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DESIGN AND INSTALLATION OF MONITORING UNIT FOR KITCHEN WASTE HORIZONTAL BIOGAS PLANT

ADHARSH R WALI[1], HANUMANTH A[2], HEMANTH K M[3], SIDDALINGESH J HUGGI[4], MANJULA A V[5]

[1,2,3,4] UG Scholar, Department of Electronics and communication Engineering, NIE Institute of Technology, Mysuru

[5]Associate Professor, Department of Electronics and Communication Engineering,

NIE Institute of Technology, Mysuru

Abstract: Waste generated from many sources are disposed or buried on an open ground, which increases the soil pollution and degrades fertility. Kitchen waste can be efficiently handled to produce biogas. There is a large amount of kitchen waste that is being generated daily and there is no proper system which uses this type of waste effectively. Conventional biogas facilities are inefficient and produce little methane because they rely on low calorific inputs such municipal solid waste, distillery effluent, and animal manure. Although it has not yet been fully exploited, biogas produced from kitchen trash is regarded as a high-calorie feed. It can replace half of the LPG used in cities and works in parallel with expensive and difficult to operate cow dung-based biogas plants in rural regions. In order to generate efficient gas from kitchen waste the pH value in a digester (of plant) should be neutral (i.e., pH=7) and temperature should be around 30℃ to 40℃, so it is essential to monitor the digester and after monitoring it is essential to check the amount of gas generated using gas sensors interfacing to ESP32 microcontroller and displaying the result in LCD.

Keywords: ESP32 NODE MCU; MQ4 SENSOR; MQ135 SENSOR; LCD DISPLAY**.**

I. INTRODUCTION

Due to the lack of oil and coal, the supply of fuel is threatened throughout the world. Additionally, the problem with their burning forces people to look in unexpected places for new sources of energy. Biogas is a sustainable source of energy. However, biogas has the ability to use, manage, and harvest natural fires while also producing compost and water for use in agrarian water systems. In addition to having no geological restrictions and not requiring cutting edge technology, biogas is also quite simple to use and implement.

In non-industrialized countries like India, where the majority of people rely on charcoal and fuel wood as their primary sources of fuel, deforestation is a big problem. This involves the clearing of forested areas. Deforestation also causes soil disintegration, which reduces the maturity of the land. The majority's health is also negatively impacted by the usage of garbage and kindling as energy since the smoke they produce pollutes the air. We are desperate for a greener form of energy.

Kitchen waste is organic material having the high calorific value and nutritive value to microbes, that is the reason productivity of methane creation can be expanded by a few significant degrees as said before. It implies higher effectiveness and size of reactor and cost of biogas creation is decreased. Also, in most of cities and places, kitchen waste is disposed in landfill or discarded which causes the public health hazards and diseases like malaria, cholera, typhoid.

Deficient administration of squanders like uncontrolled dumping bears several adverse consequences: It not only leads to polluting surface breeding of flies, mosquitoes, rats and other disease bearing vectors. Also, it emits unpleasant odor and methane which is a major greenhouse gas contributing to global warming. An approach that shows promise for treating kitchen wastes is anaerobic digestion (AD). In rural areas of non-industrial countries, anaerobic absorption for the treatment of animal manure is common, but information on specialized and functional attainments for the treatment of natural strong waste is scarce in those areas. The design and effectiveness of anerobic digestion are influenced by a variety of factors. Some are concerned with the properties of the feedstock, reactor design, and real-time operational circumstances. The physical and chemical properties of organic wastes are crucial for designing and real-time operation conditions. Because they have an impact on the production of biogas and the stability of the anaerobic digestion process,

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the chemical properties of organic wastes are significant for constructing and operating digesters.
Biogas production from kitchen waste is useful at college level. It is produced when bacteria degrade organic matter in the absence of air, biogas contains around 55% - 65% of methane, 30% - 40% of carbon dioxide and some of Hydrogen sulfide and small amount of other gases, monitoring system helps us to know the amount of gases generated from kitchen waste. The temperature has to be maintained around 35℃ to 37℃ in a digester, this can be achieved by using induction coil and temperature is displayed using sensor which is connected to microcontroller. The pH which is another important factor in biogas production, which is to be neutral (i.e., pH=7) in a digester which is another important part of monitoring system and it is displayed. If pH is altered water should be added to make neutral. All sensors are interfaced to ESP32 microcontroller.

