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DEVELOPMENT OF pH VALUE DETECTION SENSOR FOR WATER TO DETECT AND AUTOMATE WATER NEUTRALIZATION PROCESS

[1]Mr. V. Ganesh Ram, [2]Dr. D. Aravind*

[1]Lecturer, [2]Assistant Professor

[1]School of Marine Engineering and Technology (SMET),

Indian Maritime University – Chennai Campus, Chennai – 600119

[2]University Science Instrumentation Centre (USIC),

Madurai Kamaraj University, Madurai – 625021

Abstract: Water pollution is one of the severe problems that have crippling effect on public hygiene. This paper proposes a suitable method to detect and perform corrective measures using sensing components to aid maintenance of water quality. In the money conservative market like India, less importance is given for public hygiene and there is a general myth that any quality monitoring system would be costly and complex in its operation. Water is a universal solvent and in nature, it is never totally pure. No matter how for isolated, it is from sources of contamination, it will always have some chemicals. Gases or minerals in the air, soil, or rock are dissolved by the water. Some dissolved materials give water its characteristic taste, and "pure water" is generally considered to be flat and tasteless. Our main purpose is to identify and treat to remove unwanted constituents in the water and to make it safe or fit for a specific purpose in industry or domestic applications. We are making our system portable and compact, to process only upto a certain limit as it is a prototype. The development of pH electrode plays a major role for this research. Resistance is measured for various levels of water, where non-linear resistance identifies the pH value. Each individual liquid has a different resistance level for the pH. As resistivity is directly proportional to the current & voltage. The methodology presents a self-developed pH level indicator that measures pH level of the water. The end process gives quality water for people usage and indicates the same with its auto monitoring system.

Index Terms **- Automation, Testing, Microcontroller.**

1. Introduction

Water is a transparent, tasteless, odourless, and nearly colourless chemical substance, which is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. It is vital for all known forms of life, even though it provides no calories or organic nutrients. Its chemical formula is H2O, meaning that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds. Water is the name of the liquid state of H2O at standard ambient temperature and pressure. It forms precipitation in the form of rain and aerosols in the form of fog. Clouds are formed from suspended droplets of water and ice, its solid state. When finely divided, crystalline ice may precipitate in the form of snow. The gaseous state of water is steam or water vapor. Water moves continually through the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

2. pH

pH stands for 'potential of Hydrogen' which measure the acidity or alkalinity of water soluble substances. It is measured with a logarithmic scale known as pH. An acid is a substance that donates hydrogen ions that is when in a solution there are more hydrogen ions than hydroxide ions, the solution will be acidic. A base is a substance that accepts hydrogen ions that are when in a solution there are more hydroxide ions than hydrogen ions, the solution will be alkaline. The pH value of any solution is numerically equal to the logarithm of the inverse of the hydrogen ion (H+) concentration. Hence, the pH of solution is referred to as the negative logarithm of hydrogen ion.

$$pH = -\log [H+]$$
$$= \log 1/ [H+]$$

- pH of Neutral Solution (Pure Water): pH of water is 7. Whenever the pH of a solution is 7, it will be a neutral solution. Such a solution will have no effect on any litmus solution or any other indicator.
- pH of an Acidic Solution: All the acidic solutions have a pH less than 7. So, whenever a solution has a pH less than 7, it will be acidic in nature and it will turn blue litmus into red as well as methyl orange pink and phenolphthalein colourless.
- pH of a Basic Solution: All the alkaline solution has a pH of more than 7. So, whenever a solution has more than 7 values then it will be basic in nature and it will turn red litmus to blue, methyl orange to yellow and phenolphthalein to pink.

2.1 Importance of pH

- **In Agriculture:** By determining the pH of the soil. We can find whether it is acidic or alkaline. This helps in deciding the type of fertilizer to be used and the types of crops to sown.
- **In Biological process:** By knowing pH we can adjust the medium of biological processes like fermentation, enzyme hydrolysis, sterilization etc.
- **In corrosion research:** By measuring the pH of sea-water, the effect of alkaline sea-water on the material used for building ships and submarines is studied.

3. Objective

- To develop a sensor for measuring standard of water.
- To purifying measured water through automated process.

3.1 Need

- Water quality is essential for better living.
- Now days the water is polluted by many ways.
- Automated process of purification is required in fast-phased world.

