Implementasion Of Calibration in Gas Hazardous Carbon Monoxide, Carbon Dioxide and Methane In Closed Room Using Fuzzy Method

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Abstract: The results of testing the system when the active sensor detects 0 ppm CO2 gaseous gas, 440 ppm CO2 and 0 ppm CH4 air condition "safe" with a not rotate exhaust fan output. In the active sensor, it detects CO 500 ppm gas, 410 ppm CO2 and 0 ppm CH4 "Danger" air condition with speed rotating exhaust fan output. While the active sensor detects CO 0 ppm gas, 308 ppm CO2 and 540 ppm CH4 "Very Danger" air condition with high exhaust fan spinning output. In conclusion, this study shows that the results of testing the system when the active sensor detects 0 ppm CO2 gaseous gas, 440 ppm CO2 and 0 ppm CH4 air condition "safe" with a not rotate exhaust fan output. In the active sensor, it detects CO 500 ppm gas, 410 ppm CO2 and 0 ppm CH4 "Danger" air condition with speed rotating exhaust fan output. While the active sensor detects CO 0 ppm gas, 308 ppm CO2 and 540 ppm CH4 "Very Danger" air condition with high exhaust fan spinning output.

Keywords: Calibration, Gas Sensor CO, CO2, CH4

1. Introduction

Carbon monoxide (CO) is poison, gas is colorless, odorless, and tasteless. Even though it does not have a detectable odor, Carbon monoxida is often mixed with other gases that have odors. So you can pull carbon monoxide right next to the gases. You can smell and don't even know that Carbon monoxida is serving. Carbon monoxida is a general industrial hazard that results from burning natural gas and other...
carbon-containing materials such as gasoline, kerosene, oil, propane, coal or wood. Forge, the blast furnace and coke ovens produce CO, but one of the most common sources of exposure at work is the internal combustion engine. [1]Carbon dioxide, CO₂, is one of the gases in our atmosphere. Both natural and human processes activities contribute to its presence at present concentrations of around 0.040% [406 parts per million (ppm) on 7 January 2017], distributed evenly to Earth. Commercially, CO₂ finds use as a refrigerant (dry ice is solid CO₂), in carbonated beverages, and in fire extinguishers. Because the concentration of CO₂ in the atmosphere is low, no practical process has been developed to get gas by extracting it from the air. Most commercial CO₂ is recovered as a by-product of other processes, such as ethanol production by fermentation and ammonia production. Some CO₂ is obtained from burning coke or other carbon-containing fuels. Carbon dioxide is released into our atmosphere when fossil fuels containing carbon such as oil, natural gas and coal are burned in the air. As a result of the world’s extraordinary consumption of fossil fuels like that, the amount of CO₂ in the atmosphere has increased over the past two centuries, now increasing at a rate of around 2-3 ppm per year.[2]. Carbon monoxide can harm the heart, brain and lungs. Inhaling high levels of carbon monoxide can kill you. Inhaling lower levels of carbon monoxide can permanently harm your heart and brain. Carbon monoxide can be more dangerous for you if you have heart or lung disease [3]

Natural gas consists mainly of methane, and 3.6% to 7.9% of shale-gas production methane escapes into the atmosphere in ventilation and leakage during the life of a well. This methane emission is at least 30% more than and probably more than twice as large as conventional gas. Higher emissions from shale gas occur when the wells are fractured hydraulically - when the disappearance of methane from the liquid returns to flow again - and during the drill out follows the fracture. Methane is a strong greenhouse gas, with global warming potential far greater than carbon dioxide, especially during the period of the first few decades after emissions. Methane contributes greatly to the greenhouse footprint of shale gas on shorter time scales, dominating at 20 years horizon. Traces for shale gas are greater than that for conventional gas or oil when viewed at any time horizon, but especially more than 20 years. Compared to coal, the shale gas footprint is at least 20% larger and may be more than twice as large at a 20-year horizon and comparable compared to more than 100 years.[4]

