Automatic Full Gas Leakage Protection

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***Abstract*:** Electronics field open new trends towards making people life safer. One of its fields: protection systems, especially to serve the human being at their houses. This paper provides solution to LPG leakage. This protection will be done by devices when working sequentially together. When methane gas leaks inside apartment is more likely to cause explosion. This paper has six stages to stop leakage immediately after software received message by a Gas Sensor, which can sense four different types of liquefied petroleum gases (Iso Butane C_4H_{10}, Hydrogen H_2, Methane CH_4, Ethyl Alcohol C_2H_5OH). Gas sensor expected to be more efficient in monitoring detect and smell the Gas which has filaments which can changed the resistance with the respect of quantity of gas, this gas can be monitored by a software. Software can command several different devices to stop leakage. These devices will work in sequences i.e. (closing the valve of the pump, opening the ventilation fan, closing the power circuit breaker of the apartment, switching on the alarm system, dialing the telephone to apartment owner and inform them about the situation . If there is no response from owner, software will automatically start water pump. All these devices work together to provide full protection system.

Keywords- Antifire, Anti-leakage, Gas leakage, protection system

1. Introduction

Sensitive gas sensors are becoming essential for industrial processes, environment monitoring and smart systems. Three important qualities of gas sensors: speed, sensitivity & selectivity which are difficult to achieve in a single system. An inexpensive type of gas sensor is the semiconductor gas sensor, which changes its resistance when in contact with reducing or oxidizing gases. Semiconductor gas sensor is typically made from tin oxide. And that usually added to the gas sensor manufacturing to increase sensitivity to target gases or to improve service life. The major problem associated with tin oxide semiconductor gas sensor is its lack of selectivity. Humidity can also affect its resistance.
Instead of resistance change, change in partial oxygen pressure can also induce oxygen non-stoichiometry in material. Such changes can be detected in the form of mass changes. Sensitive and precise measurements of mass change can be done by using a nano- balance.
A nano-balance operates by detecting mass changes as a function of resonant frequency. The nano – balance can be represented electrically. When mass changes, the resulting resonant frequency shift can be detected using an impedance analyzer. This method can be very precise since the maximum resolution of frequency is very high. A gas sensor can be designed by depositing an active material on top of the resonant material.
In gas sensor, the material used for the nano-balance does not have any interaction with target gases. Resonant frequency can also change with temperature.
These difficulties however can be overcome by using resonator material with limited non- stoichiometry or low oxygen diffusion kinetics and by using a reference nano- balance without any active material for temperature compensation.
With the advent of stringent safety regulations designed to regulate the emission of toxic or environmentally sensitive gases into the atmosphere, the profile of gas sensing has been substantially elevated with a view to creating safer living and working conditions. These issues have fueled a rapid growth in this field with the aim of producing gas sensors that are reliable, selective and cost effective, yet possessing an intrinsic sensitivity permitting concentrations as low as several parts per million (PPM) to be detected. Semiconductor gas sensor, in

particular those based on SnO_2 offer all these inherent properties resulting in potential applications which encompass environmental, industrial, and domestic realms. [2][3]

2. Hardware Used

There are nine major devices used in this paper, starting with Gas Sensor which is connected to main switching board through computer PC, branched with different protection devices.

2.1 Gas Sensor

The Gas Sensor which was connected to external black box with 3 main wires is connected with cab connector. Gas sensor uses 10 volt power supply, needed 5 minutes warm up, high resistance input, hot wire type and sensitive with Methane CH_4 . Refer to fig.1..[1]

Fig.1 Installation of Gas Sensor

2.1.1 TESTING THROUGH CALIBRATION GAS

Making calibrating gas concentration according to volume proportion. After that using gas leak alarm in the calibrated gas. When gas sensor started sensing gas adequately, adjust RP slightly to make buzzer sound. The calibration can be completed by repeating it several times. If the detected gas is LPG, Butane and Propane which is heavier than normal air, then install gas leak alarm about 1.00 meter above ground. Adversely, for Natural gas Methane, coal gas , CO and H2,which is lighter than the normal air, install gas leak alarm about 1 meter below the roof.

2.1.2 CO SENSOR

CO sensor device has a sensor element and a reference element. Each is made up of a coil of Platinum wire covered by alumina. Sensor element has oxidation catalyst layer. When incomplete combustion occurs, CO gas is oxidized on the surface of the sensor element. And electric resistance of the sensor element becomes higher because of oxidation heat, while reference element remains unchanged.