We done monitoring unit for biogas plant which is located in NIE boy's hostel – NIE crest, Mysore, Karnataka.

1.1 Existing System

Existing system mainly concentrating on biogas production and plant maintenance. Natural matter made out of carbon (C), combined with elements like Hydrogen (H), Oxygen (O) Nitrogen (N), and Sulfur (S) to form various organic compounds such as carbohydrates, proteins and lipids. Microorganisms during digestion process breaks the complex carbon into smaller substances. Aerobic and Anaerobic are two types of digestion process. If the digestion process takes in presence of oxygen or if the digestion takes in absence of oxygen are called Aerobic and Anaerobic digestion. Aerobic process produces various gases having carbon dioxide (CO2), one of the main "Greenhouse gases" responsible for global warming.

1.2 Proposed System

The target of this project is to monitor the digester. Monitoring the pH, temperature, CO2, H2S, CH4 helps us to know the percentage of gas produced in digester. For Anaerobic Digestion pH in a digester should be neutral (i.e., pH=7). Varying pH value leads to incomplete or less biogas production. Temperature in a digester should around 30℃ to 40℃, changing temperature leads to less production of methane gas. Monitored pH and temperature value is continuously displayed in LCD, if pH value is altered in digester (whether it is acidic or basic), by adding water makes it neutral and if temperature is varied, induction coil is used to maintain required temperature. Displaying the percentage of gases helps us to know the amount of gas generated after anaerobic digestion.

II. METHODOLOGY

1. Marinating and monitoring temperature in a digester.
2. Monitoring the pH in a digester.
3. Displaying percentage of CH_4, H_2S, CO_2 gases

1. Maintaining and monitoring temperature in a digester:

The process of producing biogas is significantly influenced by the temperature inside the digester. Anaerobic fermentation can occur in three different temperature ranges: psychrophilic (30°C), mesophilic (30°–40°C), and thermophilic (50°–60°C). However, the mesophilic temperature range is where anaerobic organisms are most active. One of the key elements influencing the rate at which microorganisms grow and the production of biogas is temperature. Satisfactory gas production takes place in the mesophilic range and the optimum temperature is 35°C. Induction coil is used to maintain the temperature in a digester, it gets turned ON when the temperature is below the 35°C and turned OFF when temperature goes above 40°C.

2. Monitoring the pH in a digester:

An essential component influencing the growth of bacteria during anaerobic fermentation is the potential of hydrogen, or pH. The pH of the digester should be between 6.8 and 7.2. Methanogenic bacteria are extremely pH-sensitive and cannot survive in conditions below pH 5 and above pH 8. The pH range remains buffered between 7.2 and 8 once the methane production level has stabilized. Digester stability is enhanced by a high alkalinity concentration. A decrease in alkalinity below the normal operating level has been used as an indicator of pending failure. A decrease in alkalinity can be caused by
1) An accumulation of organic acids as a result of methane-forming bacteria's failure to convert the organic acids to methane might result in a drop in alkalinity.

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2) An organic acid slug discharge to the anaerobic digester.
3) The presence of wastes that prevent microorganisms from producing methane.
Alkalinity is a chemical measurement of waters ability to neutralize acids. By adding water to digester, we are maintaining constant pH level. pH is displayed along with red and green light. Red light indicates pH is acid or base, green light indicates pH is neutral.

3. Displaying percentage of CH_4, CO_2 sensors

By calibrating values after testing against different concentration of gases, percentage of CH_4, H_2S and CO_2 is displayed. All sensors are controlled by ESP32 node MCU which is programmable.