Earth’s atmosphere is changing because of emissions of pollutants and greenhouse gases. Carbon dioxide emissions are important and result in half of the warming of the atmosphere. Pollutants from burning like black carbon (soot), nitrogen oxides and sulphur oxides have adverse health effects and result in cooling. Pollutants have long masked the greenhouse effect, but improved air quality through reductions in air pollutants increase the warming. Atmospheric processes are intricately linked. Methane is central in all atmospheric chemistry. Methane is also important as a greenhouse gas. Although carbon dioxide should be reduced to prevent global warming, it is relatively cheap to reduce the non-CO₂ greenhouse gases such as methane at the same time. Methane’s concentration in the troposphere, after a long period of stabilisation, is rising again since 2006. Here I will give a review on methane, its atmospheric chemistry, its emission sources and global budget.[4]

Toxicity for human breathing at levels of CO₂ that could be attained with the continued unabated rise in atmospheric CO₂ associated with climate change. For humans, breathing is paramount before finding water, food and shelter. From the evidence presented here, there appears to be current health impacts of rising CO₂ levels and a significant risk of serious health issues arising in the human population at some time in this century. While there is a lack of studies in humans at lower CO₂ levels, demonstrated effects
in animals and symptoms experienced by humans indicate that longer-term mechanisms compensating for increased blood CO2 might be active when breathing at around 800-1000 ppm CO2. [5]

This research was built to overcome the danger of toxic gases from the detection of carbon monoxide gas read by gas input using the MQ-7 sensor, carbon dioxide gas read by gas input using MG-811 sensor, and methane gas that can be monitored using the MQ-4 sensor. The three sensors will continuously read each type of gas through the process on the Arduino microcontroller which will be given fuzzy logic in the program to neutralize the room with carbon monoxide, carbon dioxide and methane gas ie exhaust fan by adjusting the rotation of the fan motor to work based on fuzzy logic during slow, medium and fast speed conditions. Fan motor speed in accordance with the amount of each gas grating ie output is alarm, sms gateway and information on the android smartphone screen.

2. Literature references

Methane leaks during exploration of fields, operation of vents and flares, production of oil and gas, compression of gas for transport, oil tanker loading and transport. It is practically impossible to prevent methane from leaking all together from different parts in the oil and natural gas systems, but methane leakage should be reduced to the minimum. Transmission in high pressure pipes shows less leakage. Glycol use for the drying of gas and glycol regeneration leads to high losses. Gas distribution to the consumers in low pressure pipes is especially leaky if old town gas distribution pipes are still used. In many countries in the Middle East, Latin America, Asia and Africa, unused associated gas from oil wells is vented to the atmosphere. [4]

Arduino Arduino Arduino is an open-source prototype platform designed to be easy to use for beginners who don't have software or high-level electronic experience. This can be used to develop interactive objects that can respond to signals from the surrounding environment. This microcontroller can control various things such as buttons, motors, GPS units, LEDs, sensors, cameras and more. [6]. The Arduino microcontroller can be programmed using the Arduino (IDE) integrated development environment. To load new code on the Arduino board does not require separate hardware - just connect the USB cable. This platform is used by many musicians around the world to build electronic projects, so there is a wealth of information and source code available. However, this controller is also used by many Working scientists. [6]

Figure 1. Arduino Microcontroller

Not every pin on a microcontroller has the ability to do analog to digital conversions. On the Arduino board, these pins have an ‘A’ in front of their label (A0 through A5) to indicate these pins can read analog voltages. ADCs can vary greatly between microcontroller. The ADC on the Arduino is a 10-bit ADC meaning it has the ability to detect 1,024 (2^10) discrete analog levels. Some microcontrollers have 8-bit ADCs (2^8 = 256 discrete levels) and some have 16-bit ADCs (2^16 = 65,536 discrete levels). The way an ADC works is fairly complex.
The ADC reports a ratiometric value. This means that the ADC assumes 5V is 1023 and anything less than 5V will be a ratio between 5V and 1023.[7]

\[
\text{Resolution of the ADC} = \frac{\text{ADC reading}}{\text{Analog Voltage Measured}}
\]

