Economical and Optimal Gas Leakage Detection and Alert System

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Abstract:Safety plays a vital role in today's life therefore it is important to implement a secure, reliable and speedy safety system which response rapidly to avoid any accident before it occurs. The purpose of this work is to design an economical and effective alarming system which detects the leakage of Liquefied Petroleum Gas in the vicinity where it is put into service. The proposed system is designed and implemented to meet the health and safety standards for the gas bank of Hotel Management Department of Dr.B.R.Ambedkar Institute of Technology, Port Blair, Andaman& Nicobar Islands. The proposed system is tested and the results are verified by producing an early warning signal under the less severe condition and activate a high pitched alarm during the leakage of LPG and provide a safeguard to the users.

Index Terms: LPG gas sensor, Proteus, IC-555, Sensor module

I. INTRODUCTION

LPG (Liquid Petroleum Gas)has become the most essential commodity for our daily life. It is a smokeless fuel used for cooking and heating purposes in residential, agricultural and commercial application. It can serve as a fuel for cooking, central heating and to water heating and is a particularly cost effective and efficient way to heat odd grid homes. Increase in the demand of the use of LPG and natural gas for energy which is environment friendly has replaced the oil and coal due to their environment disadvantage. Even though, LPG and natural gas are ecofriendly fuels as they are pollution free and are derived from fossil fuel sources. LPG gas is mainly includes 60% of butane (C_4H_{10}) and 40% of propane (C_3H_8), which is an odorless gas.If leakage of such gas takes place then it mingling into air and replace oxygen which can cause suffocation and ignition can cause terrible fires and devastating explosions. To make LPG gas odorant Ethyl Mercaptan is added. Though, most of the people can't smell the odor of such gas. Therefore, due to gas leakage major accidents took place all around the world and causes both human injuries and financial losses. To stay away from such situation an effort is made to develop an uncomplicated, reliable and economical technique to detect the LPG leakage.

From a survey during the period from "2010" to "2106" it can be found that 17% of fire accidents are due to LPG leakage. There is a necessity of safety systems that provides safety assurance and takes safety measures in the absence of users. Commonly it is ignored as an absolute need for safety but since there are risks from these, there should be a safety system installed for worst case scenarios.

In this work, an attempt has made to design and fabricate a safety device for detecting LPG and natural gas that avoid any accident from the leakage. The proposed device examines the level of LPG and Natural gas as well as the other gases which are composed of propane and butane concentrations in the air and activates the audible alarm when it exceeds the threshold value.

II. BLOCK DIAGRAM OF A DEVELOPED SYSTEM

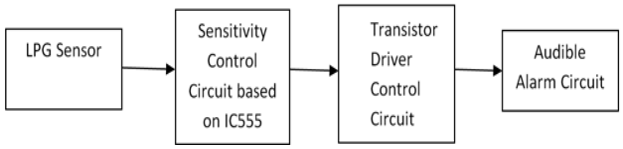

Figure.1. Functional Block Diagram of a System

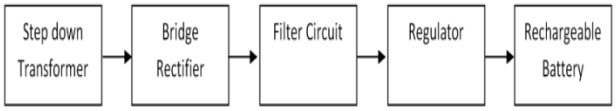

Figure.2. Functional Block Diagram of a Power Supply

Block Diagram Description:

MQ-6 LPG Sensor:

MQ-6 gas sensor is a simple gas sensor suitable for detecting propane and butane gas present in the vicinity around the gas sensor. MQ-6 can detect the leakage of gas in the atmosphere

when the concentration level of the leaked gas is from 200 to 1000 ppm. MQ-6 sensor is highly sensitive for combustible gas such as Propane, Butaneand LPG. The output of a sensor is analog, therefore need a driver circuit. It has fast time response, log life and low cost..

MQ-6 sensor is a 6 pin device used with sensor module, operate on 5 Volts DC which is derived from a Zener based power supply, allows determining when a pre-set LPG gas level has been reached or exceeded. The module uses MQ-6 sensor to sense LPG leak. The MQ-6 can detect gas concentrations anywhere from 200 to 10000 ppm in the atmosphere; its output turns high and produces a signal for further circuitry to activate.

Sensitivity Control Circuit Based on IC 555 Timers:

IC 555 timer is one of the most versatile IC and is used as a monostable and astablemultivibrators, dc-dc converters andtoxic gas alarm and many others. The device is available as an 8-pin DIP (Dual-In-Line Package). The IC-555 is a monolithic timer circuit that can produce accurate and highly stable time delays or oscillation, reliable, easy to use and low cost.In this work 555 works as a square wave oscillator and can provide time delay in the circuit by varying duty cycle from 50% to 100%.

