International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-3, September 2019

Smart Manhole Toxic Gas Identification and Alerting System

L.K.Hema,Velmurugan S, Suriya. Pa, R. Indumathi

Abstract: ***Even nowadays, sewage systems are cleaned by the manual power. Somewhere they recently stated that "More Indians were dying in cleaning sewers than fighting terrorists in Kashmir". Sewer gas is a composite amalgamation of venomous and non-hazardous gases, which is collected in sewage systems. Predominantly it also comprises that oxide of carbon, sulphur, nitrogen, ammonia and methane due to the decomposition of organic household or industrial wastes. During the maintenance practice, Sewer gases cause the health issues and fatal death to the labors also due to untreated disposal of petroleum products such as gasoline and mineral spirits. To conquer these impacts, in this proposed system, by using a set of integrated sensors MQ-4, MQ-7, MQ137 were incorporated with microcontroller unit process and LCD Display to quantify toxic gases which is produced in the system. It could be recognize the scale of toxicants and then intimated to the workers to acquire the safety precautions before entering into the manholes. The sensing range for the leak detection sensor should be from 300 ppm to 10,000 ppm. In order to reduce the toxic gases concentration, Sprinkler mechanism is provided with the resource chemical for detoxification treatment. Whenever the gas concentration level exceeds the specified threshold level, an actuator mechanism triggers the sprinkler. To upkeep the sewerage system and Prohibiting Manual Scavengers and their Rehabilitation Act, 2013, labors continually taking risk in their health and life. But they were paid for merely low wages. Despite proactive orders of the Supreme Court, the implementation of the directives remains unrealized, in the wake of frequent deaths. In this special episode of Banega Swachh India campaign, we take a look at how these deaths leave the workers' family devastated and yet no one claims responsibility for the deaths.***

Index Terms: MQ-4, MQ-7, MQ137,Carbon, sulphur, nitrogen, ammonia and methane

I.INTRODUCTION

Sewage workers continually risk their health and life to ensure upkeep of the sewerage system. But for years, they have received a little in return. Despite proactive orders of the Supreme Court, the implementation of the directives remains unrealized, in the wake of frequent deaths.

In this special episode of Banega Swachh India campaign, we take a look at how these deaths leave the workers' family devastated and yet no one claims responsibility for the deaths.

Due to decomposition of organic matters, industrial effluents, other sewage matters, gas is formed with the combination of different chemical mixtures. Sewer gases may include hydrogen sulphide, ammonia, methane, esters, carbon monoxide, sulphur dioxide and nitrogen oxides. Sewer gases can also potential to create fire or explosions severely apart from normal disturbance such as odour and health effects.

Sewer gas consists of varying levels of toxic and non-toxic gases depending on the source, says the Wisconsin DHS. It results from the decomposition of household and industrial waste, and it smells like rotten eggs. Hydrogen sulphide and ammonia are highly toxic components of this gas. Exposure to small levels of hydrogen sulphide irritates the eyes and respiratory tract. It also causes headache, dizziness, drowsiness, nausea and nervousness. Exposure to high concentrations of hydrogen sulphide sometimes causes people to experience a loss of sense of smell. Sewer gas is fatal at extremely high levels. It contains methane, which decreases the amount of oxygen in the air and leads to suffocation. When oxygen deficiency occurs, a person is likely to experience headache, dizziness, nausea and unconsciousness. Death will occur directly once an individual is exposed to terribly low oxygen concentrations.

