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Development of H_2S Gas Detection Kit to Avoid Hazards in Septic Tanks

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Abstract

Hydrogen sulfide (H_2S) is a highly toxic and flammable gas commonly found in septic tanks. Its release poses significant health and safety risks to individuals working in or near these environments. This research paper presents the development of an H_2S gas detection kit utilizing lead acetate paper as a cost-effective and reliable method to identify the presence of H_2S gas. The kit offers an accessible solution for monitoring H_2S levels, enabling timely interventions to prevent hazardous situations in septic tanks.

Keywords: H_2S gas, Sensing, Environment safety, Septic tank

1. Introduction

The pertinent literature review reveals the use of septic tanks for a wastewater treatment on the field of tank without accessing the centralized sewage systems.[01-03] Septic tanks are commonly employed in rural and suburban areas to manage domestic wastewater.[4-5] However, one of the significant challenges associated with septic tanks is the production of hydrogen sulfide (H_2S) gas during the anaerobic decomposition process. Hydrogen sulfide gas is toxic, flammable, and has a foul odor. It poses serious health and safety hazards to maintenance workers involved in septic tank maintenance, as well as to nearby residents. Inhalation of H_2S gas can lead to various health issues likes respiratory problems, eye irritation, and even loss of consciousness or death at high concentrations. Therefore, in the 21st century, the concern about the environmental safety and air pollution is the hot topic particularly scientific and technological point of view. [1-9]

Moreover, Landrigan et al., have previously reported that environmental toxic gases are also accountable for greater than one death in four and affect the children health. In 2016, about 7 million deaths were accounted because of household and outdoor pollution, which was fourth highest cause of worldwide death. Therefore, modern buildings, industries, officers, institutes are well equipped with efficient and accurate toxic gas sensors. However, present demand dones not

meet the actual requirement of the H_2S gas-sensing instrument (gas released in the tank wherein we cannot do the test with help of lab equipment). The gas sensing kit should be cost effective, portable, easy to handle.[10]

Given the potential risks associated with H_2S gas in septic tanks, there is a need for effective detection and monitoring systems to ensure the safety of individuals working with or living near septic tank installations. Herein we have attempted the development of an economical and user-friendly H_2S gas detection kit for septic tanks. The aim is to provide a reliable, portable, and user-friendly solution that can detect and alert individuals to potentially dangerous H_2S levels, enabling them to take timely action and mitigate risks effectively. This attempt will create the social awareness about utility of proposed kit and minimize the related hazards of septic tank to achieve economy in construction.

1.1 Methodology

Selecting the appropriate sensing material for a specific methodology depends on various factors, including the target gas, the desired sensitivity and selectivity, the measurement technique, and the application requirements. Here are some considerations for material selection in different sensing methodology are listed below:

1. Gas-specific sensors: For gas detection and monitoring of specific gases like hydrogen sulfide (H_2S), carbon monoxide (CO), or ammonia (NH_3), sensor materials with high selectivity and sensitivity to the target gas are necessary. Metal oxide semiconductors, conducting polymers, and specific catalysts are commonly used as sensing materials in gas-specific sensors.
2. Lead Acetate paper preparation: Preparing lead acetate paper involves steeping filter paper or blotting paper with lead(II) acetate solution. Herein below we have given details about the general procedure for preparation of lead acetate paper:

   Material requirement:

   I. Lead(II) acetate solution (prepared by dissolving lead(II) acetate trihydrate in water)
   II. Filter paper or blotting paper sheets
   III. Glass or plastic container
   IV. Gloves and protective eyewear
   V. Ventilated area or fume hood

   We worked in the in a well-ventilated area under a fume hood to minimize exposure to lead compounds. We wears the gloves and protective eyewear before starting the preparation process. The preparation of lead(II) acetate solution by dissolving the appropriate an equi-molar lead(II) acetate trihydrate in distilled water. Furteher, we cut the blotting paper into small rectangular or circular pieces of same size. But it is large enough

so that one can handle it very easily. Ahead, we poured the lead (II) acetate solution into a glass container. Followed, we have immersed the paper pieces into the lead (II) acetate container solution until paper saturation for 5 minutes. Further, we carefully removed the paper pieces from the solution, and allowed excess liquid to drain off. At the end, removed paper pieces kept in the tray on a clean, flat surface, by ensuring they are separated from each other to prevent sticking until dry completely. This procedure have taken the several hours for completions. Further, we labeled the paper strips to indicate the contents and date of preparation. Moreover, during the course of strips preparation important safety measures have taken.

