DEVELOPMENT OF AMMONIA GAS LEAKAGE DETECTION, PRECAUTION AND PURGING SYSTEM

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ABSTRAK

Tujuan projek ini adalah untuk menambah baik kaedah pemerhatian sedia ada untuk kebocoran ammonia bagi mengelakkan kemalangan yang disebabkan oleh penyedutan ammonia yang berlebihan. Kebocoran gas ammonia sangat berbahaya dan memudaratkan manusia kerana ia bersifat menghakis (kepekatan tinggi) mungkin menyebabkan muka kita terbakar dan entah bagaimana akan menyebabkan kematian [1]. Projek ini akan menambah baik kaedah pengukuran yang tidak berkaitan, yang dipasang atau dipasang pada dinding, mengehadkan tujuan mengukur sahaja. Projek ini menggabungkan teknologi Internet Perkara untuk membantu memantau bacaan sensor gas (MQ-135) dari jarak yang selamat, mencari kawasan atau bahagian di mana gas ammonia bocor berdasarkan bacaan sensor tekanan, dan termasuk sistem berjaga-jaga (penggera siren & merah dan hijau LED) yang bertindak sebagai sistem maklum balas dan pembersihan mengawal pam air dan kipas, injap solenoid untuk mengawal gas ammonia masuk. Ia juga mempunyai sistem GPS yang akan menentukan lokasi sebarang kebocoran gas. Sistem projek memfokuskan pada pemindahan data daripada unit penderiaan kepada broker, di mana ia disimpan sementara untuk aplikasi Blynk, tetapi boleh disimpan untuk masa yang lama dan dieksport untuk web ThingSpeak. Data ditunjukkan pada web dan aplikasi mudah alih yang membolehkan pengguna memantau bacaan sensor. Data dihantar ke aplikasi Blynk dan web protokol ThingSpeak melalui NodeMCU, yang membaca data daripada input dan output. Penemuan ujian prototaip mendedahkan aplikasi web Blynk dan ThingSpeak yang berfungsi, dengan meter menyediakan bacaan latitud dan longitud yang tepat dan sistem GPS menyediakan latitud dan longitud yang tepat. Sistem pengesanan dan pemantauan kebocoran gas ammonia ini telah dicipta dan diuji dengan memuaskan. Terdapat beberapa cadangan untuk projek sistem pengesanan dan pemantauan kebocoran gas ammonia ini, termasuk menukar penderia gas kepada MQ-137 kerana MQ-135 ialah penderia kualiti udara dan bukan penderia gas ammonia sepenuhnya, dan bertukar kepada platform yang berbeza untuk pemantauan aplikasi web yang mempunyai kelewatan pemindahan data yang rendah.

ABSTRACT

The purpose of this project is to improve the existing observation methods for ammonia leaks to avoid accidents caused by the inhalation of excess ammonia. The leakage of ammonia gas is very dangerous and harmful to humans because it is corrosive (high concentration) and might cause burning to our face and somehow will direct cause death [1]. This project will improve unrelated measurement methods, which are fixed or mounted on walls, limiting the purpose of measuring only. The project incorporates Internet of Things technology to help monitor gas sensor readings (MQ-135) from a safe distance, locate areas or parts where ammonia gas is leaking based on pressure sensor readings, and include a precaution system (siren alarm & red and green LEDs) that acts as feedback and purging system that controls water pumps and fans as well as the solenoid valves to control ammonia gas inlet. It also has a GPS system that will pinpoint the location of any gas leakage. The project system focuses on the transfer of data from the sensing unit to the broker, where it is temporarily saved in the Blynk app, but can be stored for a long time and exported in the web ThingSpeak. The data is shown on a mobile and web application that allows users to monitor sensor readings. The data is sent to Blynk applications and the ThingSpeak protocol web via the NodeMCU, which reads data from inputs and outputs. The findings of the prototype testing revealed a working Blynk and ThingSpeak web application, with the metre providing precise latitude and longitude readings and the GPS system providing accurate latitude and longitude. This ammonia gas leakage detection and monitoring system has been created and tested satisfactorily. There are some recommendations for this project of ammonia gas leakage detection and monitoring system, including changing the gas sensor to MQ-137 because the MQ-135 is an air quality sensor and not a fully ammonia gas sensor, and switching to a different platform for web application monitoring that has a low data transfer delay.

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LIST OF SYMBOLS

NH_3	Ammonia Gas
Bar	Unit pressure
&	and
5G	5th Generation

LIST OF ABBREVIATIONS

IoT	Internet of Things
IP	Internet Protocol
ppm	Parts per million
ADC	Analog-to-Digital Converter
OLED	Organic Light Emitting Diodes
LEDs	Light Emitting Diodes
NodeMCU	Node MicroController Unit
Wi-Fi	Wireless Fidelity
GUI	Graphical User Interface
GPS	Global Positioning System

CHAPTER 1

INTRODUCTION

1.1 Project Background

Ammonia gas (NH_3) is a useful gas and quite popular in our daily life. Ammonia normally used as a refrigerant gas, used to purify water supply, and used to make plastics, explosives, textiles, pesticides, dyes, and other chemicals [2]. Most people are familiar with the odor of ammonia because it is used in smelling salts, household cleaners, and window cleaning products [3]. Approximately 80% of ammonia produced today is converted into urea fertilizer, a dense nitrate that is more stable at room temperature and thus easier to store and transport than ammonia [4].

Review for the application history of ammonia in industry, it is used as a nitrogen rich fertilizer. This document summaries the findings of study on gas leakage incidents around the world, including those that occur in our own country. Recently, there have been few cases that involved the ammonium gas leakage in Malaysia. The newest one happened in Johor Baharu on 14th August 2009, 2 factory workers dead due to leakage of ammonia gas at ice factory. Both are currently in poor health and have difficulty breathing.

In plant, the leakage of ammonia gas is very dangerous and harmful to humans because it is corrosive (high concentration) might cause burning to our face and somehow will direct cause death. This project finds out most of the industry do not have any effective method or precaution to prevent the incident ammonia gas leakage.

The project propose is using the concept of Internet of Things (IoT) to handle or detect the leakage of ammonia gas so that can prevent the accident occurs. This project will build up a system to detect the leakage of ammonia gas and alert to workers and officials so that they will not direct expose to the ammonia gas.

1.2 Problem Statement

Gas leakage can be very dangerous to human being and others. When leakage of ammonia gas occurs, the safety officer needs to detect the gas by using their device or system which maybe they need to go to the affected area to find out where is the leakage happen, this will cause harm to the safety officer. So, to overcome this problem, we develop detection and precaution system of the ammonia gas leakage accurately. On this solution, the sensors are planted at area where the probability to leakage happen high.

Referring to problem statement at paragraph 1, the safety officer maybe needs to come to the site because their device maybe cannot be monitored from a far and function of their device is so simple which just show the status of parts per million (ppm), so if the safety officer come to the site it will exposed with ammonia gas which is dangerous for them. To overcome this problem, monitoring system with can indicate the safer route to assembly point need to be develop so that the safety officer no need to go to the exposed area and get harmed by the ammonia gas.

The above-mentioned domestic and international gas monitoring equipment, on the other hand, primarily detects basic concentrations and sounds an over-limit alert, but does not include a leakage detector source locating function, which is crucial in fire rescue operations. Ammonia releases have the potential to harm workers. When ammonia is under pressure, the risk of exposure increases because larger quantities of the refrigerant can be released into the air quickly. However, ammonia is also lighter than air, and this means that it can form clouds and travel beyond the perimeters of a fertilizer plant if there is an accidental release. When air is mixed with ammonia clouds, the problem is exacerbated because the cloud remains lower to the ground, posing a risk to workers inside a plant. To overcome this problem, the ammonia sensor located in each place that have ammonia storage. System can be monitoring to locate the exact ammonia gas leakage in each area and alert the workers or officials to act for solve that problem. The monitoring system will alert workers inside the plant by turning on the alarm and emergency lights will be displayed in the ammonia gas leakage area.