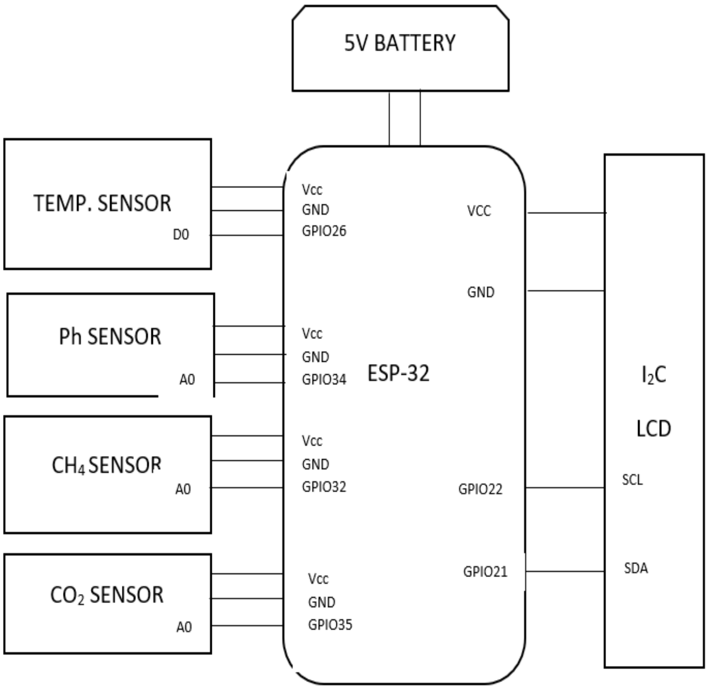
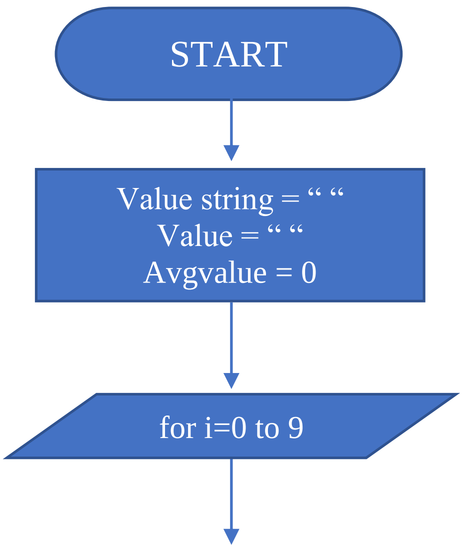


Fig 2.1 Sensors interface to microcontroller.

III.FLOW CHART

3.1 **Flow chart of pH sensor:**



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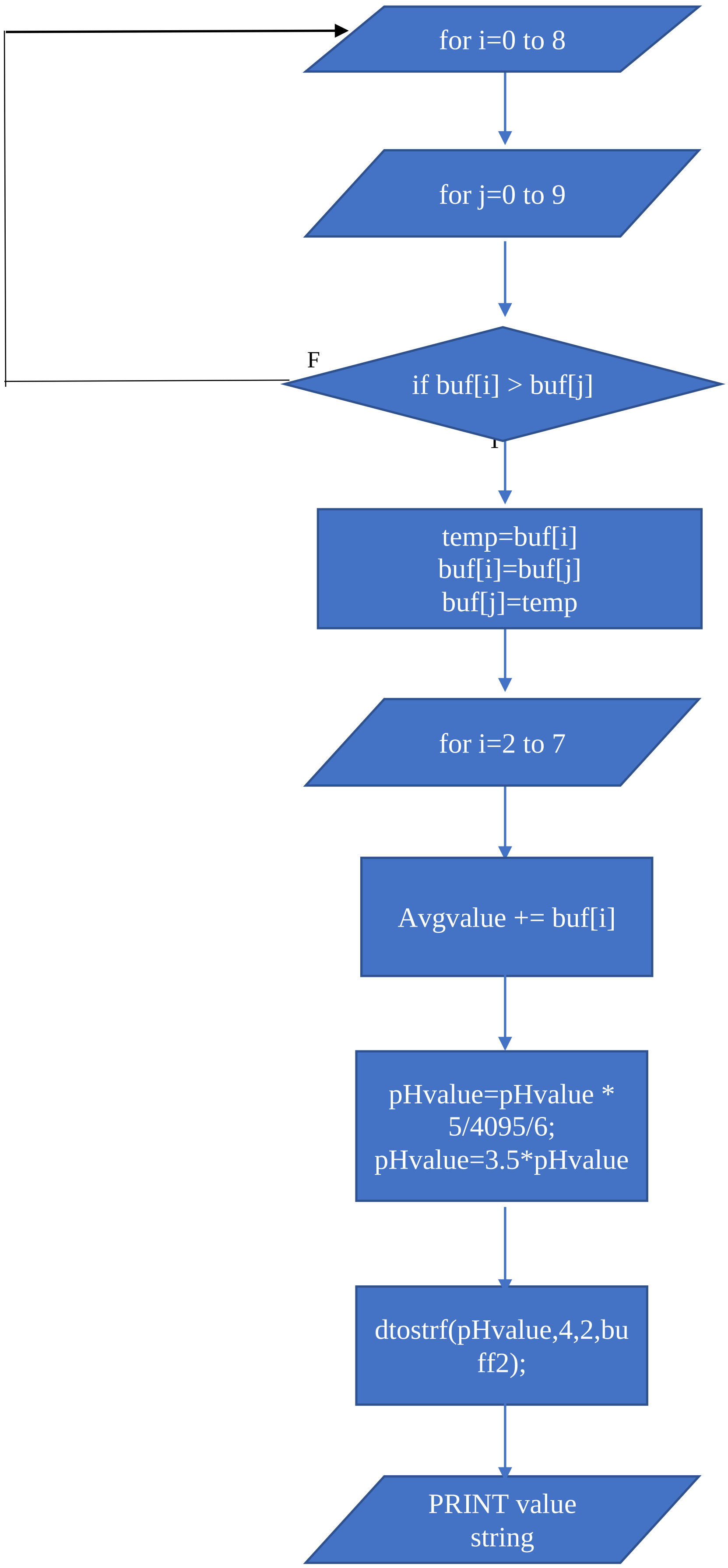

