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Simplified Chemical Approach For Monitoring, Controlling And Conversion Of Greenhouse Gas

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Abstract

The objective of the regulation, control and conversion system of Greenhouse gases are not only for reducing the level of the carbon dioxide but also to convert the them into a useful by-product. The absorption of carbon from various sources is firstly done by suction fans and they are compressed to some pressure. The air containing carbon dioxide is passed to flow through the carbon capture solution and finally it precipitates into useful carbonate solution. The carbonates are then used for other product-based manufacturing. Therefore, a large scale of about 80% carbon dioxide is reduced by this project. The advantage of the proposed system is that, the users will be able to monitor and get a display about the CO_2 value. The physical system is interfaced with the computer with the help of the Arduino. The proposed system uses pH sensor to detect the levels of carbon dioxide in the capture solution. This project will bring forth the tremendous reduction in the levels of carbon dioxide. Also, this is the most economical method of controlling CO_2 compared to the electrolytic precipitation and artificial diamond formation.

Keywords: CO2 Measurement; pH measurement; Conversion, control.

1. Introduction

There are various forms of gases in earth's atmosphere. Ozone layer acts as blanket to protect the earth from the harmful ultraviolet rays of the sun. The increased level of carbon dioxide in the atmosphere lead to greenhouse effect [1-3]. This effect absorbs the heat from the sun during the sunny time and dissipate in the atmosphere causing the rise in the heat levels. This resulted in the increase in the ocean levels and extinction of the aquatic life forms. The aim of this proposed work is not only to reduce the carbon dioxide levels in the atmosphere but also to convert the hydroxide solution in to carbonate precipitate which can be used for certain by products. The CO_2 levels are monitored both at the input and the output of the process tank. The efficiency of the output air is measured [4,5].

2.Existing Methods

In the year 1970, the Carbon Capture and Sequestration method was established. This method mainly focused on storage of the exhaust carbon dioxide under the ground in huge reservoirs. But this method was a commercial one and it certainly has some limitations. They are:

- The regular monitoring of reservoirs is needed to check the level of storage and formation of cracks.
- There should be a frequent checking of pressure in the reservoirs to avoid the explosion.
- Since, the gases occupy more space, the pressurization of CO_2 to liquid state needs to be primarily done for storing it.
- This pressurization of CO_2 leads to more expensive with increased complexity.

Some recent advancements have emerged for the management of the carbon dioxide. The Researchers have developed a model that would convert the carbon dioxide into an efficient nano particle [6-8]. The carbon dioxide is absorbed by the lithium electrodes and they are directly converted into carbon nano particles. Recent study reveals that China has started investing huge amount for converting the atmospheric carbon dioxide into artificial diamond [9-13].

3. Proposed system

Greenhouse gas monitoring, control and conversion system helps in developing a control system where the carbon dioxide emission is managed in a chemical methods. This conversion system uses Arduino controller for the display and monitoring carbon dioxide level. Firstly, the carbon capture solution is pumped

from the reservoir tank with the help of the motor pump by the centrifugal action. The tank is filled up to the desired level. It is measured by the float type level sensor. The sensor shows the maximum resolution as it moves up. This will be considered as the set point for the level controlling mechanism. When the level reaches the set point the motor pump goes off. Now the suction fan is turned on. It will suck the external air into the solution. The air has many constituents. The air containing CO_2 is allowed to bubble through the carbon capture solution. The pH of the solution is monitored by the pH sensor. Based on the pH values the control action will be taken in the disposal of the final product.
Since the carbon dioxide is acidic in nature, it will react with the calcium hydroxide to form the salt solution. Note that calcium hydroxide is basic in nature. When the pH value reaches the acidic nature, the output drain valve will be opened. When the pH value is greater than the set point, it has a basic nature of value and the output drain valve will be closed. The suction process will then commence soon.
The carbon dioxide concentration will be measured (in ppm) in the inlet and outlet through MQ-2 /MQ-135 sensor. Based on which the concentration of carbon dioxide is measured and finally the efficiency of CO_2 in the exhaust is calculated. The Block diagram is shown in Figure.1, where the process acts as a batch process. Level control process occurs first in the sequence and then the pH control process.

