The electrical properties characterization of MG-811 gas sensor toward the temperature alteration of soil testing chamber

P Saptiani*, M H Aziz, M Iriyanti and A Aminudin
Departement of Physics, Indonesia University of Education, Jl. Dr. Setiabudi No.229 Bandung, Jawa Barat Indonesia

*Corresponding author’s e-mail: penyseptiani8@gmail.com

Abstract. The concentration of CO₂ in soil and air is strongly influenced by temperature. When the temperature increase, the thermal energy will increase too and make the particle motion faster. In detecting CO₂ gases, the MG-811 gas sensor has a high sensitivity in detecting CO₂ gases in the air. The purpose of the research is characterized the electrical properties of MG-811 gas sensor toward temperature alteration. The used method is the experimental method, where the chamber is made of iron filled with CO₂ derived from the CO₂ gas tube. In the chamber has been paired digital thermometer and MG-811 gas sensor. The temperature alteration in the CO₂ gas is regulated by the heater element attached to the chamber. The output of the MG-811 gas sensor will be processed by microcontroller, so it measures the CO₂ concentration in units of parts per millions (ppm). The higher the measured temperature on the gas causes faster particle motion, the measured CO₂ gas concentration is high and the resulting output voltage is low. But it happens if the temperature change is high, because the gas sensor response is slower than the temperature sensor used.

1. Introduction
During climate change, global warming is one of the impacts of the occurrence of green house effects. Carbon dioxide gas (CO₂) is one of the gas causing green house effect that has become the centre of attention most frequently [1]. CO₂ gas has an important role in controlling the temperature of earth surface compared to other green house gases and is naturally formed in the environment or as the result of human activities. CO₂ is the second highest resulted concentration after water vapor so that its role in temperature change is very dominant. CO₂ gas has long life time in the atmosphere, that is, thousands years [2]. The excessive emission of carbon dioxide (CO₂) will increase green house gas in the atmosphere, which will increase global warming [3].

The sources of CO₂ gas coming from the combustion of firing materials, eruptions of volcanoes, forest fires, draining of peatlands, and farming areas whether due to the lands or the plants. In peatlands, carbon emission is very fluctuate depending on the influencing factors such as climate and hydrology soil. Among the factors, there are environmental factor which give great influence on carbon emission in peatlands such as soil humidity and electrical conductivity [4]. As the consequence, there is a lot more CO₂ emission in the air which will be resulted in temperature increase in the air. The rate of electrical conductivity is influenced by the depth of the ground, the deeper the ground, the higher the rate of its
electrical conductivity [5,6]. CO2 is a colorless, odorless gas and if the CO contaminated environment will not be visible by naked eye [7].

In order to find out the concentration of CO2 gas in the ground or in the air, an instrument to detect CO2 gas is needed. Gas sensor MG-811 is a sensor with high sensitivity for measuring CO2 gas in industry areas [8]. Based on the matter above, there is a need for characterization of MG-811 gas sensor for the measurement in the ground on temperature change.

2. Methods

The method used in the study is experiment method. The study was carried out in instrumentation laboratory, FPMIPA B Building of Indonesia University of Education. The instrument used is a chamber of soil test made of iron with 2 mm of thickness in the form of block shape. The chamber will be filled with CO2 gas channelled from CO2 gas tube. On the chamber there is attached heating element and digital thermometer to regulate the occurring temperature change. The output of the sensor is the processed by signal conditioning system arduino Uno in order to converse the value of output voltage to the value of gas concentration. Later, the task is observing the change of CO2 concentration as the temperature is increasing which is displayed on LCD (Liquid Crystal Display).

![Figure 1. System Flow Chart](image1)

![Figure 2. MG-811 Sensor Circuit Scheme](image2)
3. Result and Discussion

Based on the experiment, the characterization data of MG-811 gas sensor upon the change of CO₂ concentration and the electrical characterization of MG-811 sensor upon gas temperature influence is show on Figure 3 and Figure 4.

3.1. MG-811 gas sensor characterization upon CO₂ gas concentration change

![Graph of the relation of output voltage (V) upon CO₂ concentration](image)

**Figure 3.** Graph of the relation of output voltage (V) upon CO₂ concentration

Based on the study Figure 3, CO₂ concentration measured by sensor is ±1100 ppm to ±1500 ppm with output voltage around ±(1.62 – 1.67) volt. The greater CO₂ gas concentration measured, the smaller the output voltage resulted from the sensor. This happens because the greater the measured CO₂ concentration, the more amount of particles attaching to electrode so that the greater resistance appears, the smaller current running to sensor circuit and output voltage becomes smaller too. Therefore, the result of this study is suitable to the result of characterization based on data sheet of MG-811 gas sensor.

3.2. The characterization of electrical MG-811 gas sensor on CO₂ gas temperature changes.

![The Relation of Sensor Output Voltage (V) on Temperature (T) Change](image)

**Figure 4.** Graph of the relation of sensor output voltage (V) on temperature change (T)
Based on the study, there is a relation of output voltage of MG-811 gas sensor to temperature change, that is, the increase in temperature change will be resulted in the increase of output voltage. The obtained data is taken by a difference of 3 from initial temperature. According to the test on sensor sensitivity, when the system temperature increases, CO₂ gas concentration measured by the sensor decrease. The theory of kinetic gas describes that when the temperature is higher, the kinetic energy will be greater. It means that the particles movement occurring on the gas will go faster and the energy of collision among the particles become greater with the kinetic energy of gas is \( \frac{3}{2}kT \).

3.3. Characterization of CO₂ gas on Sands to Temperature Change

![Graph of the relation of sensor output voltage (V) on temperature change (T) using soil sample](image)

The result of output voltage measurement of MG-811 gas sensor on temperature influence in CO₂ gas concentration measurement in the ground with sand as soil sample shows that when the temperature indicates 64°C, the output voltage produced is 1.861328 V with measured CO₂ of 2914 ppm while at the lowest temperature of 33.4°C the resulted output voltage of 1.317383 V of measured CO₂ concentration is 412 ppm as shown on Figure 4.

On the figure, it can be seen that when the temperature increases the measured CO₂ gas concentration decreases, the voltage produced by the sensor increases. The lower the CO₂ concentration is, the higher voltage resulted by the sensor will be. The increasing temperature of CO₂ gas will make it vaporable more easily because carbon dioxide (CO₂) is one of the substances having the characteristic of less reactive or lesser solubility with other substances and of volatile (Nikmah, 2014).

4. Conclusion

Based on the study, the result is that the electrical characteristics of MG-811 gas sensor shows that the greater measured CO₂ concentration will make smaller output voltage. When influenced by temperature change, it shows that the increasing temperature will be resulted in greater output voltage from the sensor, meaning that the measured CO₂ gas concentration becomes smaller.

5. Reference

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