4. Chemical Testing

It is possible to detect thousands of chemicals in water, even at extremely low concentrations. The ever-growing list of tests that are available can feel overwhelming, and the vast majority of methods require state-of-the art lab facilities. Fortunately, we don't need to test for everything! A much smaller and more practical set of tests can provide a good sense of chemical water quality for monitoring purposes. The good news is that there are low-tech versions of these tests for situations when budgets are limited.

4.1 pH Testing

pH indicates the sample's acidity but is actually a measurement of the potential activity of hydrogen ions (H+) in the sample. pH measurements run on a scale from 0 to 14, with 7.0 considered neutral. Solutions with a pH below 7.0 are considered acids. Solutions with a pH above 7.0, up to 14.0 are considered bases. All organisms are subject to the amount of acidity of stream water and function best within a given range. The pH scale is logarithmic, so every one-unit change in pH actually represents a ten-fold change in acidity. In other words, pH 6.0 is ten times more acidic than pH 7.0; pH 5 is one hundred times mores acidic than pH 7.0.

4.2 Salt Testing

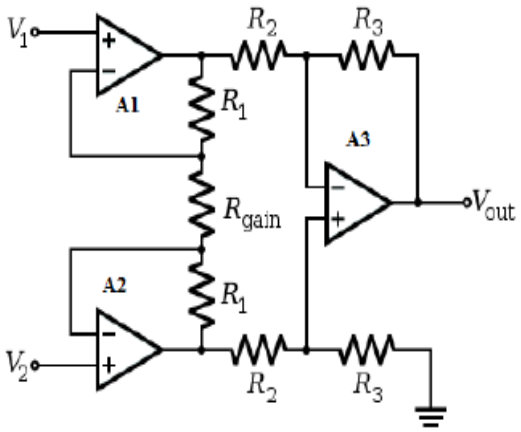


Figure 1: Instrumentation Amplifier

- **Formula**

V0 = (V1-V2) (1+2/a)

Where, a = RG/R

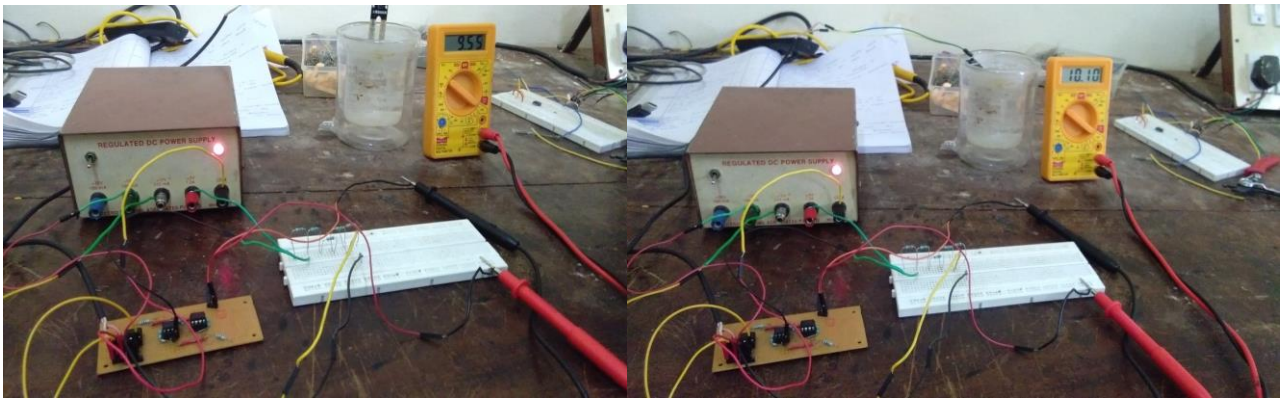


Figure 2: Self – developed pH level indicator

An Instrumentation amplifier is an integrated circuit (IC) used to amplify a signal, which is a type of differential amplifier because it amplifies between two input signal. In industries, physical quantities are converted into electrical signals using transducers and the signal is amplified for signal processing.

S.no	pH level	Salt level
1	0-7	5
2	7	10
3	7-14	8

Table 1: Concentration levels

Salinity refers to the concentration of soluble salts in soil or water. All natural waters contain some dissolved salts such as sodium, magnesium and calcium. Sodium chloride (table salt) is the most common of all the salts; it is the main constituent of seawater. Salts based on calcium and magnesium also affect the hardness and alkalinity of water. The level of salt in water affects its suitability for irrigation, stock and domestic use. Collecting samples of farm water and measuring salinity levels will enable landholders to make better use of limited water resources.