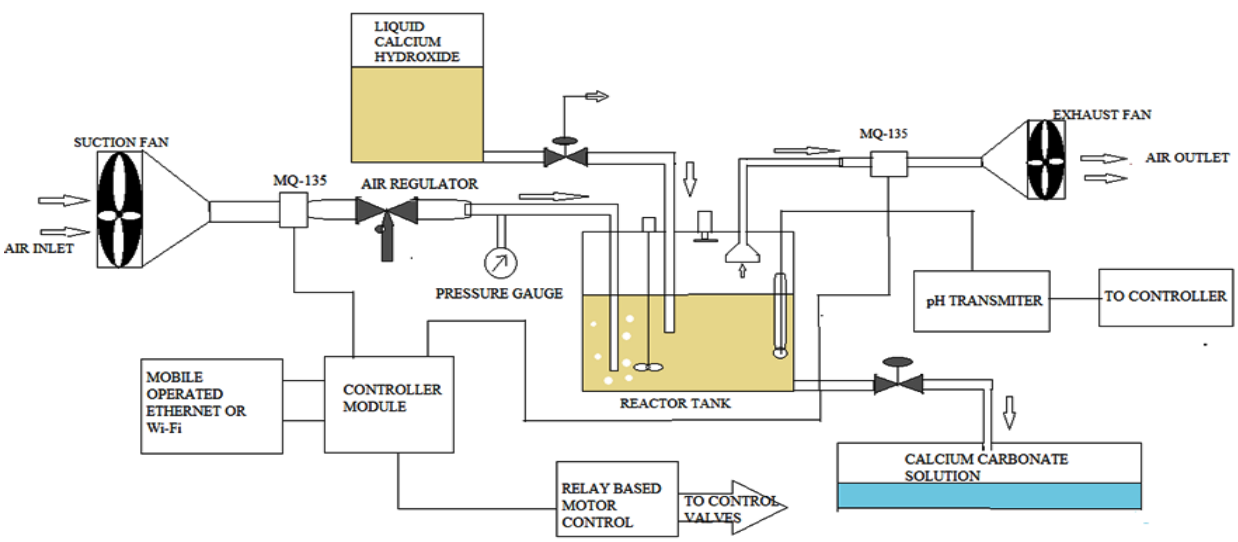

Figure.1 Block diagram of proposed system

Table 1 gives the values of pH values of chemical components.

Table 1: pH Values of chemical components

Component	Nature	pH value
Carbon dioxide	Slightly Acidic	6.2
Calcium Hydroxide	Highly Basic	12.4
Calcium Carbonate	Slightly basic	9.91

4.Implementation of the proposed model

The proposed model is implemented with experimental set up using Arduino for interfacing.

4.1Arduino Processor

It is an open-source platform which is used for applications like reading of inputs, detecting light from a sensor, to identify a finger impression on a button to activate a motor and to switch on LED based on instructions. It can also be possible to know the actions of the board by sending a set of instructions to the micro controller on the board. To perform the aforementioned applications the Arduino programming language, and the Arduino Software (IDE) have been used. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It consists of the components required to support the microcontroller .It is connected with a computer using a USB cable and powered by an AC-to-DC adapter or battery .Figure.2 Shows the Arduino processor.

Figure.2 Arduino processor

4.2 pH SENSOR

Analog pH meter is appropriately designed for Arduino controllers. It has some features like practical gravity and Bayonet Neill–Concelman (BNC) connector.

The connection made between probe and arduino will indicate pH measurements at ± 0.1pH accuracy at 25℃. This unit offers great accuracy range with low cost. It is provided with an LED as an power indicator, a BNC connector and PH2.0 sensor interface. The pH sensor is connected with BNC and PH2.0 interface is plugged into the one analog input port of Arduino controller. The pre-programmed sensor will indicate the pH value easily . The bulb of the pH sensor is always immersed in 3N KCl solution .

