacial), are liquid at room temperature, has a distinctive aroma and carcinogenic for humans. The impact caused by exposure to benzene can be acute and chronic, the acute levels can cause death, whereas in chronic levels can lead to leukemia. Because of these conditions, set the Threshold Limit Value (TLV) gas content levels of benzene were found in the workplace through Ministerial Regulation, Minister of Employment of Republic Indonesia Number 5 of 2018 concerning safety and working in the healthy environment,

MQ-135 Gas Sensor is an air quality sensor to detect, the types of harmful gases are detected such as NOx, NH_3, benzene, alcohol, smoke (CO), and CO_2. The principle works by accepting changes in resistance value (analog) at the output pin when exposed to the gas. In use, the MQ-135 sensor even more first be adjusting sensitivity to the gas to be measured [1]. Sensitivity of the sensor can be determined by graph in Fig. 1 below.

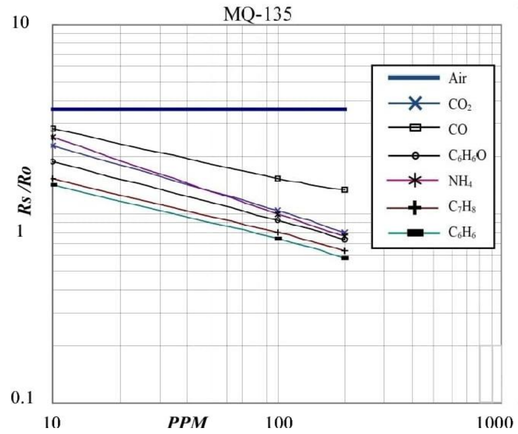

Fig. 1. MQ-135 sensor sensitivity [2]

NodeMCU ESP8266 is an open-source Internet of Things (IoT) Firmware-based board to create a simulator product Elua IoT by using Arduino IDE and has a System on Chips (SoC) that integrates ESP8266 GPIO, IIC, PWM (Pulse Width Modulation), 1-Wire, and ADC (Analog to Digital Converter) and equips with wifi feature in the board [1].

Liquid Crystal Display (LCD) is one of the electronic components that serves as a display of data, characters, letters or graphics. LCD has a data pin, power supply control, and regulating the display contrast and it is easier to program it. Based on the type of LCD display consists of an LCD Segment, Dot Matrix Graphic LCD and LCD Character [3]. In this study, the LCD is used Character Dot Matrix LCD with 20 x 4 character combinations.

Arduino Integrated Development Environment (IDE) is the Arduino software used to create or design a special program on the Arduino microcontroller. Arduino IDE can also be used to create programs on NodeMCU, In making the program using C / C ++ as a programming language [4].

As IoT platform for iOS and Android devices, Blynk can control the Raspberry Pi, Arduino, and ESP8266 via the internet [5]. Blynk has three main components i.e. to make a project application, server to server communication between the smartphone and Libraries that support the creation of a sketch on Arduino software like IDE.

The objectives of this study is to design a system for monitoring and measuring the gas content levels of benzene contained in a laboratory density to comply with the regulations set by Indonesian Ministry of Manpower Regulation No. 5 Year 2018 on Workplace Safety Health and Environment.

II. MATERIALS AND METHOD

The method used in this research includes the study of literature, design, test data analysis, and conclusions. The design includes the design of hardware and software. The following research flow chart in Fig. 2.