4. 3 Neutralization Testing

- **Governing Equations:**

$Hcl+NaOH \rightarrow Nacl+H_2O$

$CH_3cooH+NaHco3 \rightarrow CH3cooNa+H_2co_3$

$HNo_3+NaOH \rightarrow NaNo_3+H_2O$

$Hcl+KOH \rightarrow Kcl+H_2O$

$H_2SO_4+2NaOH \rightarrow Na_2SO_4+2H_2O$

5. Methodology

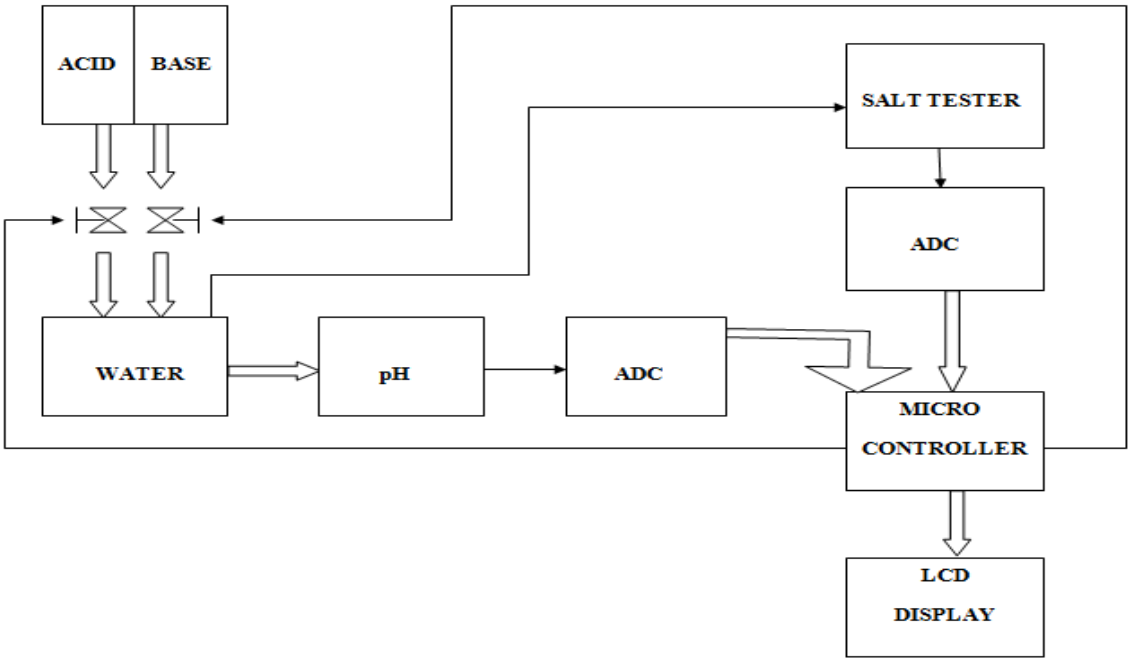


Figure 3: Block diagram of the system

5.1 System description

In this system the main purpose is neutralization process. This method has two main things (i.e) acid and alkaline (base).The whole system is controlled by microcontroller. The controller read the values of pH and salt. It is a kind of open loop system after that it will read the pH level of chemicals.

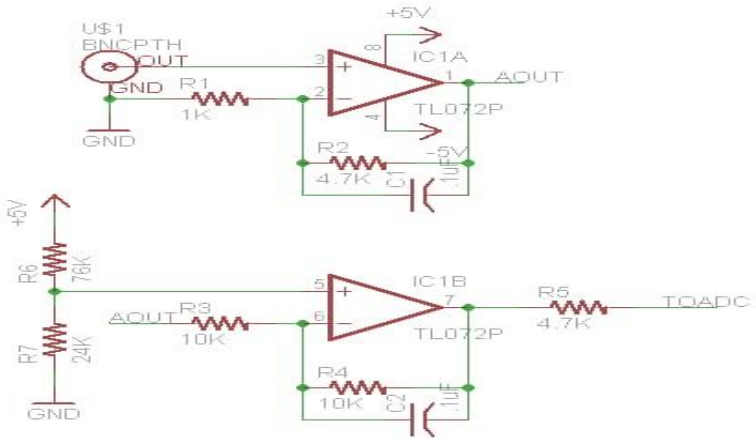


Figure 4: Amplifier circuit:

Adding the pH electrode as a input resistor(non-linear) limits the differentiators increase in gain at a ratio of Rf/R_{IN}The circuit now acts like a differentiator amplifier at low frequencies and an amplifier with resistive feedback at high frequencies giving much better noise rejection. Additional attenuation of higher frequencies is accomplished by connecting a capacitor Cf in parallel with the differentiator feedback resistor, Rf. This then forms the basis of a Active High Pass Filter as we have seen before in the filters section.

$$V_{out} = -R_F C\,(dV_{IN}/dt)$$

5.2 PCB Design

The circuit was developed in PCB by using eagle software.