Analog to digital conversions are dependant on the system voltage. Because we predominantly use the 10-bit ADC of the Arduino on a 5V system, we can simplify this equation slightly:[7]

\[
\frac{1023}{5} = \frac{\text{ADC Reading}}{\text{Analog Voltage Measured}}
\]

If your system is 3.3V, you simply change 5V out with 3.3V in the equation. If your system is 3.3V and your ADC is reporting 512, what is the voltage measured? It is approximately 1.65V.

If the analog voltage is 2.12V what will the ADC report as a value?[7]

\[
\frac{1023}{5.00v} = \frac{\chi}{2.12v}
\]

Rearrange things a bit and we get:

\[
\frac{1023}{5.00v} \times 2.12v = \chi
\]

\[
\chi = 434
\]

- The ADC should report 434.

The MQ series gas sensors use small heaters inside with electrochemical sensors that change sensitivity for various gases. When the sensor works clean air, its conductivity is lower than when the gas is present. Conductivity increases with gas concentration increasing.[5]

| Model | Target Gas                      |
|-------|---------------------------------|
| MQ2   | Sensitive for Methane, Butane, LPG, smoke |
| MQ3   | Sensitive for Alcohol, Ethanol, smoke |
| MQ4   | Sensitive for Methane, CNG Gas    |
| MQ7   | Sensitive for Carbon Monoxide    |
| MQ135 | For Air Quality, Sensitive for Benzene, Alcohol, smoke |

Fuzzy logic is based on the theory of fuzzy sets, which is a generalization of the classical set theory. Saying that the theory of fuzzy sets is a generalization of the classical set theory means that the latter is a special case of fuzzy sets theory. To make a metaphor in set theory speaking, the classical set theory is a subset of the theory of fuzzy sets, as figure 2 illustrate. [8]
Figure 2. "The classical set theory is a subset of the theory of fuzzy sets"

3. Experiment

3.1 Design flowchart Detectors Gas CO, CO₂, and CH₄

The design of the flow diagram of the workings of the detection devices of carbon monoxide (CO) gas, carbon dioxide gas (CO₂) and methane is based on fuzzy logic by developing previous research. The following figure explains how the device works to neutralize a closed room exposed to gas as follows:

Figure 3. Flow chart of how the tool works

Flow and workmanship of the flow chart is the first to initialize the serial and then see the input of three gas sensors CO, CO₂, and CH₄ that will appear in the gas content. Then the sensor will work on the
smoke band detected by the MQ-7 and MQ-135 sensors. When CO, CO2 and CH4 gases actively detect the gas beyond normal limits, "danger","very danger" air conditions with low, medium and high rotating output exhausted fan.

3.2 Fuzzy Methode

Rule evaluation process In this process the specified rules will be applied. Or it can be said its function is to find the fuzzy output value from the fuzzy input. The rules are made to control the work of the sensor in detecting the sensor so as to produce a value that corresponds to the expected output. The process is fuzzy input from the fuzzyification process included in the rules that have been created to serve fuzzy output. Figure 4. Can be explained in designing the membership function, the function of the triangle curve and the functions of the Trapezium Low and Hi curves are used with three sets of fuzzy / fuzzy sets namely Low, Med, and Hi. There are several methods of decision making in Mamdani fuzzy logic including the method of Figure 4. The following picture:[8]

![Membership Function](image)

Figure 4. Fuzzy Input Membership of Level CO,CO2, and CH4

When we define the fuzzy sets of linguistic variables, the goal is not to exhaustively define the linguistic variables. Instead, we only define a few fuzzy subsets that will be useful later in definition of the rules that we apply it. This is for example the reason why we have not defined subset "average" for the quality of the food. Indeed, this subset will not be useful in our rules. Similarly, it is also the reason why (for example) 30 is a higher tip than 25, while 25 however belongs more to the fuzzy set "high" as 30: this is due to the fact that 30 is seen not as high but very high (or exorbitant if you want to change adjective). However, we have not created of fuzzy set "very high" because we do not need it in our rules.[8]