4.3 Specifications of a pH sensor

Table –2 provides the specifications of a pH sensor.

Table 2 specifications of a pH sensor

Parameters	Range
Module Power	5.00V
Module Size	43x32mm
Measuring Range	0 - 14PH
Measuring Temperature	0 - 60 ℃
Accuracy	± 0.1pH (25 ℃)
Response Time	≤ 1min

pH Sensor is shown is shown in Figure.3

Figure.3 pH Sensor

The measure of potential difference between two electrodes such as a reference electrode (silver / silver chloride) and a glass electrode that is sensitive to hydrogen ion is used to quantify the value of pH.

4.4. Float Type Level Sensor

All float type liquid level controllers operate on the principle of buoyancy effect. As a result, float travels on the liquid surface partially submerged and moves the same distance the liquid level moves. Owing to this, it is preferred for narrow level differential applications. Another type of level controller known as Magnetrol which makes use of simple float and magnetic coupling action. In this controller, the switching action is caused by swich actuating magnet when magnetic sleeve moves on it depending on the float level. The isolation between switch and controlled liquid is provided by non-magnetic barrier tube.

Float type level controls are available for top and side mounting and also for external cage applications. The operating range of temperature and pressure possibly for the floats are +1000° F and 5000 psig with specific gravities as low as 0.32. Standard models are also available for interface control (float rides on the interface between two liquids). The Float type level sensor and its operational structure are shown in Figures.4 &5 respectively.

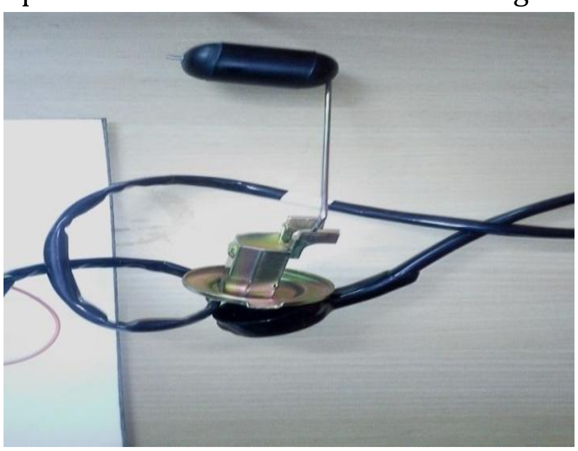

Figure.4 Float Type Level Sensor

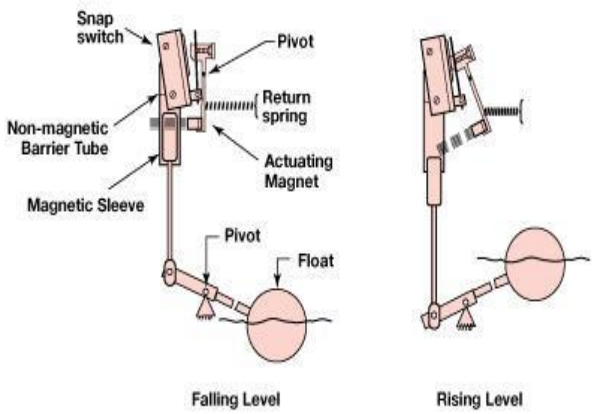

Figure.5 Operation of Float type level sensor

The Figure.5 describes the rising and falling action of the float type level sensor.