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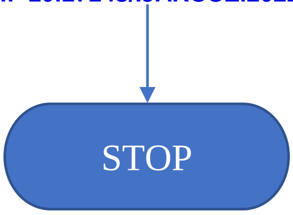
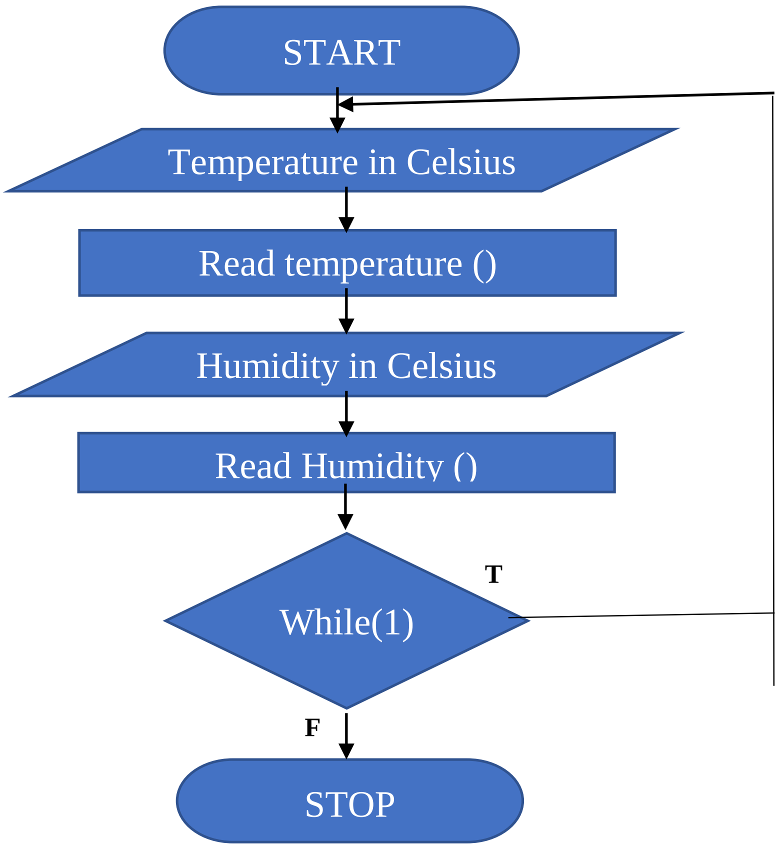


EXPLANTION:

1. Firstly, average value is initialised to zero and string value is initialised and declaring array a[i], b[j] for storing the ADC values.
2. Obtaining 10 Readings of ADC from the sensor and store it in a[j].
3. Storing 10 readings in ascending order in a buf[i].
4. Taking values from buf[2] to buf[7] and take average of the values.
5. Calculating pH values in mill volts.
6. Multiplying with maximum operating voltage.
7. Converting float value into string using dtostrf() function.