Transistor Driver Control Circuit:

The operation of a transistor depends upon the selection of quiescent point in any of the three regions i.e. active, saturation and cut-off region. Depending upon the transistor biasing, transistor can act as an amplifier (quiescent point stable in active region) as well as a switch (quiescent point stabilizes in saturation (ON) region and in cut-off (OFF) region).

In this work, SL100 transistor is used which is a general purpose, medium power NPN transistor. The transistor acts as an switch, providing a fixed 9 V DC supply through power supply to operate in the desired region of its output characteristic graph. SL 100 transistor is biased in such a way that the presence of signal from pin-3 of IC-55 at base remains the transistor in ON-state and in the absence of base signal, the transistor turns OFF.

Audio Indicator:

Depending upon the application, the audio indicator output may be local, remote or a combination. In this work, solenoid based siren alarm, which is a local alarm which do not include monitoring is used, though may produce sound which may be useful for the people to evacuate during any hazardous condition.

III. SYSTEM OPERATION

Circuit Diagram:

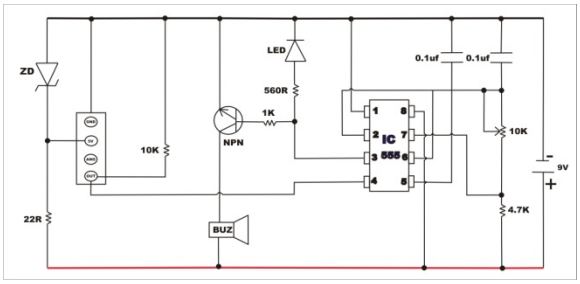

Figure.3. Circuit Diagram of IC-555 Based System

Circuit Operation:

The designed and fabricated Gas Leakage Detector circuit operates on 9 volts DC power supply or through a battery. MQ-6 gas sensor module drives through a 5 volts DC which is provided by Zener Diode, which converts 9 volts into 5 volts and works as a simple voltage regulator circuit. Interfacing with the sensor module is done through a 4-pin SIP header.

Whenever, the concentration level of leaked gas increases above the threshold level of the 200ppm butane (LPG), the OUT pin of the sensor module goes high. The OUT pin of the gas sensor is connected to the pin-4 (i.e. RESET) of the IC-555, which is wired as an Astablemultivibrator, which works as a toned generator.

The pin-3 (i.e. OUTPUT) of the IC-555 is connected with the transistor SL100 and LED through a current limiting resistor of 1KΩ and 560Ω respectively. As pin-3 of IC-555 is connected at the base of the transistor and is sufficient enough to drive the transistor in saturation region (i.e. ON-state). As the transistor is turned ON, the buzzer, which is connected at the collector terminal through a 9 volt DC supply, alarm sounds to alert the user for gas leakage and the LED glows. The pitch of the buzzer can also be changed by varying preset VR (10K).

When the concentration level of the leaked gas decreases below the threshold level, the OUT pin of gas sensor goes low and the transistor again drive in the cut-off region (i.e. OFF-state) and LED gets off.

In this way the change of concentration can be tracked and circuit operates as per the requirement.

IV. SOFTWARE& HARDWARE IMPLEMENTATION

The complete system is designed and simulated using Proteus design software package. Figure.4 &5 depicts the prototype design of the proposed gas leakage detection system which consists of a MQ-6 gas sensor, buzzer, LED and accessory circuitry for sensitivity adjustment.

In software simulation, a test pin is connected to the MQ-6 gas sensor, which is zero which means the sensor is not sensing (0 for OFF state and 1 for ON state). Since the sensing condition is not given yet, both the speaker and LED are in OFF state.

The sensor's sensing condition which is given through the test pin and here both the LED and speaker are in ON state. The simulation represents the sensing condition of the system.

The proposed system works well with power drawn from a constant DC power supply.