4.5.MQ-2 Smoke Sensor

The Groove - Gas Sensor (MQ2) module is appropriate for gas leakage detection in home and industry. It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. The measurement is possible at all times due to its high sensitivity and fast response time, The sensitivity of the sensor can be adjusted by potentiometer

The main features of the CO_2 sensor are:

- Wide detecting scope
- Stable and long lifetime
- Fast response and High sensitivity

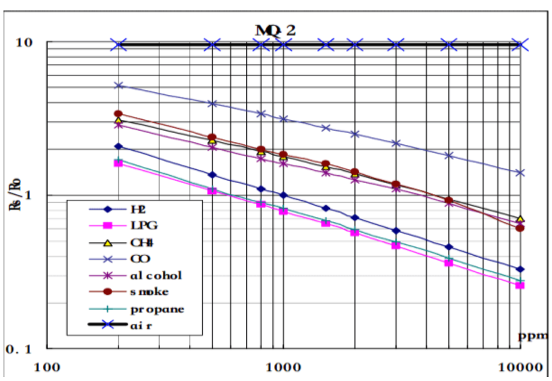

Figure.6 Plot for measurement of various gases by MQ-2 smoke sensor

According to the society of International Standards of Calibration and Measurement the graph plotted for various gases as measured by the MQ-2 smoke sensor is shown in Fig.6 where the increase in the concentration is inversely proportional to the decrease in the constant value.Fig.7 Presents the MQ-2 Smoke Sensor

Figure.7 MQ-2 Smoke Sensor

5. Other Hardware Components

5.1 Inlet Pump

A pump with 12 or 24 volts is commonly preferred for recreational vehicles like caravans, motor homes or boats, and even small homes. The advantage of DC pressure pumps over 230V household pumps are:

- More energy efficient
- Smaller in size
- DC powered

DC pumps run directly off your 24 or 12 volts battery bank without a need of an inverter. Due to this inverter losses are eliminated which normally occur when battery power is converted to AC power. The 24V/12V DC pumps consume about 40-200 Watts which may be a fraction of highly efficient 230V household pressure pump.

5.2 Output Solenoid Valve

A solenoid valve, also known as an electrically-operated valve. It is an automatic valve does not require manual operators. It uses an electromagnetic solenoid coil by which the state of a valve is changed from open to closed, or vice-versa. Solenoid valves can be selected for control in applications, where process media is clean (non-viscous), like very clean liquids/gases/light oils. It is chosen due to its quicker response than other valve technologies. some solenoid valves is operated using more advanced technology in which the flow or pressure can be controlled proportionally in accordance with input variations.

6. Calibration of pH Sensor

There are two potentiometers in the pH circuit. In which one is closer to the BNC connector of the probe and used for offset regulation. The another one is used for monitoring the pH limit.

Offset: The average range of the probe oscillates between negative and positive values. The 0V represents a pH of 7.0. In order to be able to use it with Arduino this circuit adds an offset value to the value measured by the probe, so the ADC will only have to take samples of positive voltage values. Therefore, it is forced for a pH of 7.0 by disconnecting the probe from the circuit and short-circuiting the inside of the BNC connector with the outside. Using a multimeter the value of Po pins is measured and the potentiometer is adjusted to be 2.5V pH Limit. This potentiometer is to set a limit value of the pH sensor circuit that causes the red LED to light up and the Do pin signal to turn ON. In addition, the voltage conversion is done to convert pH reference value and measure the voltage returned by the sensor on the pin Po. The best thing to do is to use a calibration solution. These solutions are sold in different values but the most common are pH 4.01, pH 6.86 and pH 9.18. Fig.8 pH versus Voltage

Graph of the measured voltage and pH equation. y= -5.70 * x + 21.34 .Using the pH 4.01 and pH 6.86 the voltages on the pin Po 3.04V and 2.54V respectively can be obtained. The sensor is linear so by taking two points the equation can be deduced to convert the measured voltage to pH. The general formula would be y = mx + b, so we need to calculate m and b since x would be the voltage and y the pH. The result is y = -5.70x + 21.34.

7.Result

This method provides an efficient way of utilising small amount of power, capture, cost and design to produce larger output. The photo of entire hardware set up is shown in Figure.9.