1.3 Project Objective

1. To develop detection and precaution system of the ammonia gas leakage.
2. To develop purging system for the ammonia gas leakage.
3. To develop GPS system to locate the area of ammonia gas leakage.
4. To develop monitoring system and to alert the workers or officials.

1.4 Scope of Work

The scope of work of this project focuses on designing an ammonia gas leakage detection system and precaution system which detects the area parts of ammonia gas leakages and to prevent the accidents occur. At the same time, the scope of work also involves the development of purging system for the ammonia gas leakage. Next, GPS system is developed to locate the area of ammonia gas leakage. Lastly, the scope of work also includes the development of distant monitoring by using IoT that will be developed on Blynk apps and ThingSpeak Web to alert the workers or officials.

1.5 Thesis Organization

This chapter has described the background research area of ammonia gas leakage detection and monitoring system. It has also briefly discussed the problem statement element that faces by industry and safety officer. When the ammonia gas leakage occurs, most of the solution is the safety officer need to go to the affected area to find out where is the leakage happened, and this might cause harm to the safety officer due to the ammonia gas leakage areas cannot be monitored from a far and does not include a leakage detector source locating function. The objective and the project scope of this project also had been listed in this chapter.

Chapter 2 elaborates the literature review of this project research area. First and foremost, this chapter described the general definition of Ammonia

(NH_3) which is very important in this project to understanding its features and dangerous to our human body. Then, it will describe the general definition of ammonia gas leakage detection system. Next, this chapter described the existing project related to this ammonia gas leakage detection and monitoring system.

Chapter 3 explains the proposed of development application of ammonia gas leakage detection, precaution, and purging system. This chapter also explaining the flowchart for overall project system and each part of the detection, precaution, and purging system will be explaining the operating of the system. Lastly, this chapter also specifically explain cost analysis of the overall project of ammonia gas leakage detection and monitoring system.

Chapter 4 explains the results obtained and recorded from prototype of the project proposed system and monitoring system analysis. The results show functionality of application development of ammonia gas leakage detection, precaution, and purging system. The issues during the results taken also discussed.

Chapter 5 elucidate the overall finding of the project including the functionality and effectiveness of the system in this project. Thus, the achieved objectives, limitations and the recommendation in this project are also discussed to any improvement can make for the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are several studies or articles to investigate ammonia gas leakage preventive and monitoring system have been carried out on the below. For its application and theory underlying the detection and interfacing of IoT technology, the case study of ammonia and integration of IoT into projects connected to gas sensors are addressed. From the related works, if large-scale ammonia gas leaks and sustained ammonia gas inhalation can result in varying degrees of physical harm to the human body.

2.2 Ammonia

From the article papers of Analisa Dampak Gas Amoniak dan Klorin pada Faal Paru Pekerja Pabrik Sarung Tangan Karet "X" Medan, the features of ammonia and its effects to human body has been studied.

Ammonia (NH_3) is an alkaline chemical that exists in the form of a gas that is highly irritating, colorless, and odorless. It is very soluble, forming an ammonium hydroxide solution that can cause irritation and burns. Explosives, pharmaceuticals, insecticides, textiles, materials made from animal skins, fire retardants, plastics, paper and paper pulp, rubber, petroleum, and cyanide are all made with ammonia. Ammonia is also used to make bleaching and household cleaning products like glass cleaners, toilet cleansers, metal coatings, floor cleaners, and wax cleaners. The safe ammonia concentration for workers to inhale for 8 hours per day or 40 hours per week is 25 ppm. [5]

Workers can be exposed to ammonia through inhaling the gas or vapor, ingesting it, or coming into touch with it on their skin (inhalation). Ammonia is very light in the form of gas, lighter than air, so it can rise, but it is heavier than air in the form of vapor, so it stays below. [5]

The symptoms of ammonia poisoning vary depending on the route of exposure, dose, and length of exposure. Watery and itchy eyes, irritated nose, itching and congestion, inflammation of the throat, esophagus, and airways, and cough are some of the symptoms. It can cause blindness, lung damage, and even death in excessive dosages. Ammonia can also pass through the skin and into the body. [5]

Airway obstruction causes sudden mortality after acute ammonia exposure, and the presence of infection or other problems is a factor that can induce death in persons who can survive for days or weeks after being exposed to ammonia. Exposed tissues, such as the respiratory tract, eyes, and skin, are damaged or burned at this level. According to research conducted by de la Hoz et al. in 1996, out of 94 instances, 20 were fatal and 35 required cares for a year or more. [5]

The following are the effects of ammonia exposure, which vary depending on the level: [5]

- 25 ppm is a threshold value that is considered acceptable.
- 25-50ppm, odor can be noticeable, but does not usually have an impact
- 50-100ppm, which causes a minor rash on the eyes, nose, and throat; tolerance can develop in 1-2 weeks without causing harm.
- 140 ppm, causing moderate eye discomfort for less than 2 hours; no cause of more severe impact.
- 400 parts per million (ppm), causing significant throat discomfort
- A concentration of 500 parts per million (ppm) has a direct negative influence on human health.

2.3 Ammonia gas detection system

Ammonia gas detection system are an essential part of workplace safety due to the strong-smelling ammonia gas can become toxic when exposed to air. Continuous air monitoring reduces the risk of skin, eye, nose, and throat irritation, and may even assist prevent respiratory failure. [6]

Electromechanical gas sensors with a liquid electrolyte are used in fixed gas detection. As air passes through the sensor, electrodes in the electrolyte produce a current that digitises the flow and produces a measured value that is communicated as an analogue signal. The ammonia gas sensor sends out a warning signal or an alarm when the concentration exceeds the maximum allowed by safety rules. [6]

2.4 Related Research Articles of Project

2.4.1 Implementation of Ammonia Gas Leakage Detection & Monitoring System using Internet of Things

This project used MQ-135 as ammonia gas sensor, Arduino as micro-controller and buzzer act as warning noise to officials. Next, the monitoring system is using idea Internet of Things (IoT) which are Wi-Fi module and Cloud. The Cloud analyses the data to make better decisions of result. MQ-137 ammonia gas sensor is proposed to use in the preventive of ammonia gas leakage by the author. In this project, a smart system is created for monitoring ammonia gas values in laboratories, based on the safety levels that have been established. The gas sensor is linked to the microcontroller to detect the precise values present in the monitored environment. If the gas levels rise, the data is sent from the controller to the mobile device via the Internet of Things. To make smarter decisions, the Cloud analyses the data. [7]

The disadvantages of this project:

- Precaution steps are not possible.
- No alert notification.
- Long monitoring time.
- Lot of manual work.

2.4.2 Interfacing of Ammonia Gas Sensors Using IoT Technology

This project used MQ-137 ammonia gas sensor and Arduino Mega as micro-controller while it based on ATmega1280. The project also used buzzer and LEDs to alert while detected the leakage of ammonia gas. The idea of IoT (Internet of Things) is used in this system. The sensor data is delivered to an Arduino Mega microcontroller, which is then relayed over USB. The restriction is that it does not have any safety countermeasures and is only capable of detecting ammonia. [8]

2.4.3 Ammonia Gas Leakage Monitoring System Using MQ-137 Sensors, IoT and Framing suitable Reflexive Actions

This project used MQ-137 as ammonia gas sensor, Arduino Uno as microcontroller, and idea of IoT (Internet of Things). The project is aimed to discover the leakage of ammonia gas in the system of refrigeration. The Cloud computing is used to transmit or store the data wirelessly through the ThingSpeak. In the findings and results, because ammonia is soluble in water, a mechanism was developed to sprinkle water as soon as the ammonia gas levels in the closed chamber above the threshold amount, nullifying the gas. A loud alarm was also sounded, and an alert message was sent to the Konigtronics branch office, which is around 2 miles away from Konigtronics headquarters. [9]

When MQ137 sensors detect ammonia gas leakage in the plant, the following related reflexes are framed:

- A loud alarm is being sounded.
- Exiting by emergency exits.
- Water Sprinklers are turned on (since ammonia gas is soluble in water) to stop the leak.
- The nearest hospital, fire station, police station, and other authorities received an alert signal.
- Residents around the plant should be alerted.