II. SYSTEMMODEL

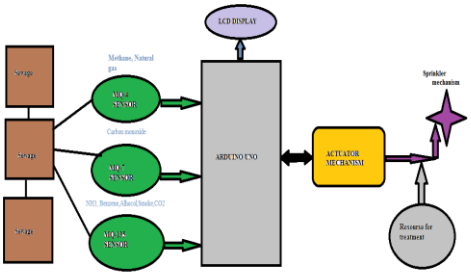

Figure 1.Block diagram of proposed system

Manuscript published on 30 September 2019
* Correspondence Author
Dr.L.K. Hema*, Dept. of ECE, Aarupadai Veedu Institute of Technology, Vinayaka Mission's Research Foundation, Chennai, India.
Velmurugan S, Dept. of ECE, Aarupadai Veedu Institute of Technology, Vinayaka Mission's Research Foundation Chennai, India.
Suriya.Pa, Dept. of Civil, Aarupadai Veedu Institute of Technology, Vinayaka Mission's Research Foundation Chennai, India.
R. Indumathi, Dept. Of ECE, Aarupadai Veedu Institute of Technology, Vinayaka Mission's Research Foundation Chennai, India.

A. Block diagram description

The model manhole safety system is used to measure the concentration levels of different toxic gases, such as Methane, Carbon Monoxide and Ammonia inside the manhole or Drainages. It incorporates a set of Gas sensors namely MQ4, MQ7 and MQ135 in order to measure the concentration levels of those gases.

A microcontroller unit processes the sensor values anddisplays in a LCD Display. The concentration level of toxic gases exceeds the specified threshold value means, an actuator gets turn ON and its causes the sprinkler movement. It is preferred to reduce the toxic substance level for some instant. According to the level of concentration workers takes the necessary safety measures before they entered into the manhole.

MQ-4 -Methane Gas Sensor

The methane series gas device detects the concentration of methane series gas within the air associate degreed outputs its reading as an analog voltage. The concentration sensing vary of 300-10000 ppm is appropriate for leak detection. For example, the device might observe if somebody left a stove on however not lit. The device will operate at temperatures from -10 to five0°C and consumes but a hundred and fifty mA at 5 V.

MQ-7 Gas Sensor

Sensitive material of MQ-7 gas device is SnO2, that with lower physical phenomenon in clean air.

It build detection by technique of cycle high and temperature, and observe CO once temperature (heated by 1.5V). The sensor's physical phenomenon is higher together with the gas concentration rising. When hot temperature (heated by 5 V), it cleans the other gases adsorbed under low temperature.MQ-7 gas sensor has high sensitivity to Carbon Monoxide. The device may be accustomed observe completely different gases contains CO, it is with low cost and suitable for different application.

MQ-135 –Air quality sensor

Sensitive material of MQ137 gas device is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conduction is higher at the side of the gas concentration rising. MQ137 gas device has high sensitivity to Ammonia, additionally to different organic alkaline.

III. SYSTEMDESIGN

In the design developed we fixed different sensors at various positions of the stick based on the concentration level of the gases in the underground drainage system. The handheld device is also housed with micro controller, display devices and alert system namely a buzzer which are positioned appropriately to handle the device ergonomically.

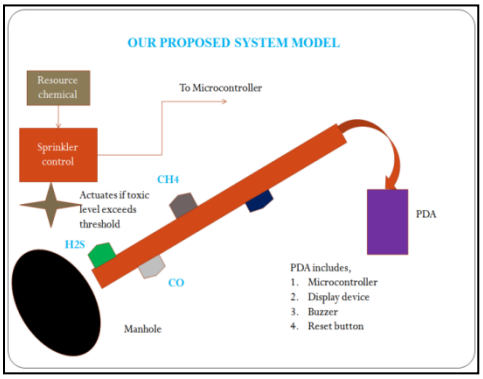

Figure 2.Proposed system design

Figure 3. Hardware module

IV.WORKING

The demonstration of the system design was carried out in the real time environment. The hand held device is inserted into the drainage; it displays the concentrations toxic gases using set of integrated gas sensors at different levels. Arduino board has ATMEGA328P processor and displays gas concentration through sensor values in LCD Display. If a displayed value will be more than the specified value, intimation will be given to the worker through Buzzer module and instantaneously, it will actuate the sprinkler mechanism into the manhole.