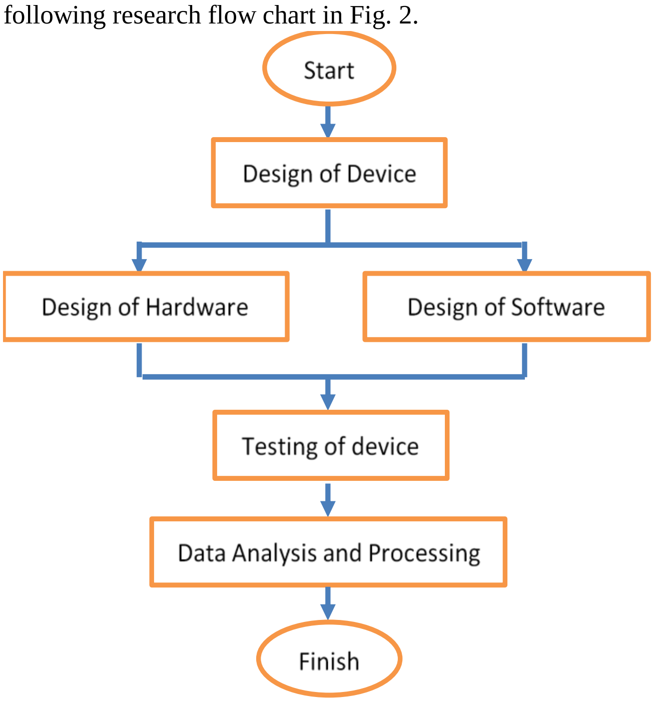

Fig. 2.Research flow chart

In Fig. 3 below, the described block diagram of a monitoring system is made. The results of the readings MQ-135 sensor will be processed into the program at NodeMCU, resulting in value ppm of benzene gas levels detected. Then the value will be sent to the LCD for display. Besides sending the data to the LCD, the data is also sent to Blynk through the Internet to be monitored also using an android smartphone from different locations. Values that have been measured and processed in NodeMCU also be a parameter to activate the buzzer and blowers. For the blower, the source current is derived directly from the grid.

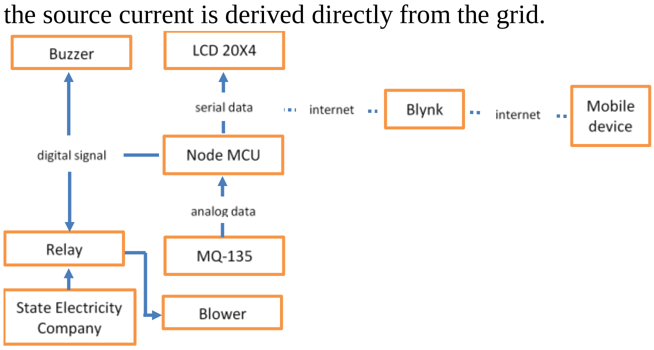

Fig. 3.Block diagram of monitoring system

For a schematic of the overall hardware circuit, as shown in Fig. 4.

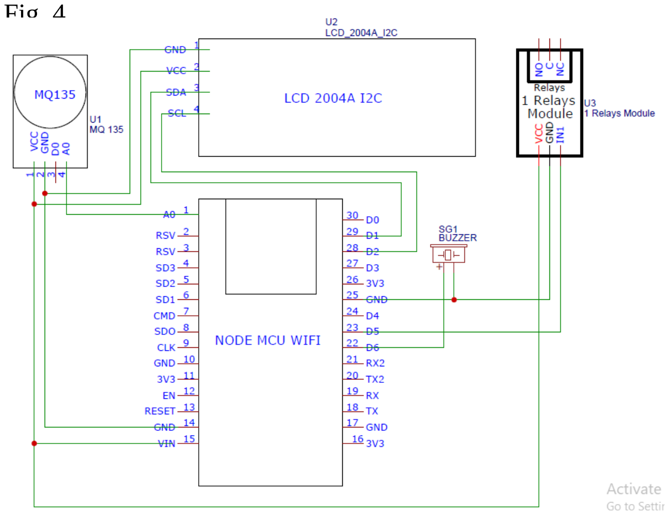

Fig. 4.The circuit schematic hardware

On detection of the gas concentration sensor using MQ-135 so that the tool can detect benzene gas with units of ppm, should know the graph of Rs / Ro against ppm were obtained from MQ-135 datasheet for benzene gas readings. Rs is the resistance value of the gas concentration sensor and Ro is the resistance of the sensor in clean air, so it is constant. Note that the value of Rs / Ro time in freshwater a constant value of 3.6 [6]. To find the value of Rs, required formula:

$$Rs = \left(\frac{Vc \; x \; Rl}{VRl}\right) - Rl \qquad (1)$$

While the value of Ro obtained from (2) below:

$$Ro = \frac{Rs}{3.6} \qquad (2)$$

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Both of the above formulae are then inserted into the Arduino programming. Having obtained Ro, then to connect the ppm value ratio and the value equation-based approach used in Fig. 1 to obtain MQ-135 sensor sensitivity graph benzene gas, as shown in Fig. 5 below.

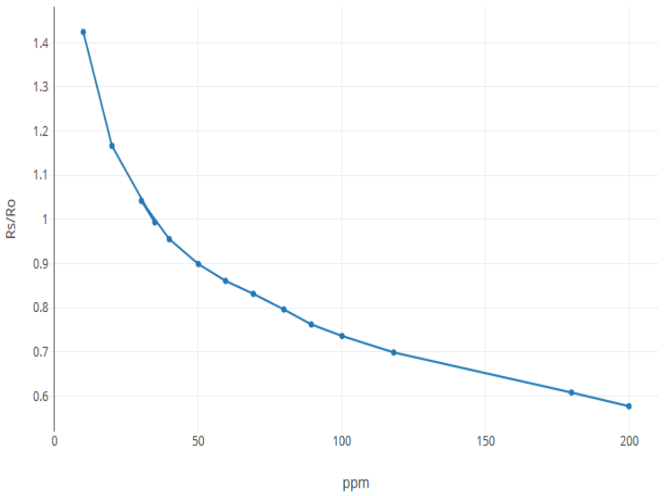

Fig. 5.MQ 135 sensor sensitivity on benzene gas

From Fig. 5 was obtained equation to determine the concentration (ppm) of sensor readings in the form (3).

$$y = 2.845 * (x^{-0.295}) \qquad (3)$$

Where the value of y is ppm and x is the ratio. Then by entering the formula with the value that has been calculated based on the formula in debug programming were the values obtained from the measurement of MQ-135 sensor. After designing and manufacturing conducted some testing of the calibration, testing and Exhaustfan buzzer control, and implementation tools.