The major advantage of using cloud computing and IoT in this project is the leakage data will be recorded for study of the situation and to develop innovative methods to take preventive measures. The Table 2.1 shows physiological response to ammonia.

Table 2.1: Physiological Response to Ammonia

Response	Concentration (ppm)
Immediate danger to life and health	500
Minimal Irritation	5
Moderate Irritation	9 - 50
Definite Irritation	125 - 137
Cyclic hyperpnoea	500 (for 30 minutes)
Immediate Irritation	700
Dyspnoea, conclusive coughing, chest pain, pulmonary edema, may be fatal	1500 – 10000

2.5 Summary

In this chapter, the author has introduced about the features of ammonia and its effect to our human body. The author has explained about the ammonia gas detection system that is important in this project for development of ammonia gas leakage detection, precaution, and purging system.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter is focusing about the methods on development of the detection, precaution, and purging system for the project of Ammonia Gas Leakage Detection and Monitoring System. The detection, precaution and purging system is very important in this project, may help to prevent the accidents occurs due to the inhalation of ammonia gas when the ammonia gas leakages occur.

3.2 Proposed System Description

Figure 3.1 shows the flowchart of proposed system. This proposed system included few functional subsystems which are detection system, precaution system, purging system, GPS system and monitoring system. The detection system revolves around gas sensor and pressure sensor. The gas sensor MQ-135 is used to detect the ammonia gas leakage in unit ppm outside the tanks while the pressure sensor is measuring the change of ammonia gas pressure in unit bar inside the tanks. The precaution system involves green and red LEDs and siren alarm to warning the workers and officials besides the solenoid valve will auto cut off the inlet of ammonia gas when the leakage occurs. The purging system includes the pump of water sprinkler and fans that will only be triggered depending on the detection of the sensors in which the threshold value is set differently according to the type of sensor. At the same time, the GPS module will send the location to IoT system which is the monitoring system. Monitoring system uses the IoT concept that is comprised of Blynk application and ThingSpeak web. Through the Blynk and ThingSpeak in mobile phone and web, the officials can distantly monitor system and checking the data increase or decrease when the ammonia gas leakage occurs. To ensure the monitoring system is working, wireless internet connection is required.

The prototype of the proposed system is designed to have two semi-enclosed room with one tank inside each of the room. The pressure sensor is setup inside both of tank to measure the ammonia gas pressure changing inside the tanks. The gas sensor is setup at outside both of tank to ensure the surrounding of the tank is safe and clean. There are 3 solenoid valves in the prototype, one is used to cut off the inlet of ammonia gas and the other two are used to simulate the leakages of the ammonia gas from the tanks. When the start button of the proposed system is activated, the control box will display the value of voltage and current supply to ensure the power supply is enough to run whole proposed system. When the power supply is on, the proposed system connects to Wi-Fi and Blynk. The gas sensor and pressure sensor will start working. Ammonia gas is supply into two tanks through solenoid valve and pass through the one-way valve. There are two buttons in the control box to control the leakage of ammonia gas by using solenoid valve.

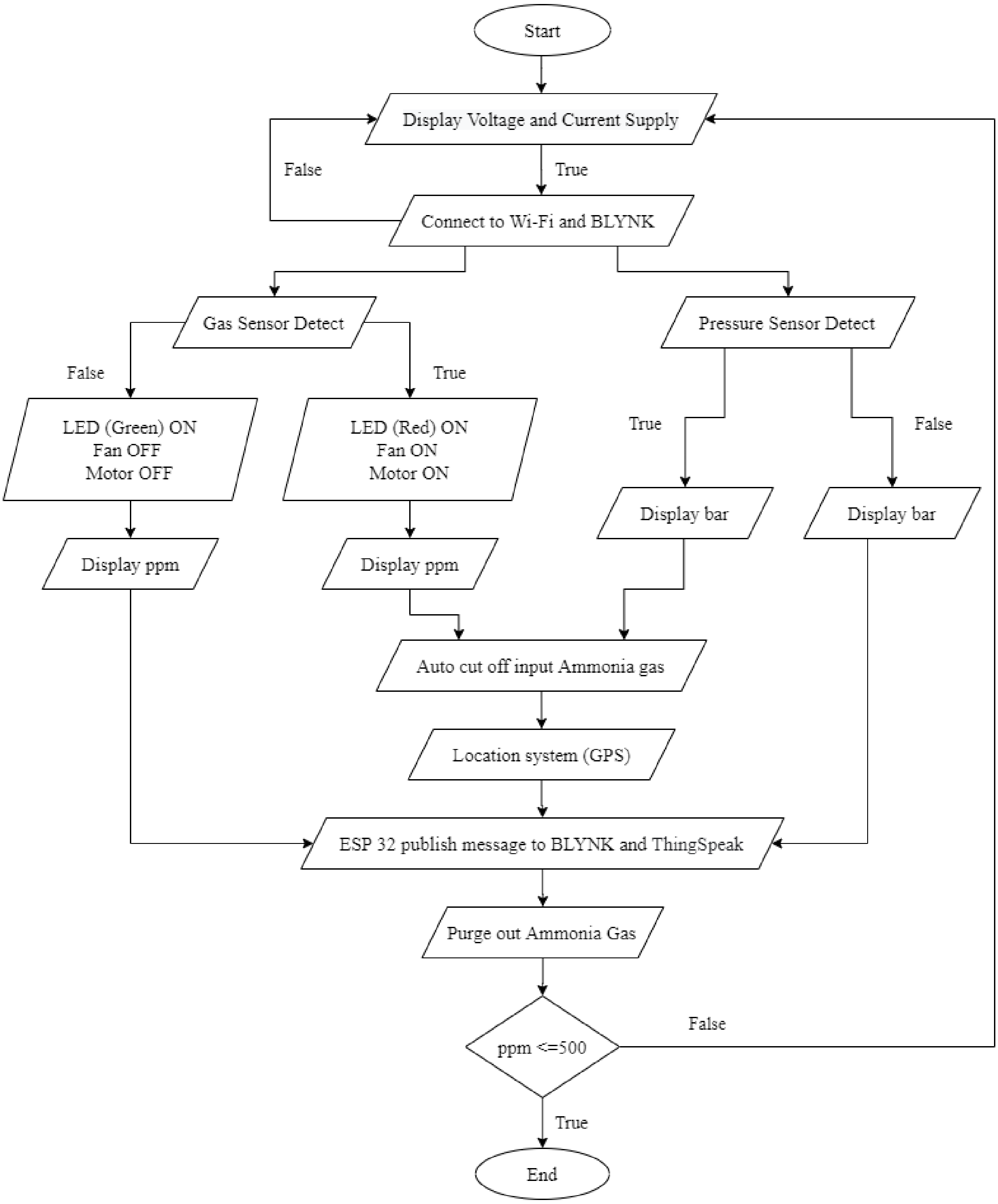

Figure 3.1: Flowchart of Proposed system

3.3 Detection System

3.3.1 MQ-135 Air Quality Sensor code setup

```
#define mq135 34
#define mq135V2 35
```

Figure 3.2: Pin setup of MQ-135 at NodeMCU ESP 32

```
float dataa = 0 ;
float dataaa = 0;
float Test = 0;
float Test2 = 0;
```

Figure 3.3: Initial value setup

The Figure 3.2 and Figure 3.3 show the coding for the two MQ-135 (air quality sensor) setup. The coding setup in Arduino IDE of two air quality sensor MQ-135 which are define at Pin 34 and Pin 35 at NodeMCU ESP 32. The initial data are calibrated as 0 so that can ensue the function of the sensors MQ-135.

```
float dataa = analogRead(mq135);
float Test = (dataa-360);

float dataaa = analogRead(mq135V2);
float Test2 = (dataaa-290);
```

Figure 3.4: Calibration of air quality sensor

The Figure 3.4 shows the coding for the calibration of MQ-135 air quality sensor. By testing the function component MQ-135 sensors, the initial values found out are not equal to zero might be due to the quality of components or the environment issues. So, the calibration for the sensors were required to minus the interference value.