3.3 Tool Calibration Steps

Make a measurement theory diagram based on the theory of data sheet tools on each sensor Carbon monoxide gas, carbon dioxide gas and methane gas based on Resistance and Vout. Next make a design of how to work diagram measuring instruments industry standards and design results. Then mengambil measurement data on industry standard measuring instruments and tools designed and processed in the form of a measurement chart and determine the reading of the sensor with the standard.

Measuring instrument used is CH4(methane) and CO2 (karbon dioksida Gas Gauge. In the trial of methane gas measurement with a range of 300 - 1000 ppm using the combustible detector 602 type. CO (Carbon Monoksida) Gas Gauges. In the trial of measurement of carbon monoxide gas in the range 0 - 1000 ppm with CO Gas Gauge Type SANFIX carbon monoxide meter GM8805.
Function Implications are used in making decisions with the Mamdani method using MIN and in making compositions using MAX. The composition method is often called MAX-MIN. The following is an evaluation of twenty-seven rules that can be determined:

### Rules Evaluation

The design of fuzzy logic in this study uses 3 input components consisting of detection of carbon monoxide (CO), methane (CH₄), and carbon dioxide (CO₂) with one output of the exhaust fan blower motion speed control using the MATLAB application software. The following is the basic form of the detection condition.

Here is the rulebase of the sensor detection conditions:

1. If (CO is low) and (CO₂ is Low) and (CH₄ is Low) then (Speed) is Low) (1)
2. If (CO is low) and (CO₂ is Med) and (CH₄ is Low) then (Speed) is Med) (1)
3. If (CO is low) and (CO₂ is Med) and (CH₄ is Low) then (Speed) is Med) (1)
4. If (CO is Med) and (CO₂ is Low) and (CH₄ is Low) then (Speed) is Med) (1)
5. If (CO is low) and (CO₂ is Med) and (CH₄ is Med) then (Speed) is Med) (1)
6. If (CO is Med) and (CO₂ is Med) and (CH₄ is Low) then (Speed) is Med) (1)
7. If (CO is Med) and (CO₂ is Med) and (CH₄ is Med) then (Speed) is Med) (1)
8. If (CO is low) and (CO₂ is Low) and (CH₄ is High) then (Speed) is High) (1)
9. If (CO is low) and (CO₂ is Med) and (CH₄ is High) then (Speed) is High) (1)
10. If (CO is Med) and (CO₂ is High) and (CH₄ is Low) then (Speed) is Med) (1)
11. If (CO is High) and (CO₂ is Low) and (CH₄ is Low) then (Speed) is Med) (1)
12. If (CO is Low) and (CO₂ is High) and (CH₄ is Low) then (Speed) is High) (1)
13. If (CO is High) and (CO₂ is High) and (CH₄ is Low) then (Speed) is High) (1)
14. If (CO is High) and (CO₂ is Low) and (CH₄ is Med) then (Speed) is High) (1)
15. If (CO is Med) and (CO₂ is Med) and (CH₄ is Med) then (Speed) is High) (1)
16. If (CO is Med) and (CO₂ is High) and (CH₄ is Med) then (Speed) is High) (1)
17. If (CO is High) and (CO₂ is Med) and (CH₄ is Med) then (Speed) is High) (1)
18. If (CO is Med) and (CO₂ is High) and (CH₄ is High) then (Speed) is High) (1)
19. If (CO is High) and (CO₂ is High) and (CH₄ is Med) then (Speed) is High) (1)
20. If (CO is High) and (CO₂ is Med) and (CH₄ is High) then (Speed) is High) (1)
21. If (CO is Low) and (CO₂ is Med) and (CH₄ is High) then (Speed) is High) (1)
22. If (CO is Low) and (CO₂ is High) and (CH₄ is Med) then (Speed) is High) (1)
23. If (CO is High) and (CO₂ is Med) and (CH₄ is Low) then (Speed) is High) (1)
24. If (CO is High) and (CO₂ is Med) and (CH₄ is Med) then (Speed) is High) (1)
25. If (CO is Med) and (CO₂ is High) and (CH₄ is Low) then (Speed) is High) (1)
26. If (CO is Med) and (CO₂ is Low) and (CH₄ is High) then (Speed) is High) (1)
27. If (CO is High) and (CO₂ is Low) and (CH₄ is Med) then (Speed) is High) (1)