III. RESULT AND DISCUSSION

A. Benzene Gas Calibration Monitoring Tool.

The calibration process is done by comparing the measurement of the standard test equipment and tools, as showed in Fig. 6.

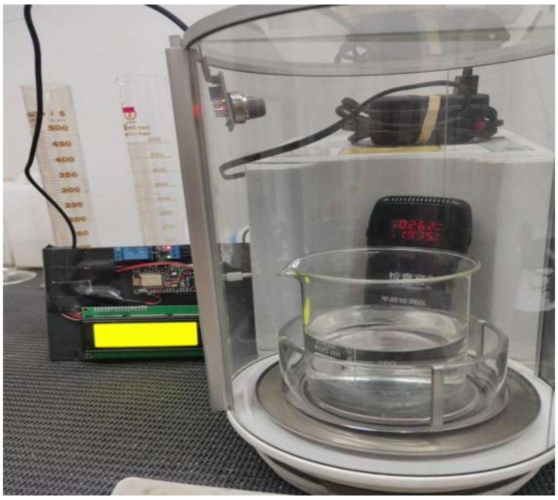

Fig. 6.Calibration monitoring tool on benzene gas

Table- I: Calibration results

Benzene volume (mL)	Time (min)	Concentration benzene from device (ppm)	Concentration benzene from standard (ppm)
250	1	0.63	0.605
	2	0.63	0.604
	3	0.63	0.604
	4	0.63	0.606
	5	0.63	0.607
	6	0.63	0.607
	7	0.64	0.609
	8	0.64	0.609
	9	0.64	0.609
	10	0.64	0.610
	11	0.64	0.612
	12	0.64	0.612
	13	0.64	0.612
	14	0.64	0.614
	15	0.64	0.614

Based on the experimental results as shown in Table I, errors as 4.48% due to the specification of the MQ-135 sensor, not only to detect and measure the gas content levels of benzene but also other gases such as ammonia, CO, CO_2, and alcohol.

B. Exhaust Fan Control Testing Results and Buzzer

From table II was known automatic control systems at the buzzer function properly and the sound produced is able to be heard in the laboratory and basement area of 174 m² on the building.

Table- II: Buzzer control results

Changes in gas concentration (ppm)		Buzzer condition		Information
Initial	*End*	*Initial position*	*End position*	
0.48	0.54	Not active	Active	There are sound
0.56	0.47	Active	Not active	-
The concentration of Benzene Gas Setpoint legible > 0.5 ppm				

Exhaust fan control testing is done to test the response time (delay) of the control system exhaust fan. Delay used for testing as a standard stopwatch timing. The results are shown in Table III.

From Table III, it can be seen that the control system exhaust fan function properly, the current response time off to active position 2.04 seconds and at the time of active to inactive position at 1.82 seconds.

Table- III: Controlling of exhaust fan

Changes in gas concentration (ppm)		Conditions exhaust Fan		Response time (Seconds)
Initial	*End*	*Early position*	*End position*	
0.48	0.54	Not active	Active	2.04
0.56	0.47	Active	Not active	1.82
The concentration of Benzene Gas Setpoint legible > 0.5 ppm				

C. Implementation Results

Implementation of the benzene gas monitoring tool, by placing the tool on a workbench with a distance of 1 meter of laboratory staff positions. As for the position exhaust fan placed on the ceiling with a distance of 4 meters of laboratory staff positions.results Installation tool as shown in Fig. 7.

Fig. 7.Benzene Gas Monitoring Equipment

To view the results of the monitoring on the LCD and android smartphone on the show in the following Fig. 8.