3.3.2 Pressure Sensor code setup

```
int sensorValue1=analogRead(36);

  float voltage = (sensorValue1*1.0)/1024.0;

     float pressure_pascal = (3.0*((float)voltage-0.47))*1000000.0;
     float pressure_bar = pressure_pascal/10e5;

     Serial.print("Pressure Level Tank 1: ");
     Serial.println(pressure_bar);
    Blynk.virtualWrite(V20, pressure_bar);
    delay(100);
```

Figure 3.5: Code setup of Pressure Sensor 1

```
int sensorValue2=analogRead(39);

  float voltage1 = (sensorValue2*1.0)/1024.0;

     float pressure_pascal1 = (3.0*((float)voltage1-0.47))*1000000.0;
     float pressure_bar1 = pressure_pascal1/10e5;

     Serial.print("Pressure Level Tank 2: ");
     Serial.println(pressure_bar1);
    Blynk.virtualWrite(V21, pressure_bar1);
    delay(100);
```

Figure 3.6: Code setup of Pressure Sensor 2

The Figure 3.5 and Figure 3.6 show the coding setup of pressure sensor. The pressure sensor 1 is setup at Pin 36 of NodeMCU ESP 32 while pressure sensor 2 is setup at Pin39. However, the sensors detect the pressure of ammonia gas inside the tank required calibration.

For the result value of pressure sensors can be reading in unit Bar, the sensor voltage must be converted Analog to Digital by the equation shown as Figure 3.5 and Figure 3.6 above. The ADC values is required to calculate the values in pascal then the last equation convert the values Pascal into values Bar.

3.4 Precaution System

3.4.1 LEDs code setup

```
#define GREEN1 19
#define GREEN2 22
#define RED1 21
#define RED2 23
```

Figure 3.7: Pin setup of LEDs at NodeMCU ESP 32

The Figure 3.7 show the coding setup of LEDs at Arduino IDE. The LED GREEN1 and LED RED1 is placed at Pin 19 and Pin 21 at NodeMCU ESP 32 while the LED GREEN2 and LED RED2 is placed at Pin 22 and Pin 23 at NodeMCU ESP 32.

3.4.2 Siren Alarm code setup

```
#define ALARM 2
```

Figure 3.8: Pin setup of Siren Alarm at NodeMCU ESP 32

The Figure 3.8 shows the coding setup of Siren Alarm at Arduino IDE. The Siren Alarm defines as name ALARM at Pin 2 of NodeMCU ESP 32.

3.5 Purging System

3.5.1 Pump code setup

```
#define PUMP 4
```

Figure 3.9: Pin setup of Pump at NodeMCU ESP 32

The Figure 3.9 shows the coding setup of Pump at Arduino IDE. The pump of water sprinkler defines as name PUMP at Pin 4 of NodeMCU ESP 32.

3.5.2 Fans code setup

```
#define FAN1 5
#define FAN2 18
```

Figure 3.10: Pin setup of Fans at NodeMCU ESP 32

The Figure 3.10 show the coding setup of Fans at Arduino IDE. The Fans define as name FAN1 and FAN2 at Pin 5 and Pin 18 of NodeMCU ESP 32.

3.5.3 pinMode at Arduino IDE

```
pinMode(mq135, INPUT);
pinMode(mq135V2, INPUT);
pinMode(GREEN1, OUTPUT);
pinMode(GREEN2, OUTPUT);
pinMode(RED1, OUTPUT);
pinMode(RED2, OUTPUT);
pinMode(ALARM, OUTPUT);
pinMode(PUMP, OUTPUT);
pinMode(FAN1, OUTPUT);
pinMode(FAN2, OUTPUT);
```

Figure 3.11: pinMode setup

The Figure 3.11 show the pins has been configured as an INPUT and OUTPUT with pinMode() at Arduino IDE. Its voltage is set to the appropriate value: 5V (or 3.3V on 3.3V boards) for HIGH, and 0V (ground) for LOW.

3.6 Code for Gas Sensors System Operation

```
void sensorData()
{
  dataa = analogRead(mq135);
  Blynk.virtualWrite(V2,Test);
  Test = (dataa-360);


if (Test > 600)
 {

      led1.off();
      led2.on();
      digitalWrite(GREEN1, LOW);
      digitalWrite(RED1, HIGH);
      digitalWrite(VALVE, LOW);
      digitalWrite(PUMP, HIGH);
      digitalWrite(FAN1, HIGH);
      digitalWrite(ALARM, HIGH);
      delay(1000);
      Blynk.notify("Leakage Detected");
  }
```

Figure 3.12: Gas Sensor 1 operation part 1

```
  else
  {
      led1.on();
      led2.off();
      digitalWrite(GREEN1, HIGH);
      digitalWrite(RED1, LOW);
      digitalWrite(VALVE, HIGH);
      digitalWrite(PUMP, LOW);
      digitalWrite(FAN1, LOW);
      digitalWrite(ALARM, LOW);

  }
}
```

Figure 3.13: Gas Sensor 1 operation part 2

```
void sensorDataV2()
{
  dataaa = analogRead(mq135V2);
  Blynk.virtualWrite(V3,Test2);
  Test2 = (dataaa-290);


if (Test2 > 600)
 {

      led3.off();
      led4.on();
      digitalWrite(GREEN2, LOW);
      digitalWrite(RED2, HIGH);
      digitalWrite(VALVE, LOW);
      digitalWrite(PUMP, HIGH);
      digitalWrite(FAN2, HIGH);
      digitalWrite(ALARM, HIGH);
      delay(1000);
      Blynk.notify("Leakage Detected");

  }
```

Figure 3.14: Gas Sensor 2 operation part 1

```
  else
  {
      led3.on();
      led4.off();
      digitalWrite(GREEN2, HIGH);
      digitalWrite(RED2, LOW);
      digitalWrite(VALVE, HIGH);
      digitalWrite(PUMP, LOW);
      digitalWrite(FAN2, LOW);
      digitalWrite(ALARM, LOW);
  }
}
```

Figure 3.15: Gas Sensor 2 operation part 2

The Figure 3.12 and Figure 3.13 show the Gas Sensor 1 (MQ-135 air quality sensor 1) operation code in Arduino IDE while Figure 3.14 and Figure 3.15 show the Gas Sensor 2 (MQ-135 air quality sensor 2) operation code. From the Figures, the calibration within two air quality sensors is different due to their interference values. However, the condition of the operation system of two gas sensor are the same.

The digitalWrite() sets the value of a digital pin to HIGH or LOW. From the Figure 3.12 and Figure 3.14 of the part 1 operation Gas Sensor 1 and Gas Sensor 2, if one of the gas sensors detect the ammonia gas leakages, the following operation or condition will on and off else the following operation or condition part 2 of Gas Sensor 1 and Gas Sensor 2 of Figure 3.13 and Figure 3.15 will carry on.

3.7 Budget analysis

Table 3.1: Cost analysis

NO	ITEM	PRICE(RM)
1	Raspberry Pi 4	RM 189
2	Jumper wire, MQ135	RM 31.30
3	Raspberry Pi 4 Display	RM 82.15
4	ESP32	RM 29.50
5	Trigger switch relay, jumper wire, breadboard, esp32, water pump motor, GPS module	RM 97.40
6	Warning siren alarm	RM 26.28
7	Pressure Transcoder Sender Sensor	RM 69.36
8	Electric Solenoid Valve	RM 45.41
9	Air compressor pressure gauge	RM 24.60
10	Water sprinkle	RM 33.21
11	Electric solenoid valve & gas check valve	RM 29.85
12	Cylinder Adapter connector converter	RM 15
13	Electric solenoid valve	RM 17.41
14	GP back up battery 12V	RM 40.80
15	Push button switch connector, push button momentary electrical screw terminal block	RM 25.35
16	Dc 12v 2 PIN Desktop/ CPU cooling fan	RM 12.50
17	Acrylic Sheet/Perspex A3/A2	RM 125.40
Total amount		RM 896.52

The Table 3.1 shows the cost analysis of whole project proposed system.