2.1.3 Characteristics

Response and initial action fig. shows changes in the continuous output signal when sensor is exposed to CO and returned to clean air. The effective sensor output signal is obtained every 10 seconds. When sensor is exposed to CO, output signal reaches to approx. 80% of stable level after two cycles.
After switching it to clean air, the detection signal reaches to a stable level after several heat cycles.

2.2 Sound Alarm Detection

Sound Alarm system connected to external black box with Gas sensor, uses 2 volt power supply, Low resistance input.

Fig.2 Installation of Speaker with Gas Sensor

2.3 Wan/ Lan Connector

It has 8 wires. Each wire has its own specification which is connected from this black box to main switch board through long simulator wire.

Fig.3 WAN/ LAN Connector

2.4 Main Switching Board

Main Switching board is the interference between the protection devices, sensing devices and personnel computer PC. Main switching box with 4 I/O connectors: (i) control, (ii) telephone system, (iii) Play/ Record System, and (iv) LPT1 in PC. This box has five power relays for using power control like (Gas Leakage Auto Switching Protection System 12 Volt dc, Exhausting Fan 220 Volt, Alarm system 12 volt dc , Circuit Breaker auto system220 volt and water pump 220 volt AC) . These relays are controlled by LPT1 from PC.

Fig.4 Main Switching Board

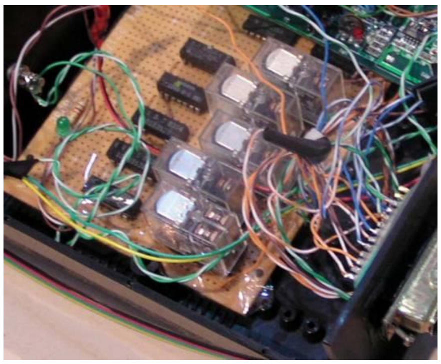

Fig.4 Gas Leakage Auto Switching Protection System

2.5 Gas Leakage Auto Switching Protection System

Gas Leakage Auto Switching Protection System works at 12 volt power supply. On leaking of gas with the help software , this system closes the valve .

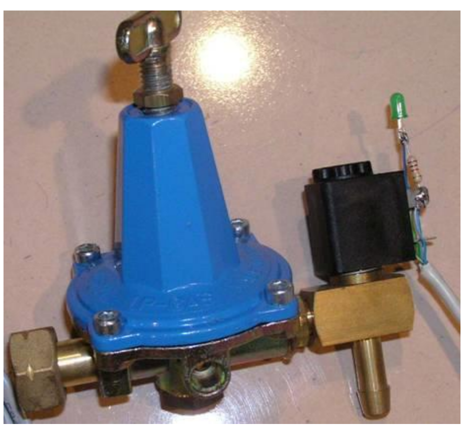

Fig.5 Gas Leakage Auto Switching Protecting System

2.6 Exhausting Fan:
Exhausting Fan works at 220 volt, which is good simulator for the exhausting Fan where is connected through the small control box.

Fig.6 Exhaust Fan

2.7 Auto Switching Circuit Breaker:
Auto Switching Circuit Breaker works at 220 volt , which is a good simulator for the main apartment A1 and A2 connected to 220V, coil feed by normal voltage, low current input with high resistance input. This circuit breaker has three phase connectors which can be coined to 3 phase load 100A.

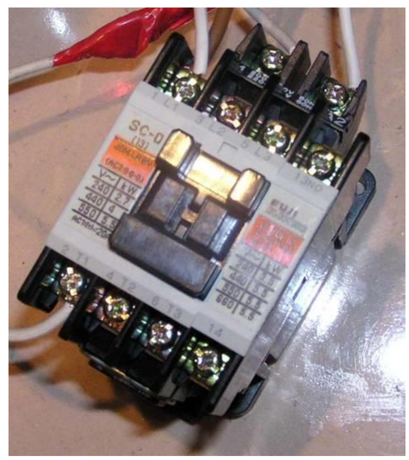

Fig.7 Circuit Breaker with load

2.8 Circling Light Alarm System
Alarm system is a simulator of large alarm system in the site, which uses 12 volt dc power supply and controlled by the small black control box.

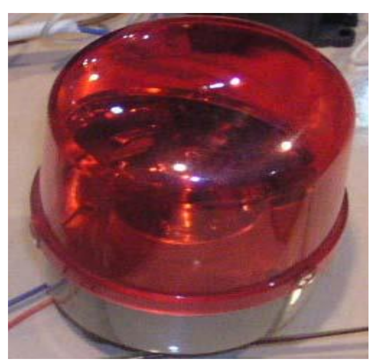

Fig.8 Circling Light Alarm System

2.9 Calling System
The calling system has telephone set with play/recorder set. Computer sends a command to telephone set, which automatically dial to owner of apartment through pressing memory switch through the main switching board and play recorder with personnel voice. Or user can use computer sound of high-quality recorded system. While most all sound boards can play and record sound samples at 10K samples per seconds, a few boards can play and record at CD quality (16-bit samples, 44.1 K times per second). Most cards playback and record somewhere in between these two extremes samples.

