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PORTABLE MULTI GAS ANALYSER

KANURI UDAYA SHANKAR[1], DONARUN DAS [2]

Temple Adventures, Puducherry,I ndia

Abstract - *The main objective of this research and development project is to create a highly efficient and cost-effective device capable of monitoring the composition of gasses in a scuba diving air tank. The importance of this device cannot be overstated, as it plays a crucial role in ensuring the safety and well-being of divers during their dives. With multiple gasses present in the tank, it is essential to accurately measure their proportion and concentration in the air tank.. To achieve this goal, we have carefully selected a range of sensitive and precise sensors that are integrated with a 32-bit microcontroller. This combination allows for continuous data collection and monitoring of various parameters, including oxygen percentage, carbon dioxide and carbon monoxide concentrations in parts per million (ppm), volatile organic compound (VOC) index in points, temperature in Celsius, humidity percentage, and pressure levels in bar/psi. The collected data is then displayed on a high-resolution TFT LCD screen, providing real-time updates and alerts for any changes in gas levels. To ensure uninterrupted operation, the device is powered by a lithium polymer battery charged by a specialized module with current protection. Every detail has been meticulously designed and implemented to offer accurate readings and optimal functionality for divers' safety and peace of mind.*

Key Words*: *Multi gas analyser, Oxygen, carbon dioxide and carbon monoxide, volatile organic compound (VOC), temperature, Humidity, Tank pressure, Sensor unit, Micro controller, TFT LCD Display, lithium polymer battery, battery charging unit.

1.INTRODUCTION

The multi-gas analyser, also known as a gas monitor or gas detector, was an advanced instrument designed to measure and track the levels of multiple gasses in an air tank simultaneously. Its complex system was specifically calibrated to accurately detect and monitor the concentration of oxygen, carbon dioxide, carbon monoxide, temperature, humidity, pressure, and volatile organic compounds (VOCs) in real-time. Despite its superior capabilities, this state-of-the-art in-line multi-gas analyser boasted a surprisingly affordable price when compared to other models on the market.

2. EXISTING SOLUTION

When it comes to detecting gasses and collecting data from Scuba diving air tanks, there are several sensor technologies for detecting gasses and collecting data. These advanced tools are especially useful in Scuba diving, allowing divers to monitor the contents of their air tanks with precision and accuracy.From laser-based spectrometry to electrochemical sensors,these devices offer a range of methods for detecting different types of gasses in underwater environments. With the aid of these innovative tools, divers can safely explore the depths of the ocean while ensuring the quality and safety of their breathing air.

2.1 Fourier Transform Infrared (FTIR) Spectroscopy

FTIR analyzers utilize the power of infrared light absorption to meticulously examine various gas molecules, enabling simultaneous testing of multiple gasses. With advanced technology, these analyzers provide constant, real-time monitoring of gasses at incredibly low levels, with precision down to parts-per-billion (ppb) or even parts-per-million (ppm). This capability is unmatched and vital in industries where gas levels must be closely monitored for safety and efficiency.

2.2 Gas Chromatography (GC)

The complex mixture of gasses is expertly separated into its individual components through the use of GC analysers for precise analysis. With remarkable sensitivity and accuracy, a multitude of gasses can be sequentially measured using a variety of columns and detectors, revealing their unique properties and proportions. This advanced technology allows for a thorough understanding of gas mixtures, providing valuable insights for various industries and research fields.

2.3 Photoacoustic Spectroscopy (PAS)

The revolutionary photoacoustic effect is harnessed by PAS analysers to precisely identify and measure gasses. These advanced instruments are able to detect the subtle changes in sound waves that occur when gas molecules absorb modulated light, allowing for unparalleled

accuracy in measurement. With this technology, it is even possible to simultaneously detect and measure multiple gasses at once, making it a vital tool in a variety of industries. The intricate process of gas analysis becomes effortless and efficient with the utilization of the photoacoustic effect.

2.4 Electrochemical Sensors

As scientific advancements continue to evolve, portable gas analysers have become a crucial tool in monitoring the levels of various gasses. These advanced devices utilize electrochemical sensors, which work by creating an electrical signal through a chemical reaction that corresponds to the concentration of the target gas. These sensors are integral components in multi-gas analysers, as they allow for the simultaneous monitoring of multiple gasses using different sensor cells. The precision and accuracy of these electrochemical sensors make them essential tools in ensuring safety and detecting potential hazards in various environments.