3.8 Summary

In this chapter, the author has explained about flowchart, methods and codes that used to design on development of ammonia gas leakage detection, precaution, and purging system. The cost analysis of project also provided by the author in this chapter.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results of the detection system of web development ThingSpeak and Blynk application is discussed in detail. The interface of ammonia gas leakages detection system and the GUI of the ThingSpeak and Blynk are discussed. The results of precaution and purging system also will be discussed in this chapter.

4.2 Prototype design of the proposed system

Figure 4.1: Prototype Front View

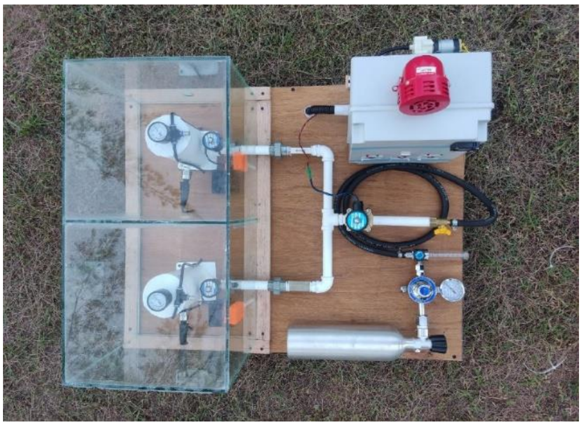

Figure 4.2: Prototype Top View

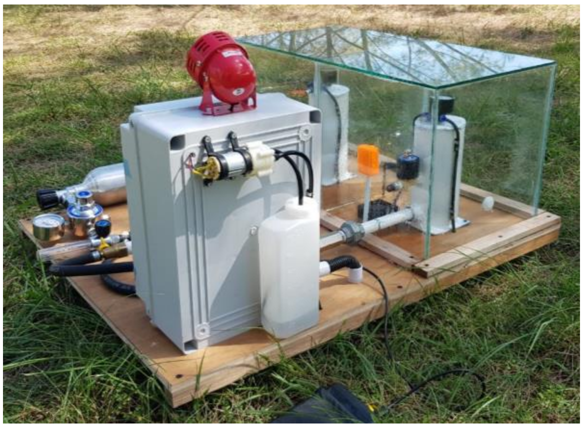

Figure 4.3: Prototype Side View

Figure 4.1, Figure 4.2, and Figure 4.3 show the Prototype Front View, Prototype Top View and Prototype Side View. The final prototype has been built up by our team.

The prototype of the proposed system is designed to have two semi enclosed room with one tank inside each of the container as shown in Figure 4.1. The pressure sensor is setup inside both of tank to measure the ammonia gas pressure increase or decrease inside the tanks. The gas sensor is setup at outside both of tank to ensure the surrounding of the tank is safe and clean. There are 3 solenoid valves in the prototype, one is used to cut off the inlet of ammonia gas and the other two are used to simulate the leakages of the ammonia gas from the tanks. The siren alarm is setup on the control box while the pump of water sprinkler is setup behind the control box as shown in Figure 4.3.

The control box will display the value of voltage and current supply to ensure the power supply is enough to run whole proposed system. When the power supply is on, the proposed system connects to Wi-Fi and Blynk. The gas sensor and pressure sensor will start working. Ammonia gas is supply into two tanks through solenoid valve and pass through the one-way valve. There are two buttons in the control box to control the leakage of ammonia gas by using solenoid valve.

4.3 Results and Discussion

4.3.1 Detection system

Figure 4.4: Initial Results in Blynk

The Figure 4.4 show the distant monitoring for the detection system of the prototype project in Blynk application. Upper side of the GUI are the initial result of MQ-135 air quality sensors and downside are the initial result of pressure sensors.

Figure 4.5: Detected Results in Blynk

When the ammonia gas leakages are occurs, the distant monitoring system is shown as the Figure 4.5 for the detection system of the prototype project in Blynk application. Upper side of the GUI are the detected result of MQ-135 air quality sensors and downside are the detected result of pressure sensors.

The values of the gas sensor are high due to the leakages detecting outside the tank of prototype while the values of the pressure sensor are quite low compared to initial because of the air pressure inside the tank of prototype is decrease as the ammonia gas leakages occurs.

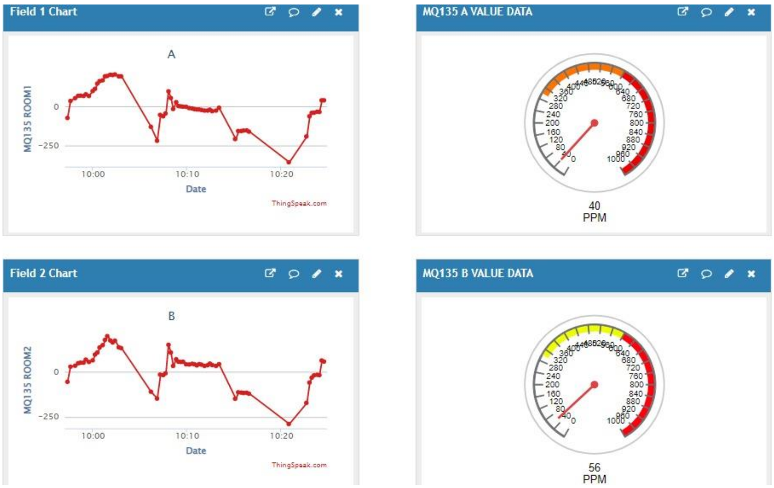

Figure 4.6: Initial Results of Gas Sensors in ThingSpeak

The Figure 4.6 show the distant monitoring for the detection system of the prototype project in ThingSpeak web. Upper side of the GUI are the initial result of MQ-135 air quality sensor in Room A/Room 1 and downside are the initial result of MQ-135 air quality sensor in Room B/Room 2.

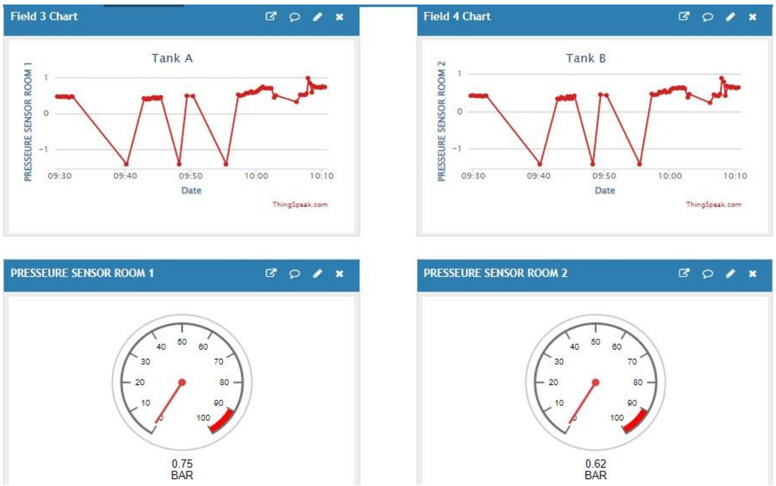

Figure 4.7: Initial Results of Pressure Sensors in ThingSpeak

The Figure 4.7 show the distant monitoring for the detection system of the prototype project in ThingSpeak web. Left side of the GUI are the initial result of pressure sensor in Room A/Room1 and right side are the initial result of pressure sensor in Room B/Room2.

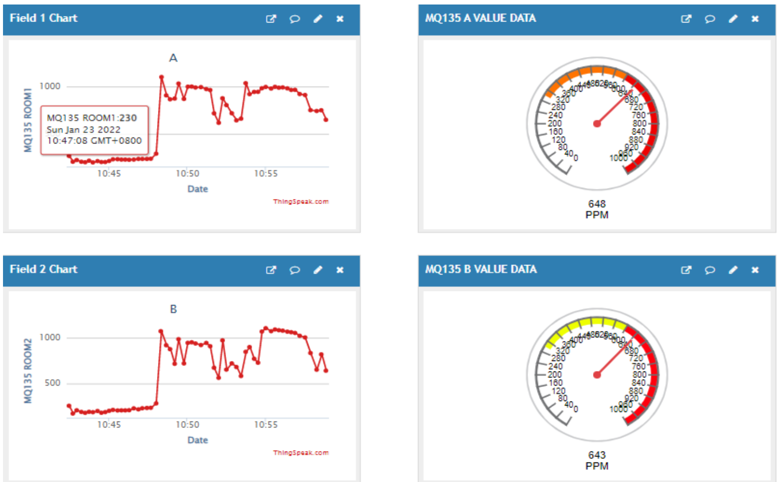

Figure 4.8: Detected Results of Gas Sensors in ThingSpeak

When the ammonia gas leakages are occurs, the distant monitoring system is shown as the Figure 4.8 for the detection system of the prototype project in ThingSpeak web. Upper side of the GUI are the detected result of MQ-135 air quality sensors in Room A/Room 1 and downside are the detected result of MQ-135 air quality sensors in Room B/Room 2.