A sprinkler mechanism contains the Resource chemical such as a mixture of water and sodium hypochlorite (Bleach) as detoxification agent to reduce the toxic content inside the drainage. After certain period the concentration level of gases will be reduced and provide the favorable working condition for the labors to ensure their safety precautions.

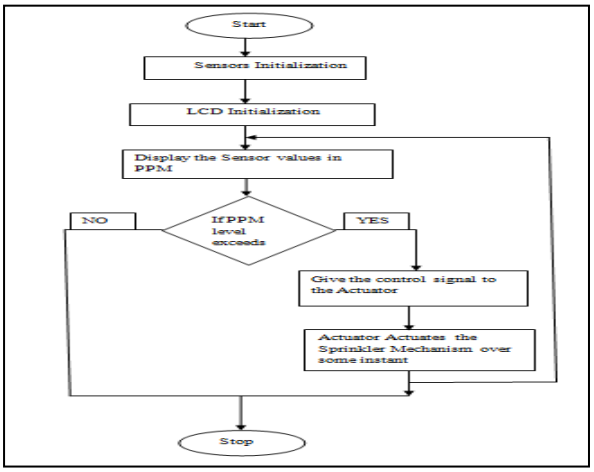

Figure 4. Flow diagram

V. RESULT AND DESCUSSION

The handheld device has been developed and tested under 3 different conditions. Initially, device has inserted into first test bed at particular depth and identify the type of gas .It was repeated for various gas concentrations levels and measured.

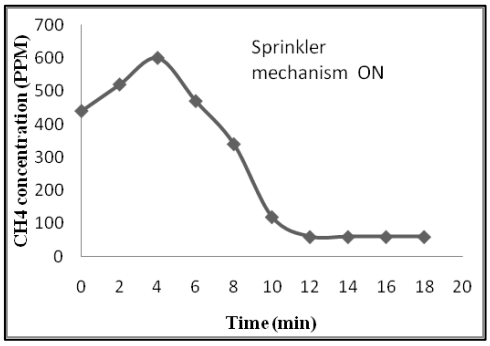

Fig 4. CH_3 Concentration variation with time

Once the concentration level exceeds the predefined value means, automatically actuate the sprinkler mechanism and simultaneously it measures the gas concentration in PPM. In the below, test result, identified that upper threshold limit is reduced to the lower gas concentration level which is convenient for the worker one could expose for a short period of time without suffering from irritation and suffocation. For methane gas, initial gas concentration at 400 PPM and reduced to 50 PPM after sprinkler mechanism gets actuates with detoxification agent. Similarly CO and NH3 were initially measured that 150 and 240 PPM respectively and reduced to 50 PPM.

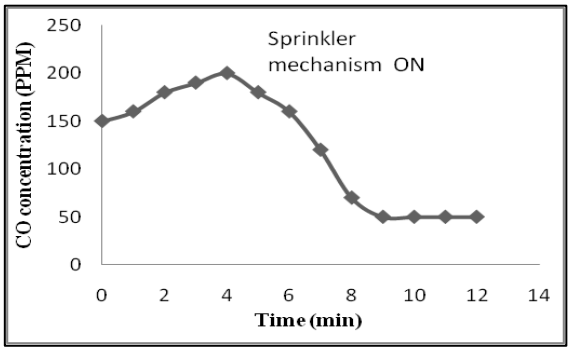

Fig 5. CO Concentration variation with time

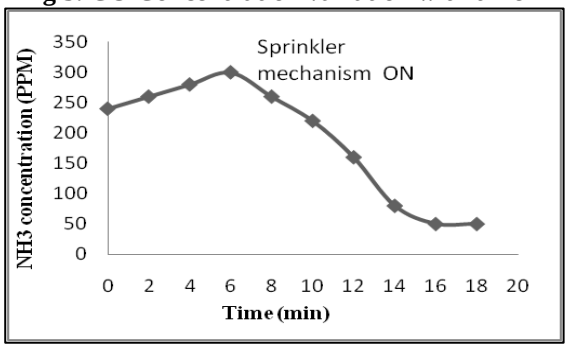

Fig 6. NH_3 Concentration variation with time

The initial virgin gas concentration and final level of gas concentration after sprinkler mechanism is tabulated below for different gases. Refer table 1.