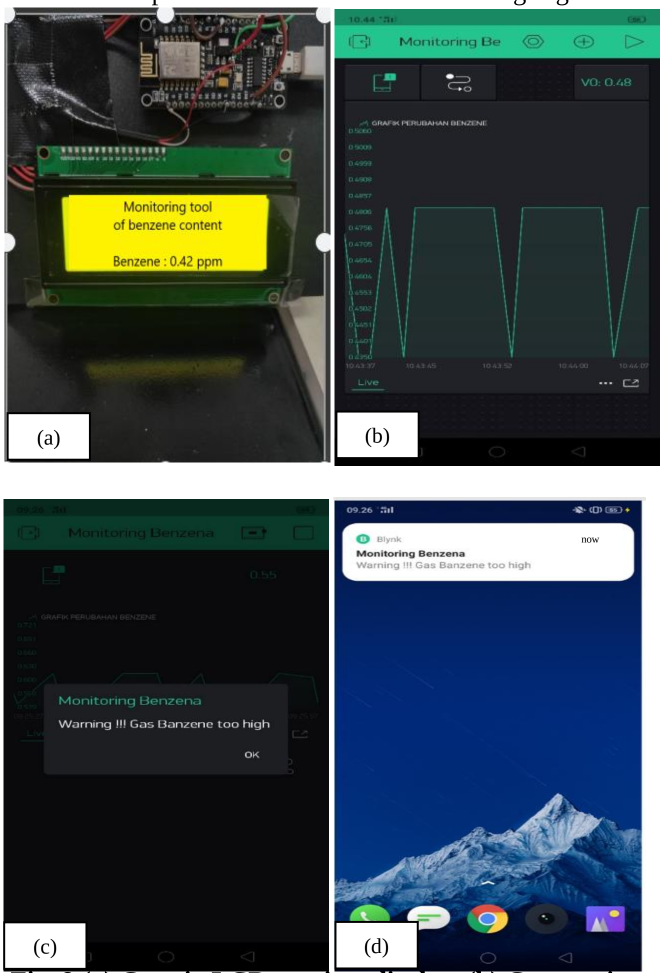

Fig. 8.(a) Gas via LCD monitor display, (b) Gas monitor display via smartphone, (c) Display a notification by opened Blynk, (d) Display a notification by closed Blynk

Data were taken from the benzene gas monitoring device from 08.00 until 16.00 with recording time per 15 minutes.

Table- IV: Implementation of benzene gas monitoring devices

Benzene level (ppm)	Time	Activity		Buzzer		Exhaust fan	
		Yes	*No*	*Active*	*No*	*Active*	*No*
0.33	08.00		v		v		v
0.32	08.15		v		v		v
0.32	08.30		v		v		v
0.33	08.45		v		v		v
0.52	09.00	v		v		v	
0.46	09.15	v			v		v
0.46	09.30	v			v		v
0.45	09.45	v			v		v
0.45	10.00	v			v		v
0.45	10.15	v			v		v
0.45	10.30	v			v		v
0.46	10.45	v			v		v
0.44	11.00	v			v		v
0.39	11.15		v		v		v
0.38	11.30		v		v		v
0.35	11.45		v		v		v
0.34	12.00		v		v		v
0.33	12.15		v		v		v
0.33	12.30		v		v		v
0.34	12.45		v		v		v
0.34	13.00		v		v		v
0.32	13.15		v		v		v
0.51	13.30	v		v		v	
0.46	13.45	v			v		v
0.45	14.00	v			v		v
0.45	14.15	v			v		v
0.46	14.30	v			v		v
0.46	14.45	v			v		v
0.44	15.00	v			v		v
0.45	15.15	v			v		v
0.44	15.30	v			v		v
0.37	15.45		v		v		v
0.33	16.00		v		v		v

Results were shown in Table IV below, a benzene gas monitoring tool can be implemented on a density laboratory because it is able to detect and measure the gas content of benzene in real-time, monitor the condition of gas in the room and provide notification through the smartphone, giving a warning through the alarm/buzzer and Exhaust fan enable to remove the air from the room.

From table IV, when there are activities, average gas content of benzene is 0.46 ppm and when there is no activity, average gas content of benzene is 0.35 ppm, so that it can be analyzed that the value of the gas content of benzene in density laboratory is 0.42 ppm still below TLV set by the Indonesian Ministry of Manpower Regulation No. 5 Year 2018 on Workplace Safety Health and Environment.

IV. CONCLUSION

A benzene gas monitoring device has been designed using a NodeMCU microcontroller with an MQ-135 sensor based on the Blynk IoT platform. The results of the design of the instrument can measure benzene gas levels in realtime and have an average error value of 4.48%.

The device was able to measure the levels of benzene gas, to control the buzzer and exhaust fan, as well as to monitor and notify via a smartphone if the benzene gas content in the room exceeds the setpoint.

With benzene gas monitoring equipment, the average gas content of benzene in a density laboratory is 0.42 ppm, where the value is still under threshold limit value (TLV) defined by Indonesian Ministry of Manpower Regulation No. 5 Year 2018 on Workplace Safety Health and Environment.

This monitoring system can help provide information about gas levels of benzene in density laboratory for laboratory workers to reduce the risk of workplace accidents due to gas poisoning benzene.

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