3.2 Flow chart of pH sensor:



EXPLANATION

1. Start the process
2. Print temperature in Celsius.
3. Read temperature as analog voltage in the range 0 to 3.3.
4. Print humidity in Celsius.
5. Read humidity as analog voltage in the range 0 to 3.3.

Repeat the loop for continuous value reading the temperature and humidity

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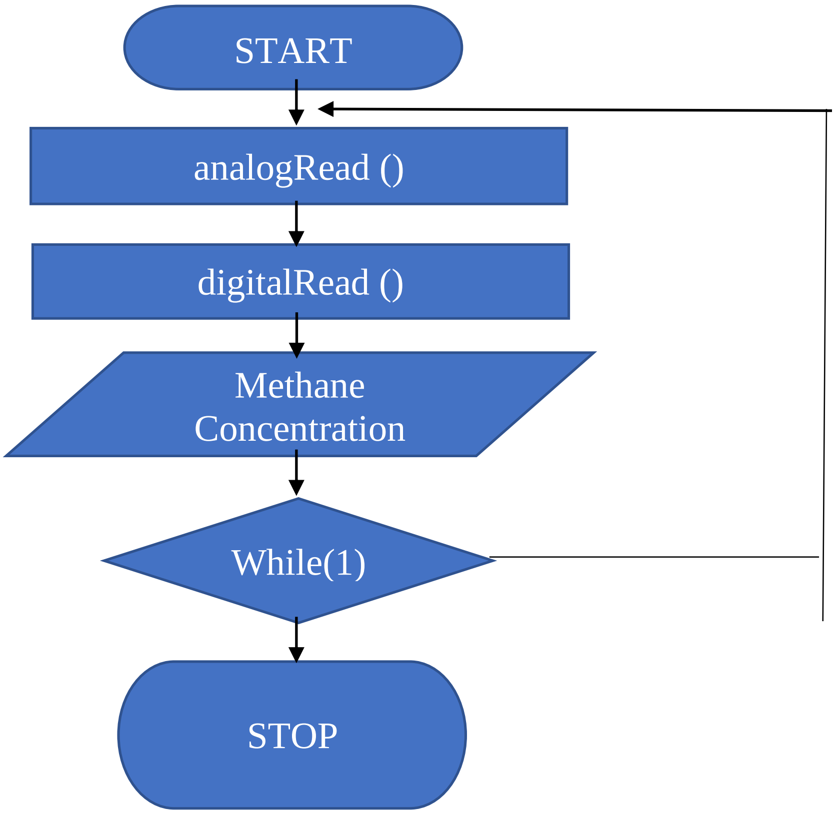
3.3 Flow Chart of Methane Sensor



EXPLANATION

1.Start the process.
2. read analog value from the sensor in the range of 0 to 3.3.
3. since we are using 12bit ADC its maximum value is from 0 to 4095.
4. ch4 = (analog value * 3.3) / 4095.
5. repeat the loop for values for continuous results.
6.Stop the process after taking the value.

IV. RESULTS

By monitoring temperature and pH in a digester, maintaining neutral pH and temperature around 30℃ to 40℃ we are able to generate more efficient biogas which is supplied to hostel kitchen. Using gas sensors, we are able to display the percentage of gas obtained. Which helps us to know the amount of gas generated in a digester.

Fig 4.1 Biogas plant

Fig 4.2 pH calibration

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Fig 4.3 Output in LCD display

V. CONCLUSION

Automation components installed in the plant has reduced the retention period for generation of the bio gas and efficiency of the plant is improved. A constant vigil can be kept on working of biogas plant through the control unit installed to ensure safety and continuous working. This bio gas plant requires less manual interference for during the operation. The bio gas generated in the plant is stored in pressurized conditions to supply the gas easily to applications. This also avoids the use of intermediate pressure building devices. Waste management is better and easier in the plant. The intensity of the flame obtained is improved due to the use of pressurized gas.

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