SPD = output value of the fan speed level discards Results and Discussion

4. Result and discussion

Based on the calibration test carried out with a test sample consisting of pollutant sources namely gas from clean air, vehicle smoke, livestock manure and cigarette smoke to test CO and CO₂ sensors, and CH₄ gas from animal feces to calculate the CH₄ sensor response, The following is testing table 1 for each response from that input.

Fig. 5 Designing Data Processing of Gas Input Sensors CO, CO₂ and CH₄ Using Fuzzy Mamdani

In the following picture, the design of the analysis of processing data from sensor readings with the input of three Carbon Monoxide gas sensors, carbon dioxide gas and methane gas using the fuzzy mamdani method

Figure 5. Data Processing Design of the Results of Sensor Inputs for Gas CO, CO₂ and CH₄ Using Fuzzy Mamdani.

In Figure 6. below describes the results of the graph reading the Carbon Monoxide Gas sensor, Carbon Dioxide Gas and Methane Gas Using Mathlab With the Fuzzy Rule Base Logic. Figure 6. Next shows the hazard conditions in carbon monoxide gas
Figure 6. Explaining the Safe Condition with the No Rotating Speed Indicator

Figure 7. Displays Large Palutants Carbon Monoxide (CO) gas is 500 ppm, Carbon Dioxide (CO2) Gas is 410 ppm, and CH4 is 0 ppm with Hazard conditions, where High output level with fan motor indicator rotates rapidly.

Figure 7. Hazard conditions with a Medium Rotating Fan Fan indicator

Gambar 8. Menampilkan Besar Palutan Gas karbon Monoksida (CO) sebesar 0 ppm, Gas Karbon Dioksida (CO2) sebesar 308 ppm, dan CH4 sebesar 540 ppm dengan kondisi Sangat Bahaya, dimana level keluaran High dengan indikator motor kipas berputar Sangat Cepat

Figure 8. Very dangerous conditions with a very fast rotating fan motor indicator
The graph of the measurement results of carbon monoxide, carbon dioxide and methane gas in Figure 6. Describes the Safe Condition when the large gas CO gas is 0 ppm, CO2 is 410 ppm and CH4 is 0 ppm. With the results of the Output No Fan Rotating Speed as a neutralizing condition of the room. Whereas Figure 7. Displays Large Palutants of Carbon Monoxide (CO) Gas of 500 ppm, Carbon Dioxide Gas (CO2) of 410 ppm, and CH4 of 0 ppm with Hazard conditions, where the High output level with the fan motor indicator rotates Fast. In Figure 8. Displays Large Palutan of Carbon Monoxide (CO) Gas of 0 ppm, Carbon Dioxide Gas (CO2) of 308 ppm, and CH4 of 540 ppm with Very Hazardous conditions, where the High output level with the rotating fan motor indicator is Very Fast

5. Conclusion

In conclusion, this study shows that the results of testing the system when the active sensor CO detects 0 ppm, CO2 gaseous gas 440 ppm CO2 and 0 ppm CH4 air condition "safe" with a not rotate exhaust fan output. In the active sensor, it detects CO 500 ppm gas, 410 ppm CO2 and 0 ppm CH4 "Danger" air condition with speed rotating exhaust fan output. While the active sensor detects CO 0 ppm gas, 308 ppm CO2 and 540 ppm CH4 "Very Danger" air condition with high exhaust fan spinning output.

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