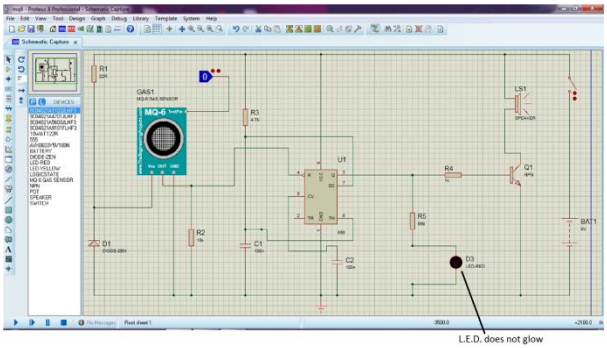

Figure.4. Simulation of Initial Stage

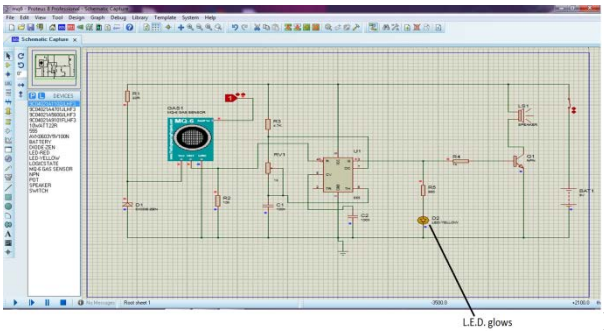

Figure.5. Simulation of Sensing Stage

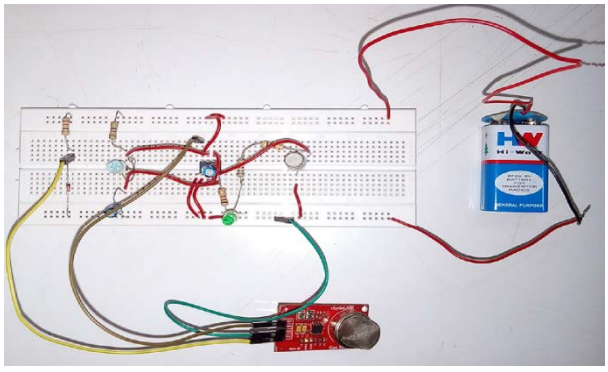

Figure.6. Component fabrication on Bread Board

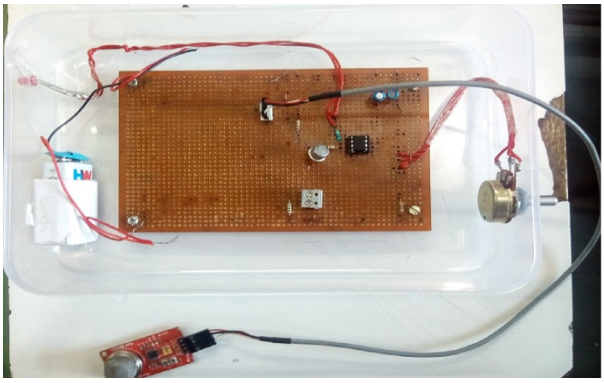

Figure.7. Photograph of Prototype Model

V. TEST AND RESULTS

The testing of the proposed system was carried out using a lighter as a replicate of a LPG gas source. The lighter was held at a long distance to imitate low level concentration and was gradually brought closer to the gas sensor to imitate high level gas concentration.

The proposed gas leakage detector showed an excellent performance and provides satisfactory results regarding the gas leakage for the period of testing. The cost of the proposed system is Rs.375/- which is very less in comparison to the other commercially available gas leakage detector.

The test was carried out several times and the result was the same in almost all of the cases. The sensor takes some time around 1.5 to 2 minutes to get heated and ready to the sense the gases. The sensing time is almost immediate once the sensor is ready to sense. Once the concentration of gas reduces below 30% of the threshold value then the buzzer goes off automatically.

The results are summarized below are as follows:

S.No.	Test Condition	LED	Buzzer
1	No gas leakage	Off	Off
2	Low Level gas leakage	Glow	Sound
3	High Level gas leakage	Glow	Sound

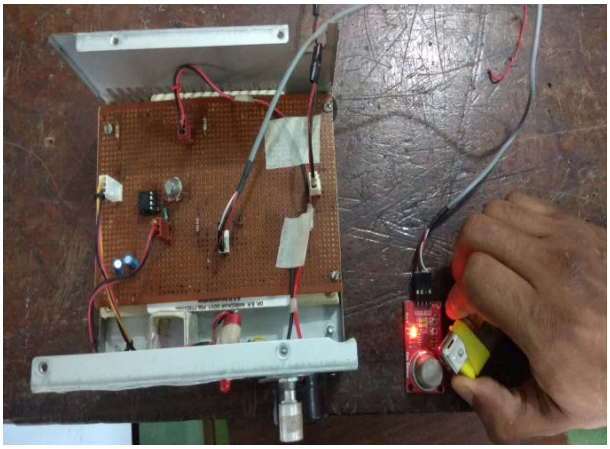

Figure.8. Testing of L.P.G. leakagedetector

VI. CONCLUSION

An economical gas leakage detector system was proposed, designed, fabricated and installed in the gas bank of Hotel Management Department of Dr.B.R.Ambedkar Institute of Technology, Port Blair to meet the safety requirement, which is presented in the paper. The test results are obtained using butane based lighter as a replicate of a LPG gas source. The test result verify the effective and efficient operation of the prototype by detecting low and high gas leakage levels and alert the user by providing a audible alarm warning signal. The cost of proposed system is significantly low and is much less than the cost of gas leakage detector commercially available in the market.

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