Figure 4.9: Detected Results of Pressure Sensors in ThingSpeak

When the ammonia gas leakages are occurs, the distant monitoring system is shown as the Figure 4.9 for the detection system of the prototype project in ThingSpeak web. Left side of the GUI are the detected result of pressure sensors in Room A/Room 1 and right side are the detected result of pressure sensors in Room B/Room 2.

Table 4.1: Obtained results before leakage (data in CSV format)

	A	B	C	D	E	F
1	created_at	entry_id	field1	field2	field3	field4
2	2022-01-23 02:31:52 UTC	3334	86	69	0.48	0.47
3	2022-01-23 02:32:08 UTC	3335	84	85	0.52	0.53
4	2022-01-23 02:32:24 UTC	3336	83	77	0.58	0.62
5	2022-01-23 02:32:39 UTC	3337	74	60	0.7	0.68
6	2022-01-23 02:32:58 UTC	3338	86	79	0.75	0.71
7	2022-01-23 02:33:13 UTC	3339	69	69	0.81	0.78
8	2022-01-23 02:33:29 UTC	3340	71	78	0.88	0.86
9	2022-01-23 02:33:47 UTC	3341	78	66	0.94	0.91
10	2022-01-23 02:34:03 UTC	3342	63	68	1.01	0.99
11	2022-01-23 02:34:19 UTC	3343	71	67	1.06	1.06
12	2022-01-23 02:34:35 UTC	3344	77	79	1.12	1.13

The Table 4.1 show the obtained results before leakage (data in CSV format). The field1 in column C is represented the values of gas sensor in Room A/Room 1 and the field2 in column D is represented the values of the gas sensor in Room B/Room 2. While the field3 in column E is represented the values of pressure sensor in Room A/Room 1 and the field4 in column F is represented the values of the pressure sensor in Room B/Room 2. The pressure values in field3 and field4 is increase because of the inlet ammonia gas is move in the tanks.

Table 4.2: Obtained results during leakage (data in CSV format)

	A	B	C	D	E	F
1	created_at	entry_id	field1	field2	field3	field4
21	2022-01-23 02:36:59 UTC	3353	60	66	1.89	1.88
22	2022-01-23 02:37:15 UTC	3354	72	71	1.91	1.92
23	2022-01-23 02:37:33 UTC	3355	73	76	1.96	1.94
24	2022-01-23 02:37:51 UTC	3356	1105	1074	0.87	0.76
25	2022-01-23 02:38:09 UTC	3357	909	921	0.9	0.8
26	2022-01-23 02:38:24 UTC	3358	867	878	0.91	0.83
27	2022-01-23 02:38:39 UTC	3359	875	718	0.9	0.8
28	2022-01-23 02:38:54 UTC	3360	1035	987	0.85	0.76
29	2022-01-23 02:39:10 UTC	3361	871	722	0.92	0.83
30	2022-01-23 02:39:25 UTC	3362	1002	947	0.89	0.81
31	2022-01-23 02:39:40 UTC	3363	1003	953	0.82	0.8
32	2022-01-23 02:39:55 UTC	3364	993	940	0.79	0.76

The Table 4.2 show the obtained results before leakage (data in CSV format). The field1 in column C is represented the values of gas sensor in Room A/Room 1 and the field2 in column D is represented the values of the gas sensor in Room B/Room 2. While the field3 in column E is represented the values of pressure sensor in Room A/Room 1 and the field4 in column F is represented the values of the pressure sensor in Room B/Room 2.

When the ammonia gas leakages is occur, the gas sensor values in field1 and field2 will increase due to the detection of gas sensors MQ-135 while the pressure values in field3 and field4 will decrease because of the inlet ammonia gas is auto cut off.

Table 4.3: Obtained results after purging system functioning (data in CSV format)

	A	B	C	D	E	F
1	created_at	entry_id	field1	field2	field3	field4
31	2022-01-23 02:39:40 UTC	3363	1003	953	0.82	0.8
32	2022-01-23 02:39:55 UTC	3364	993	940	0.79	0.76
33	2022-01-23 02:40:10 UTC	3365	734	719	0.7	0.68
34	2022-01-23 02:40:26 UTC	3366	637	614	0.75	0.71
35	2022-01-23 02:40:41 UTC	3367	532	527	0.81	0.78
36	2022-01-23 02:40:56 UTC	3368	438	436	0.79	0.72
37	2022-01-23 02:41:11 UTC	3369	439	433	0.71	0.69
38	2022-01-23 02:41:27 UTC	3370	332	333	0.68	0.67
39	2022-01-23 02:41:42 UTC	3371	245	232	0.61	0.62
40	2022-01-23 02:41:57 UTC	3372	249	238	0.61	0.64
41	2022-01-23 02:42:13 UTC	3373	164	163	0.58	0.6
42	2022-01-23 02:42:28 UTC	3374	162	160	0.57	0.55

The Table 4.3 show the obtained after purging system functioning (data in CSV format). The field1 in column C is represented the values of gas sensor in Room A/Room 1 and the field2 in column D is represented the values of the gas sensor in Room B/Room 2. While the field3 in column E is represented the values of pressure sensor in Room A/Room 1 and the field4 in column F is represented the values of the pressure sensor in Room B/Room 2.

After the purging system (fans and water sprinkler) is functioning, the values of gas sensors of field1 and field2 in column C and D will decrease. The pressure values in field3 and field4 will decrease because of the inlet ammonia gas is auto cut off.

4.3.2 Precaution system

Figure 4.10: GREEN LEDs ON

When the prototype is started to run, the Figure 4.10 show the GREEN LED 1 and GREEN LED 2 ON as the gas sensor do not detect the ammonia gas leakages occur.

Figure 4.11: RED LEDs ON

The Figure 4.11 show the RED LED 1 and RED LED 2 ON, when the gas sensors detect the ammonia gas leakages occur.

Figure 4.12: Siren Alarm ON

The Figure 4.12 show the Siren Alarm turn ON if the gas sensors detect the ammonia gas leakages occur.

4.3.3 Purging system

Figure 4.13: Pump ON

Figure 4.14: Fans ON

The Figure 4.13 and Figure 4.14 show the Pump (water sprinkler) and Fans turn ON if the gas sensors detect the ammonia gas leakages occur. When the ammonia gas leakages occur in the tanks, the pump will turn ON and water sprinkler will function to sprinkle water so that the water will dilute the ammonia gas, the fans will also purge out the ammonia gas to surrounding environment.

4.4 Summary

In this chapter, the author discussed the obtained results of the development of ammonia gas leakage detection, precaution, and purging system. The detection, precaution, and purging system successfully function in this project. While the MQ-135 air quality gas sensors are being found out some technical problems. The gas sensor values detect by the air quality sensors MQ-135 will not go back to the initial values after each time testing. The results in ThingSpeak are delay compared to results in Blynk, cannot get in simultaneously.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter concludes the overall finding of the project. In addition, the objectives are also checked in this chapter to decide whether it is achieved. In this section, the contribution of this research, the constraint and recommendation for future works are also discussed.

5.2 Conclusion

In the conclusion, the detection and precaution system of the ammonia gas leakage has been successfully developed as the proposed system is able to detect the ammonia gas leakage and alert the worker or officials. From the obtained results in Chapter 4 of Table 4.1, Table 4.2, and Table 4.3, we know that the purging system has been successfully developed as proposed system is able to purge out the ammonia gas from the room.