Fig.9 Telephone System of Calling Process

2.10 Water Pump System
Water pump device is last step in our protection system. Water pump device is working at 220 volt controlled by small black box.

Fig.10 Water Pump System

2.11 Control Box
Control box is use to simplify control signal to main switching board.

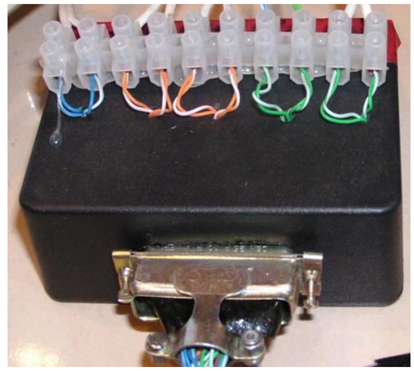

Fig.11 Control box

2.12 Connectors
Connectors are important part in protection system.

Fig. 12 Auxilliary Connectors

3. SOFTWARE USED AND PROJECT MONITORING
QBasic is very easy to use. Almost every single computer included it. Here approach is to converting QB program to VB.

3.1 SOFTWARE PROCESS
Q- basic software used in this paper is to simulate real control devices. The software will initialize and reset hardware components starting with auto switching off valve of gas pump and by ending water pump of fire protection. Figure show simulation of 8 rooms apartment with main entrance in middle of monitor. In the middle of monitor there is a message box which keep updating about current situations.

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Fig.13 Main Monitoring System of Automatic Gas Leakage Protection

3.2Gas Leakage Indicator

When gas start leaking, suddenly gas sensor passes 5 volt to computer LPT port pins to indicate software that gas started leaking. As shown is fig.14, now message is coming as "warning gas leakage".

Fig.14 Main Monitoring After Gas leaked

3.3 First Step of Protection

The software will wait for15 seconds before closing gas valve. Main box will send 12 volt through high power relay working by LPT1 command. After 10 seconds software checks gas again around gas sensor, if it's found then software will move to second step of protection.

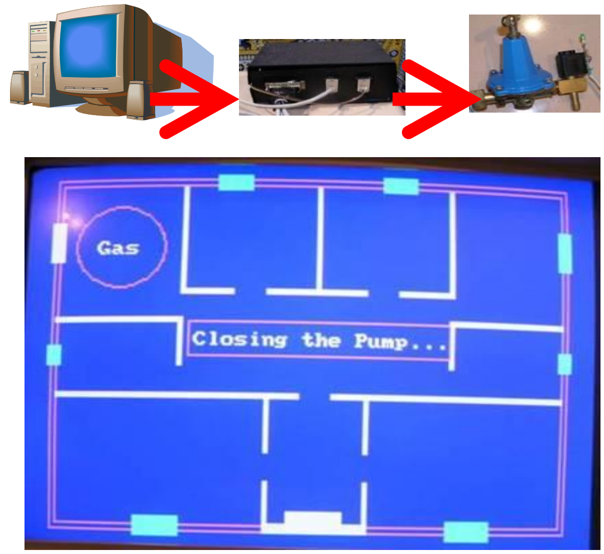

Fig.15 Software closed valve

3.4 Second Step of Protection

Second step of protection is to operate the exhausting fan. Main box will send 12 volt through high power relay working by LPT1 command. After 10 seconds software check again gas around gas sensor, if it's found then software will move to third step of protection.

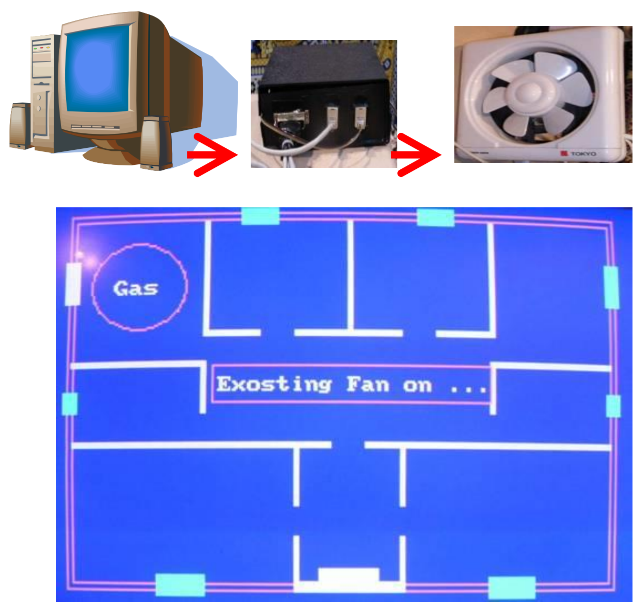

Fig.16 Software switch on exhaust fan

3.5 Third Step of Protection

Third step of protection is to turn off main circuit breaker of the apartment. Main box will send 220 Volt AC through high power relay working by LPT1 command. After 10 seconds the software check again the gas around the gas sensor, if it's found then software will move to the fourth step of protection.