Table 1. Gas concentration Variation Before and after Sprinkler mechanism

S.No	Name of the Gas	Virgin gas concentration (PPM) at various depth	After sprinkler mechanism gas concentration (PPM)
1	CH_3	440	60
2	CO	150	50
3	NH_3	240	50

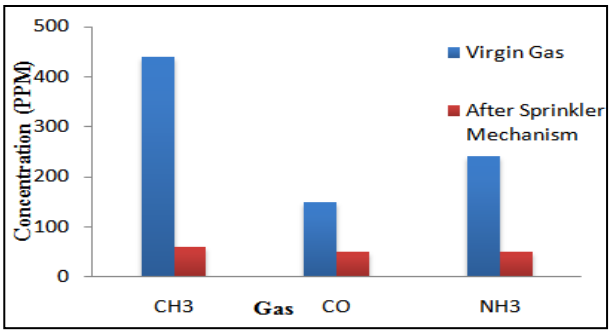

Fig 7. Gas Concentration variation before and after sprinkler mechanism

There are few predominant gases found in the sewage manhole and their respective depth range is show in the table below. Refer table 2.

Table 2.Gas concentration and their depth range

SI.No	Name of the Gas	Depth range (m)
1	CH_3	2-6
2	CO	4-6
3	NH_3	8-10

VI. CONCLUSION

In the developed hardware system for analyzing gas concentration at sewage system has more advantages like easy to handle for labours, cost effective and convenient to use. In the developing countries like India, sewerage cleaning method should have some advancement in order to reduce the life risk of cleaning laborers. The principal applications of the device are toxic gases detection, intimation and minimizing gas concentration level for favorable working conditions. From the test results, predominant gases present in the sewage manhole could to reduce with the help of suitable detoxification agent through the sprinkler mechanism, when the gas exceeds its threshold limits.

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AUTHORS PROFILE

L.K.Hema received her B.E Degree in Electrical and Electronics Engineering from Madurai Kamaraj University, Tamilnadu, in 1990, M.S Degree in Education Management from Alagappa University in the year 2007 and M. Tech Degree in VLSI Design from Sathyabama University in 2009. She has acquired her Doctorate Degree from Manonmaniam Sundaranar University.Since 1991 she has been working as Faculty in the Departments of Computer Science and Engineering, Electronics and Communication Engineering. Her research interests include Wireless Sensor Networks, VLSI Design, Hardware Security and Embedded systems. At present she is working as Professor and Head of the Department at AVIT and engaged in various Governments funded projects. She is the life member of ISTE since 2009 and member in IEEE. Mail Id: hemalk@avit.ac.in, hemjith2005@gmail.com

Pa.Suriya has completed her master's in Soil Mechanics and Foundation Engineering at College of Engineering, Guindy. She has published more than 10 papers in International journals. Her area of research is related to soil stabilization. She is also member in Indian geotechnical society - Chennai chapter, TamilNadu Construction Engineers and Contractors associations, International Association of Engineers and Indian Society for Technical Education.

Mr. VelmuruganS, is an Undergraduate in B.E(ECE) stream at Aarupadai Veedu Institute of technology. He is also the member of IEEE (Institute of Electrical and Electronics Engineering. His Project proposal has been selected as the best project by **IEEE** Madras Section under SPF scheme for financial support.

Ms.R.Indumathi currently working as Assistant Professor in the Department of Biomedical Engineering of Aarupadai Veedu Institute of Technology. She obtained her B.E degree in Electronics and Communication Engineering and M.E in Medical Electronics from Anna University. Her area of research is in Image Processing. Her area of interest includes Medical Instrumentation, Image Processing. She published 10 papers in Scopus indexed international journals. She is member of ISTE.