The parts of software coding for MQ-135 air quality sensors (used as ammonia gas sensors) and pressure sensors need to combine with the coding for monitoring system by using the concept Internet of Things (IoT). These result readings will be sent to a broker, who will then send them to a mobile and web application, which will receive them and display them as gauges and graphs.

The advantages or benefits of this project are included to reduce the risk of death due to inhale ammonia gas and preliminary treatment of leakage problems. The solenoid valve in hardware design is to control the inlet ammonia gas to prevent the ammonia gas keep supply when ammonia gas leakage is occurs. One way valve in hardware design is prevent air ammonia gas flow back through the path of pipe when ammonia gas leakage is occurs. The GPS location system is important to allow rescuers to quickly lock in position of ammonia gas leakage. The distant monitoring system avoids the workers or officials coming into close contact with the leakage area.

5.3 Recommendation

There are few limitations or disadvantages in this project. The MQ-135 air quality sensor needs to be calibrated each time after use to detect the ammonia gas leakage due to the values detect by the gas sensors will compound each time testing. The results shown in ThingSpeak are delay compared to results in Blynk due to the internet slow or other technical problem, the result cannot get in simultaneously. The GPS module not quite accurate to locate the location.

In the future, this project can be further improved by changing the gas sensor to MQ-137 because the MQ-135 is an air quality sensor and able to detect various range of gas. The delay exchange data between the ThingSpeak and Blynk can be improved by using the 5G network.

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APPENDICES

Appendix A: pressure sensor Arduino IDE code

```
void sendUptime()
{

int sensorValue1=analogRead(36);


  float voltage = (sensorValue1*1.0)/1024.0;


     float pressure_pascal = (3.0*((float)voltage-0.47))*1000000.0;
     float pressure_bar = pressure_pascal/10e5;

     Serial.print("Pressure Level Tank 1: ");
     Serial.println(pressure_bar);
    Blynk.virtualWrite(V20, pressure_bar);
    delay(100);


int sensorValue2=analogRead(39);

  float voltage1 = (sensorValue2*1.0)/1024.0;

     float pressure_pascal1 = (3.0*((float)voltage1-0.47))*1000000.0;
     float pressure_bar1 = pressure_pascal1/10e5;

     Serial.print("Pressure Level Tank 2: ");
     Serial.println(pressure_bar1);
    Blynk.virtualWrite(V21, pressure_bar1);
    delay(100);
}
```

Appendix B: MQ-135 air quality sensors Arduino IDE code

```
************************// 1ST SENS setup////***************************


void sensorData()
{
  dataa = analogRead(mq135);
  Blynk.virtualWrite(V2,Test);
  Test = (data-360);
if (Test > 600)
 {

      led1.off();
      led2.on();
      digitalWrite(GREEN1, LOW);
      digitalWrite(RED1, HIGH);
      digitalWrite(VALVE, LOW);
      digitalWrite(PUMP, HIGH);
      digitalWrite(FAN1, HIGH);
      digitalWrite(ALARM, HIGH);
      delay(1000);
      Blynk.notify("Leakage Detected");
  }
  else
  {
      led1.on();
      led2.off();
      digitalWrite(GREEN1, HIGH);
      digitalWrite(RED1, LOW);
      digitalWrite(VALVE, HIGH);
      digitalWrite(PUMP, LOW);
      digitalWrite(FAN1, LOW);
      digitalWrite(ALARM, LOW);

  }
}

*************************// 2ND SENS setup////**************************

void sensorDataV2()
{
  dataaa = analogRead(mq135V2);
  Blynk.virtualWrite(V3,Test2);
  Test2 = (dataaa-290);
```

```
if (Test2 > 600)
 {

      led3.off();
      led4.on();
      digitalWrite(GREEN2, LOW);
      digitalWrite(RED2, HIGH);
      digitalWrite(VALVE, LOW);
      digitalWrite(PUMP, HIGH);
      digitalWrite(FAN2, HIGH);
      digitalWrite(ALARM, HIGH);
      delay(1000);
      Blynk.notify("Leakage Detected");

  }
  else
  {
      led3.on();
      led4.off();
      digitalWrite(GREEN2, HIGH);
      digitalWrite(RED2, LOW);
      digitalWrite(VALVE, HIGH);
      digitalWrite(PUMP, LOW);
      digitalWrite(FAN2, LOW);
      digitalWrite(ALARM, LOW);
  }
}
```