3. PROPOSED SOLUTION

After careful consideration, we have proposed a revolutionary concept - the creation of a compact, portable multi-gas analyser. This advanced device would utilize a collection of cutting-edge sensors, including electrochemical and non-dispersive infrared (NDIR) sensors, to accurately measure and analyze an extensive spectrum of gasses. From common pollutants such as oxygen (O2), carbon dioxide (CO2), and carbon monoxide (CO), to more complex compounds like volatile organic compounds (VOCs), this marvel of technology would provide comprehensive data on the Air Tank. Additionally, This instrument would revolutionize the field of gas analysis and pave the way for unparalleled accuracy and convenience in research and diving applications.

3.1 Gas Detection

The advanced technology of multi-gas analyzers includes specialized sensors with the ability to detect and measure the levels of various gasses. These may include vital gasses such as oxygen (O2), crucial for sustaining life, or harmful gasses like carbon dioxide (CO2) and carbon monoxide, capable of causing serious health hazards. Each sensor is meticulously calibrated and fine-tuned, ensuring precise and reliable readings for each gas present in the environment. With this powerful tool, accurate information on gas concentrations can be obtained quickly and efficiently.

3.2 Sensor Technology

The multi-gas analyser was a complex machine, equipped with an array of sensors designed to detect a multitude of gasses. The catalytic bead sensors were particularly effective at identifying combustible gasses, while electrochemical sensors were commonly used to sniff out poisonous ones. Infrared sensors were highly sensitive to carbon dioxide (CO2) and hydrocarbons, capturing even the slightest trace of these potentially dangerous gasses. And for volatile organic compounds (VOCs), the photoionization detectors (PID) were the go-to sensors. With its integrated sensor technologies, this versatile analyser had the ability to monitor and measure a wide range of gasses simultaneously. It was a crucial tool in ensuring safety and protection against potential gas hazards.

3.3 Portable Design

In order to meet the diverse requirements of different work environments, multi-gas analyzers are meticulously crafted to be compact. These vital tools are designed with convenience in mind, often boasting a lightweight construction and user-friendly operation. Their compact design allows for easy transport and use in various settings, ensuring they are readily available when needed most.

3.4 Calibration and Maintenance

The multi-gas analyser, a vital tool in accurately measuring gas levels, requires routine calibration using recognized calibration gasses to ensure precise and reliable readings. To guarantee its peak performance and reliability, the analyser must undergo regular maintenance tasks such as sensor replacement, battery charging, and thorough sensor cleaning. These tasks are crucial in ensuring the accuracy and efficiency of the analyser, making it an indispensable tool for any gas monitoring situation.

3.5 Block diagram of Multi Gas Analyzer

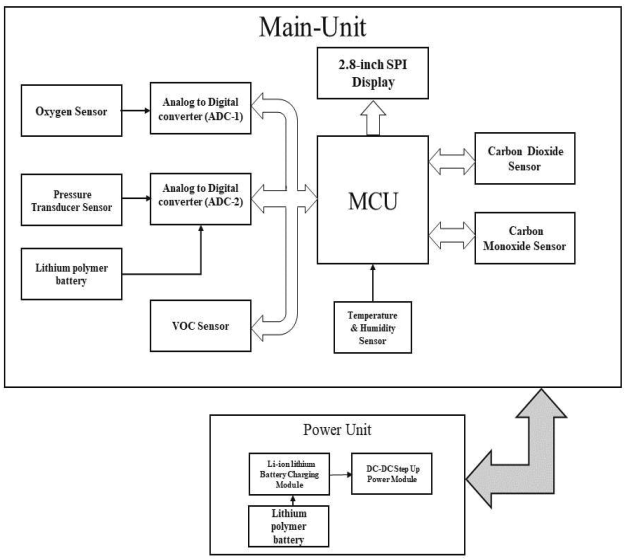

Figure.1: Block diagram for multi gas Analyser.

This advanced multi-gas analyzer is equipped with a state-of-the-art oxygen sensor that accurately measures the oxygen levels, a highly-sensitive carbon dioxide sensor that calculates precise ppm values, and a specialized carbon monoxide sensor for detecting even the slightest traces of this dangerous gas. Additionally, it features a temperature humidity sensor to monitor the Air tank's temperature and humidity, while a VOC sensor measures the concentration of volatile organic compounds (VOCs) in scuba diving oxygen tanks. To ensure accurate readings, this device also includes a high-precision pressure sensor capable of predicting the air pressure inside the oxygen tank in both imperial and metric units. The collected data from these sensors is neatly displayed on a large 2.8-inch SPI display, providing users with real-time updates on their gas levels. This advanced system is powered by a powerful 32-bit microcontroller which supports various communication protocols such as UART, SPI, and I2C for seamless integration with other devices and equipment.