2. Result and Discussion

Lead acetate strips were used to detect hydrogen sulfide (H_2S) gas by taking advantage of the reaction between lead acetate and H_2S. The study were carried out at Cygnet School Narhe, Pune, dated **28/12/2022.** Herein we mentioned the general procedure for H_2S gas sensing (with the help of lead acetate strips). An experimentally prepared lead acetate stripes were used for the sensing mechanism. The detail procedure for the lead acetate strips preparation were mentioned in the methodology section.

Furthermore, the prepared lead acetate strips (dimensions 01 cm × 05 cm) were bind with the hangers with the help of sticky gum. Followed, all the five strips were dipped simultaneously in to the septic tank under and allow strip to react with any H_2S present in the environment under experimental prevailing conditions. The experimental observation of dipped lead acetate strips into the septic tank shows that, color of the strip changed from no color to dark brown color in the presence of H_2S. Typically, observations of the strips color change with respect to different period is mentioned in the table no 01. The intensity of the color change can indicate the concentration of H_2S gas present in the septic tank. The dilation of color change from low time to high time period shows the change in concentration from low to high of H_2S gas in the tank.

Based on the color change and the reference chart, we can determine the approximate level of H_2S in the tested area. It's important to note that lead acetate strips provide qualitative rather than quantitative measurements, meaning it will give only an indication of the presence or absence of H_2S rather than an exact concentration value.

After the successful completion of the experiment, lead acetate strips were disposed safely. We have repeated the experiment five times and were observed the same results. It shows the repeatability of the experimental procedure and simplicity as compared to conventional available wireless and with wire sensor method.

The detail chart flow of the experiment is given in the below diagram

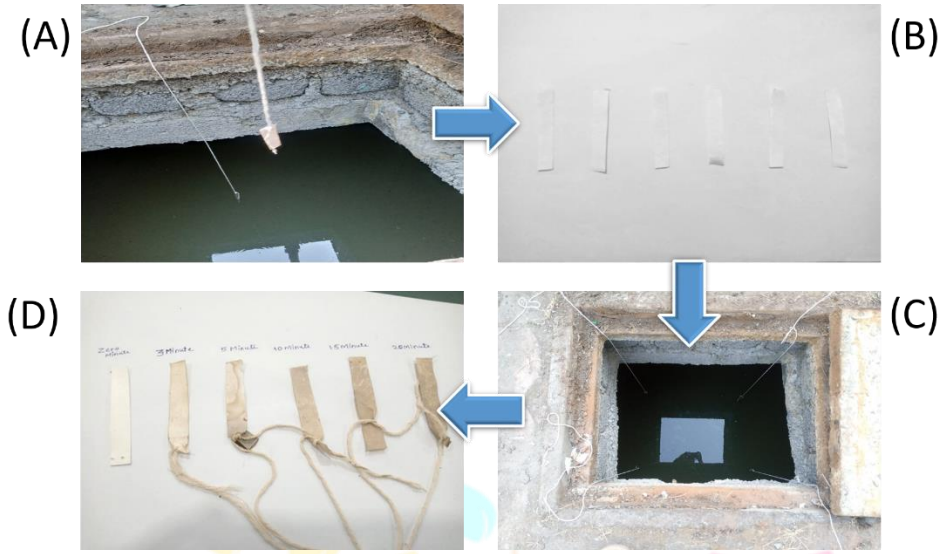

Figure 01: Depicts (A) Septic tank, (B) Prepared lead acetate strips (C) dipped the lead acetate strips in the tank with the help of string and (d) sensed H_2S gas stripes from the tank (under experimental conditions) of H_2S

Sr. No.	Time	Color
1	0 min.	No change
2	3 min.	light brown
3	5 min.	Faint brown
4	10 min.	Medium Brown
5	15 min.	Pale Brown
6	20 min	Dark brown blackish

Table: 01 shows the variation of time and corresponding change in color of lead acetate strips with H_2S gas in septic tank

3. CONCLUSION

In conclusion, lead acetate strips can be used as a simple and convenient method for detecting the presence of hydrogen sulfide (H_2S) gas. The strips undergo a color change reaction when exposed to H_2S, with the intensity of the color change roughly indicating the concentration of H_2S present. However, it is important to note that lead acetate strips provide qualitative results rather than quantitative measurements. Importantly, lead acetate strips can be useful for initial screening of H_2S presence. We believed that, present technique is very useful for quick detection of H_2S gas in the ambience. The technique is cost effective, durable, portable etc have the advantages.

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