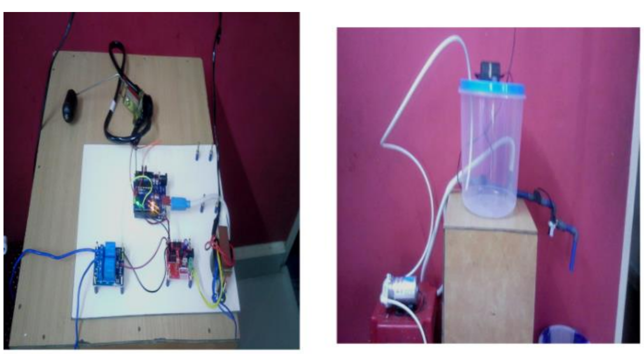

Figure.9 Experimental Set up

The following readings were taken during the measurement of CO_2 from vehicular exhaust.

Inlet concentration of CO_2= 960 ppm
Outlet concentration of CO_2= 724 ppm
Efficiency (in %) = (724/960)*100 = 75.416%
The results obtained during the pH testing were follows:
Initial condition of $Ca(OH)_2$ = 12.14
Addition of CO_2at time (t = 60 Secs) = 10.98
Addition of CO_2 at time (t = 120 Secs) = 9.10
Addition of CO_2at time (t = 180 Secs) = 7.23 (which if further less than the pH value of $CaCO_3$.
The resources are cheap and are available in larger amounts. It is also non-hazardous when compared to carbon capture and storage.

8. Conclusion and Future Scope

The above proposed project can be implemented on large scale basis. They can be set-up in the places where there is a minimal chances of plant vegetation to absorb CO_2 (such as deserts). The future aims in developing a mesh structure where continuous capturing of CO_2 is possible by the capture solution flowing over the Nano scale mesh. This still increases the area of the absorption.

REFERENCES

[1] Omaye, T, "Metabolic modulation of carbon monoxide toxicity" ,Toxicology 180 (2)(2002
) pp:139–50,
[2] Jirage, G., Jadhav, B.,Kadam, P. "Portable Wireless Liquid PetroleumGas leakage Detection". International Journal of Electronics, Electrical and Computational System. May 2016. ISSN 2348-117X, Volume 5.pp:31-34
[3] Chen, C., Tsow, F., Campbell, K., Iglesias, R., Forzani, E., Tao, N., "Awireless hybrid chemical sensor for detection of environmenal volatile organic compounds", IEEE Sens J. 2010 May; 13(5): 1748–1755.
[4] De Nevers, N., "Air Pollution Control Engineering," McGraw-Hill chemical Engineering Series. 1995
[5] Nidhra, S., and Dondeti, J., Black Box and White Box Testing Techniques - A Literature Review. International Journal of Embedded Systems and Applications (IJESA), Vol. 2, No. 2, pp. 29-50.June 2012
[6] Ministry of Healthy, Hazardous Materials and Its Impact on Human Health, Environmental Health Impact Project Sub. 1996
[7] Fauzy Satrio Wibowo et al, Developing Portable Instrument Based on Internet of Things for Air Quality Information System 2017, IEEE International Conference on Signals and Systems.

[8] Veronica F. Grasso,Draft report United Nations Environment Programme (UNEP). Early Warning Systems: State-of-Art Analysis and Future Directions.https://na.unep.net/geas/docs/early_warning_system_report.pdf/)
[9] Diego Fernando Baquero Hernández et al,Advances, Processes today, methods of Control and Automation for greenhouse gases for crops. International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 1 (2017) pp. 62-67
[10] Carbon engineering IEA World Energy Outlook Special Report on Climate and Energy June 2015
[11] Anonim, "Nest Protect Smoke & Carbon Monoxide Alarm", Battery (2ndGen), (Online). (https://www.amazon.com/Nest-Protect-CarbonMonoxideBattery/dp/B00XV1RCRY/)
[12] 2017 Carbon Engineering Background
https://www.youtube.com/watch?v=mG9FZ9zqOdo
[13] Myers, G., Sandler, C., and Badgett, T. The Art of Software Testing.Canada: John Wiley & Sons, Inc. 2012.
[14] Carbon Engineering - Industrial-scale capture of CO2 from ambient air.