The oxygen sensor and pressure transducer, with their faint output signals, were meticulously converted from analog-to-digital by a state-of-the-art 16-bit converter. This advanced ADC boasted an impressive array of selectable output ranges and customizable gains, allowing for precise control over the conversion process. The delicate inputs were transformed into digital data with very high accuracy and efficiency.

The central unit will be powered by the power unit, drawing energy from its lithium polymer batteries. These Li-po batteries are designed specifically for use in power units, providing efficient and reliable storage of energy. To charge and discharge the batteries, li-ion polymer charging modules are used, ensuring safe and controlled transfer of power. This module is also equipped with short circuit and over voltage protection, as well as automatic cut-off to prevent any potential hazards. The maximum output voltage of the charging module is 4.2V, but to overcome this limitation we have incorporated a DC-DC Step up module into our design. This powerful component boosts the voltage to 5V, allowing for smooth and consistent operation of the entire system.

4. ADVANTAGES

1. Effortlessly portable and stylish in design.

2. Maintenance requires minimal effort.

3. Allowing for ease of use.Boasting impeccable accuracy and impressive sensitivity.

4. This device sets the standard for precision. Not only is it efficient in its function, but it also conserves energy through its use of a lithium polymer battery.

5. This makes it an affordable option to purchase.

6. Keep track of your readings with ease on the large, vibrant color display designed for optimal monitoring.

5. APPLICATIONS

1. Commercial Diving, SCUBA Diving.
2. Industrial Emissions Monitoring.
3. Indoor Air Quality Assessment.
4. Environmental Monitoring.
5. Process Control in Chemical Industries.

6. RESULT

We crafted a sleek and intuitive user interface for the display, designed to simplify understanding and swiftly provide accurate readings for each gas. The layout is clean and modern, with bold fonts and easy-to-navigate menus. Its functionality mirrors that of a finely-tuned machine, effortlessly displaying precise values for every gas with just a few taps. Our goal was to create a user experience so seamless and effortless that even a novice could master it in minutes. And we succeeded.

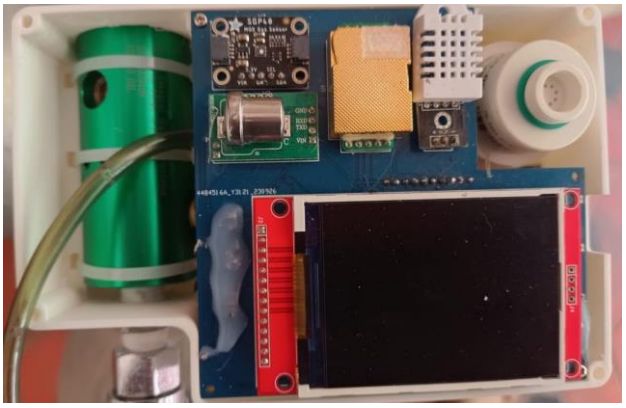

Figure-2: Device Overview

Figure-3: Initializing Sensors

Figure.4: updating the sensor data.

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The air was thick with a mixture of gasses - O2, MOD, CO2, CO, and VOCs. The temperature and humidity levels were constantly monitored, along with the pressure in the tank and the percentage of battery remaining. Every second, these crucial elements would be updated and analyzed to ensure safety and efficiency in this situation.

7. CONCLUSION

Our project is dedicated to meticulously analyzing the levels of various gasses in different Air tanks. Our cutting-edge device boasts unparalleled precision, reliably detecting all gasses with consistent success. Its compact design makes it incredibly portable and effortless to transport to any location.

Thanks to its automatic calibration feature, each sensor is fine-tuned for optimal accuracy as soon as the device is powered on. Within a mere 2 to 5 seconds, our instrument delivers a response, making it perfect for time-sensitive situations. It's no wonder this apparatus is frequently chosen for Tank's air quality assessments.

With a built-in battery that lasts for three to four hours, our instrument offers long-lasting power without sacrificing portability. Its high sensitivity level ensures that even the slightest changes in air composition are accurately displayed on the screen. To achieve such precise readings, we utilize low-power sensors that boast exceptional accuracy and sensitivity, all powered by a 5V DC source. Additionally, our 32-bit power-efficient controller optimizes workflow for seamless operation.

8. FUTURE SCOPE

In the years to come, this innovative device will undergo significant upgrades and advancements. Additional features and options will be added, such as the ability to detect and filter out additional harmful gasses like helium, Nitrogen Oxide (NOx), and Sulphur Dioxide (SO2).

To further enhance its capabilities, this device may become directly connected to our smartphones, providing constant access to real-time readings. It is also possible that this gadget will be utilized in indoor air purifiers for even more effective results. Furthermore, efforts will be made to improve the accuracy levels of the device, ensuring optimal performance and precise measurements.

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