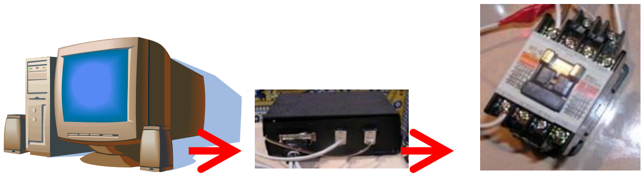

Fig.17 Software turn off the breaker

3.6 Fourth Step of Protection

The fourth step of protection is to operate the alarm system. The main box will send 12 volt DC through high power relay working by LPT1 command.
After 10 seconds the software check again the gas around the gas sensor, if it's found then software will move to second step of protection.

Fig.18 Software turning on alarm system

3.7 Fifth Step of Protection

The fifth step of protection is to calling the apartment owner by dialing his number and inform him about situation. The main box will send 3 volt DC through high power relay working by LPT1 command.
After 10 seconds the software check again the gas around the gas sensor , if it's found then software will move to the last step of protection.

3.8 Last Step of Protection

The process will be finalized by operating water pump device by software . These stages in protection system helps form gas leakage.

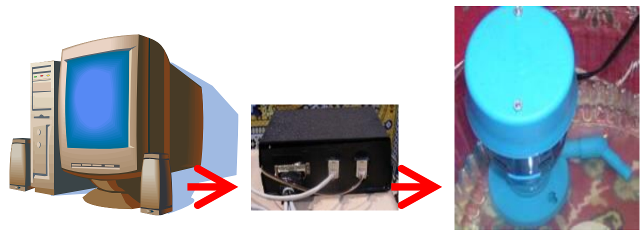

Fig. 19 Software turns on water pump device

RESULT & CONCLUSION

Main benefits of this paper are complete automation protection from gas leakage. Its task is to allocate protection over set of dispatch able gas generation devices in such a way as to determine the optimal combination of Gas Protection system, which minimize the total effect of gas leakage of gas while satisfying all system constraints. The problem is traditionally solved using gas sensing and quick basic programming. In order to realize main objective, set out in this paper, the author has felt the need for the development of a software package based on basic language to analyze and investigate gas in the environment and operate full product of protection system. The steps done to protect gas leakage is very useful , all steps are logically good and that be done to decrease the level of gas.
Finally, the author of paper believes that this work could further extended for a more comprehensive development on the impact of Leakage Gas Protection devices. The following aspects may address:
(1). Leakage Gas Protection by Using Programmable interface controller devices system.
(2) Increase the number of protection devices add to that (SMS massage, calling multiple of telephone numbers, calling through the internet).

References

1. Ji Yuan Fan & Lan Zhang, "gas sensors modification and emission allowances in multi-use purposes of modern protection systems ", IEEE Spectrum , Vol. 13 , NO.2 , May 1993.
2. Kwang Y. Lee & June Ho Park, ' Adaptive Chemical system based on defective numbers of gases through sensors ', IEEE , Spectrum , Vol.13 No.2 , May 1991.
3. O.Alsac and B.Stott , ' Optimal gas flow in certain chemical approach to the calculation gas flow in the air and devices , IEEE , environments protection of Engineering Committee , Canada , July 15-20, 1990.
4. Nailu Li, Yan Xu & Heng Chen , ' Steady state model models of several gas sensors protection systems and their application ',Spectrum -400- PWRS-0-11-1999.
5. P.K. Dash , A.K. Pradhan , G. Panda and A.C. Liew , ' apparent gas leakage control and the optimim protection system used, 'spectrum-040PRD (06-99).
6. R.Ramanation , efficient and reliable process to detect gases and standard carves of multiple gases in the world ', IEEE spectrum , Vol. PAS-104 ,No.7 , July 1985.
7. E.J.de Oliveira , J.W. Marangon Lima & K.C. de Almedia , ' Allocation and introduced Gas protection protocols and theories , PE-414-PWRS-0-03-1999.

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