Appendix C: Whole system Arduino IDE code

```
#define BLYNK_PRINT Serial
#define ss Serial2
#include <WiFi.h>
#include "Wire.h"
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <TinyGPS++.h>
#include <TinyGPS.h>



static const uint32_t GPSBaud = 9600;
BlynkTimer timer;
WidgetLED led1(V4);
WidgetLED led2(V5);
WidgetLED led3(V6);
WidgetLED led4(V7);


String apiKey = "SSTMYCFZVKS9I9XN";
char auth[] = "xSSHLijfsavmVmMGmlFZOwEMALKy7A-S";
char ssid[] = "wan";
char pass[] = "123456789";
const char* server = "api.thingspeak.com";

WidgetMap myMap(V0);
WiFiClient client;
TinyGPSPlus gps;
#define mq135 34
#define mq135V2 35
#define ALARM 2
#define PUMP 4
#define VALVE 15
#define GREEN1 19
#define GREEN2 22
#define RED1 21
#define RED2 23
#define FAN1 5
#define FAN2 18




float dataa = 0 ;
float dataaa = 0;
float Test = 0;
```

```
float Test2 = 0;
float spd;
float sats;
String bearing;

unsigned int move_index = 1;

void sensorData()
{
  dataa = analogRead(mq135);
  Blynk.virtualWrite(V2,Test);
  Test = (dataa-360);


if (Test > 600)

      led1.off();
      led2.on();
      digitalWrite(GREEN1, LOW);
      digitalWrite(RED1, HIGH);
      digitalWrite(VALVE, LOW);
      digitalWrite(PUMP, HIGH);
      digitalWrite(FAN1, HIGH);
      digitalWrite(ALARM, HIGH);
      delay(1000);
      Blynk.notify("Leakage Detected");
  }
  else
  {
      led1.on();
      led2.off();
      digitalWrite(GREEN1, HIGH);
      digitalWrite(RED1, LOW);
      digitalWrite(VALVE, HIGH);
      digitalWrite(PUMP, LOW);
      digitalWrite(FAN1, LOW);
      digitalWrite(ALARM, LOW);

  }
}



void sensorDataV2()
{
  dataaa = analogRead(mq135V2);
  Blynk.virtualWrite(V3,Test2);
  Test2 = (dataaa-290);
```

```
if (Test2 > 600)
 {

      led3.off();
      led4.on();
      digitalWrite(GREEN2, LOW);
      digitalWrite(RED2, HIGH);
      digitalWrite(VALVE, LOW);
      digitalWrite(PUMP, HIGH);
      digitalWrite(FAN2, HIGH);
      digitalWrite(ALARM, HIGH);
      delay(1000);
      Blynk.notify("Leakage Detected");

  }
  else
  {
      led3.on();
      led4.off();
      digitalWrite(GREEN2, HIGH);
      digitalWrite(RED2, LOW);
      digitalWrite(VALVE, HIGH);
      digitalWrite(PUMP, LOW);
      digitalWrite(FAN2, LOW);
      digitalWrite(ALARM, LOW);
  }
}


void setup()
{
  Serial.begin(9600);

  Serial.println();
  ss.begin(GPSBaud);

  Blynk.begin(auth, ssid, pass,"188.166.206.43");
  pinMode(ALARM, OUTPUT);
  pinMode(mq135, INPUT);
  pinMode(mq135V2, INPUT);
  pinMode(GREEN1, OUTPUT);
  pinMode(GREEN2, OUTPUT);
  pinMode(RED1, OUTPUT);
  pinMode(RED2, OUTPUT);
  pinMode(ALARM, OUTPUT);
  pinMode(PUMP, OUTPUT);
  pinMode(FAN1, OUTPUT);
  pinMode(FAN2, OUTPUT);
```

```
  pinMode(VALVE, OUTPUT);
  timer.setInterval(1000L, sensorData);
  timer.setInterval(1000L, sensorDataV2);
  timer.setInterval(1000L, sendUptime);

  delay(10);
  Serial.println("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED)
  {
  delay(500);
  Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
}
void sendUptime()
{

int sensorValue1=analogRead(36);


  float voltage = (sensorValue1*1.0)/1024.0;


     float pressure_pascal = (3.0*((float)voltage-0.47))*1000000.0;
     float pressure_bar = pressure_pascal/10e5;

     Serial.print("Pressure Level Tank 1: ");
     Serial.println(pressure_bar);
    Blynk.virtualWrite(V20, pressure_bar);
    delay(100);


int sensorValue2=analogRead(39);

  float voltage1 = (sensorValue2*1.0)/1024.0;

     float pressure_pascal1 = (3.0*((float)voltage1-0.47))*1000000.0;
     float pressure_bar1 = pressure_pascal1/10e5;

     Serial.print("Pressure Level Tank 2: ");
     Serial.println(pressure_bar1);
    Blynk.virtualWrite(V21, pressure_bar1);
    delay(100);
}
void loop()
{
```

```
    while (ss.available() > 0)
    {

      if (gps.encode(ss.read()))
        displayInfo();

     if (millis() > 5000 && gps.charsProcessed() < 10)
  {
    Serial.println(F("No GPS detected: check wiring."));
    while(true);
  }
    }
  Blynk.run();
  timer.run();
;

  float dataa = analogRead(mq135);
  float Test = (dataa-360);

  float dataaa = analogRead(mq135V2);
  float Test2 = (dataaa-290);



  int sensorValue1=analogRead(36);
  float voltage = (sensorValue1*1.0)/1024.0;
  float pressure_pascal = (3.0*((float)voltage-0.47))*1000000.0;
  float pressure_bar = pressure_pascal/10e5;

  int sensorValue2=analogRead(39);
  float voltage1 = (sensorValue2*1.0)/1024.0;
  float pressure_pascal1 = (3.0*((float)voltage1-0.47))*1000000.0;
  float pressure_bar1 = pressure_pascal1/10e5;

   if (isnan(mq135) || isnan(mq135V2) || isnan(pressure_bar)|| isnan(pres
sure_bar1))
  {
 Serial.println("Failed to read from MQ-135 and pressure sensor");
  return;
  }

  if (client.connect(server, 80))
  {
    String postStr = apiKey;
    postStr +="&field1=";
    postStr += String(Test);
    postStr +="&field2=";
    postStr += String(Test2);
```

```
    postStr +="&field3=";
    postStr += String(pressure_bar);
    postStr +="&field4=";
    postStr += String(pressure_bar1);
    postStr += "\r\n\r\n\r\n\r\n";


    client.print("POST /update HTTP/1.1\n");
    client.print("Host: api.thingspeak.com\n");
    client.print("Connection: close\n");
    client.print("X-THINGSPEAKAPIKEY: " + apiKey + "\n");
    client.print("Content-Type: application/x-www-form-urlencoded\n");
    client.print("Content-Length: ");
    client.print(postStr.length());
    client.print("\n\n");
    client.print(postStr);
    Serial.print("Gas Level: ");
    Serial.println(Test);
    Serial.print("Gas Level 2: ");
    Serial.println(Test2);

    Serial.println("Data Send to Thingspeak");
 }
    delay(500);
    client.stop();
    Serial.println("Waiting...");


    delay(1500);
}

void displayInfo()
{
  Serial.print(F("Location: "));
  if (gps.location.isValid() )
  {
    float latitude = (gps.location.lat());
    float longitude = (gps.location.lng());

    Serial.print(gps.location.lat(), 6);
    Serial.print(F(","));
    Serial.print(gps.location.lng(), 6);


    Blynk.virtualWrite(V10, String(latitude, 6));
    Blynk.virtualWrite(V11, String(longitude, 6));
    myMap.location(move_index, latitude, longitude, "GPS_Location");
```

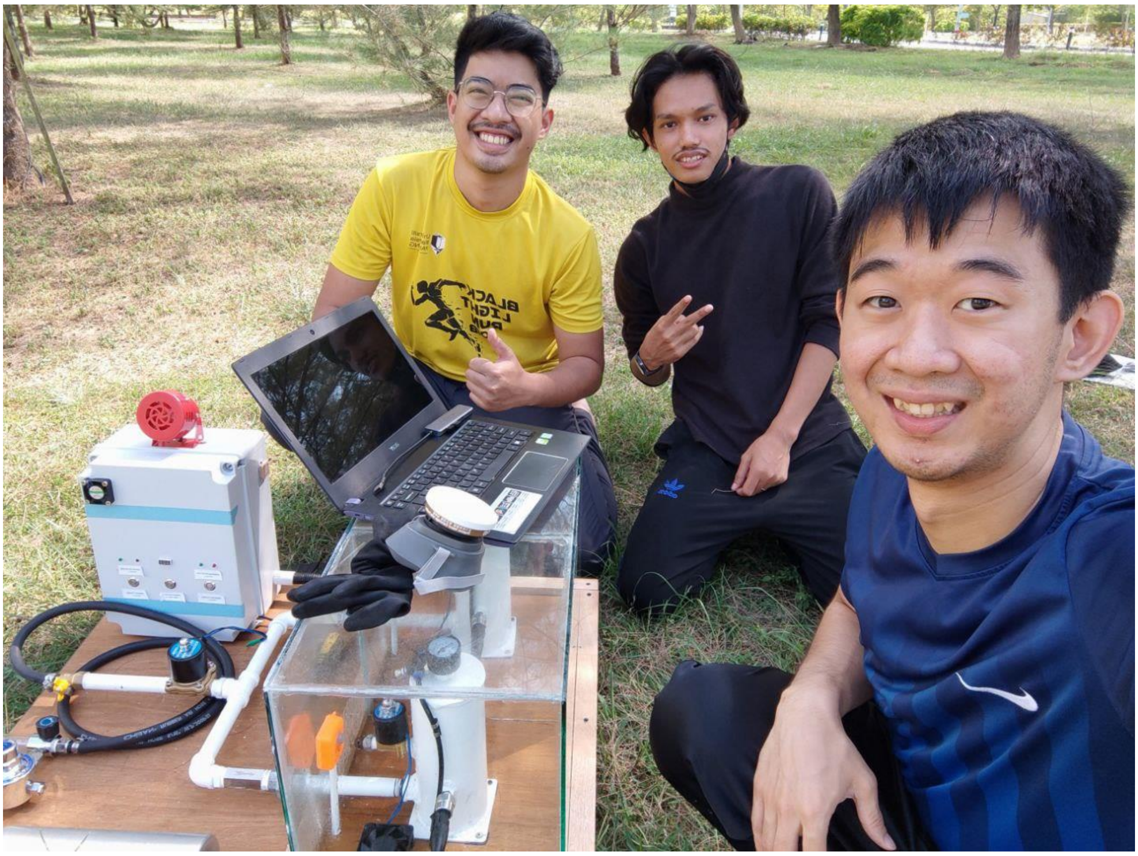
```
    spd = gps.speed.kmph();
    Blynk.virtualWrite(V13, spd);

    sats = gps.satellites.value();
    Blynk.virtualWrite(V12, sats);

    bearing = TinyGPSPlus::cardinal(gps.course.value());
    Blynk.virtualWrite(V14, bearing);
  }
    else
  {
    Serial.print(F("INVALID"));
  }

 Serial.println();
}
```

Appendix D: Project Group Members



Appendix E: Gantt Chart project planning of SDP 2

TASK/WEEK	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
SDP 2 Briefing	■												
Project meeting	■	■	■	■	■	■	■	■	■	■	■	■	■
Specify requirement		■	■										
Develop prototype	■	■	■	■	■	■	■	■	■	■	■		
Construct the Circuit and monitoring system	■	■	■	■	■	■	■	■	■	■			
Thesis first draft						■	■						
Draft correction							■	■					
Thesis second draft								■	■				
Finalize porotype and monitoring system										■	■	■	
Presentation SDP 2													■