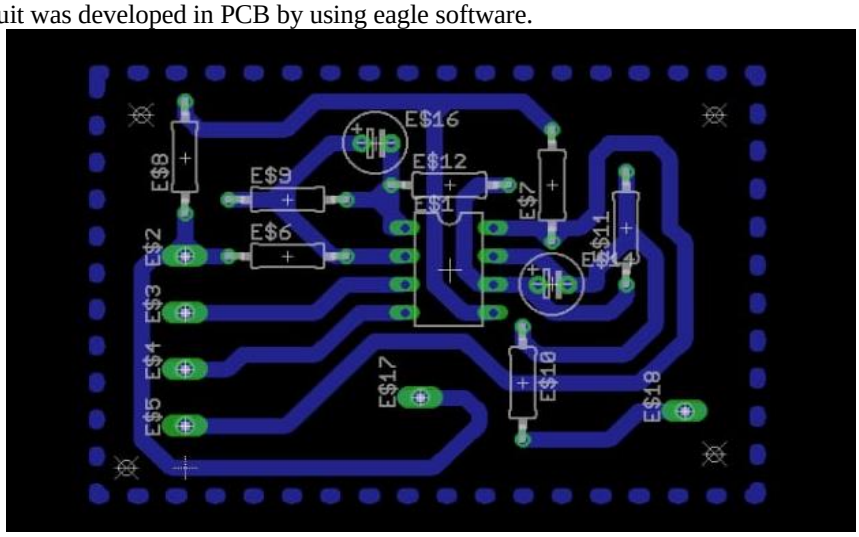
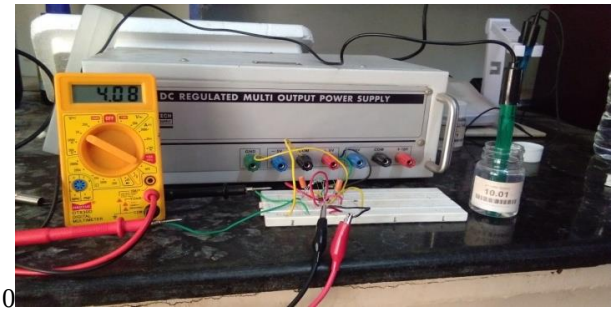


Figure 5: TL072P PCB design

In this circuit we are using TL072P IC. It has two op-amps and the IC contains 8-pins. This IC is only suitable for pH electrode (non-linear resistance). It also gains the low power consumption according to pH resistance. High gain is used for measuring the pH value via differentiator amplifier. In this IC we were developed two differentiator amplifier. One is act as a amplifier for measuring the (non-linear resistance). An additional differential makes use of gain purpose and reference voltage.



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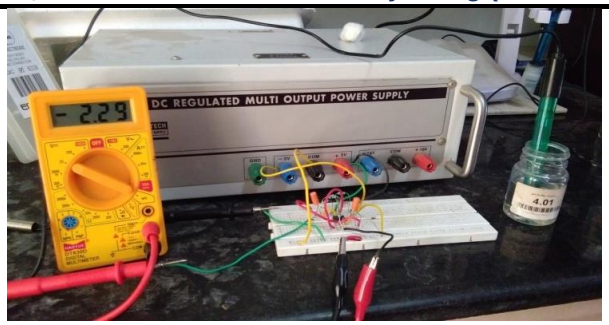
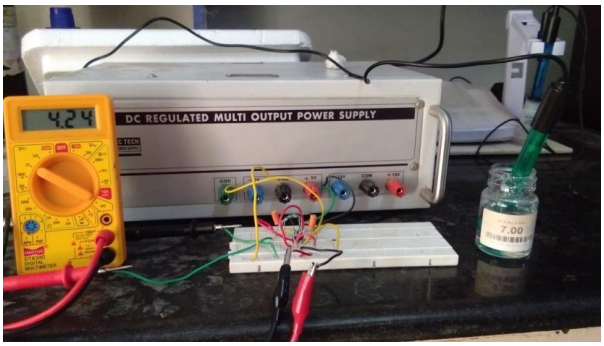


x=2.29*7/4.2=3.8



Type of water	***pH level***
Tap water	*Varies; typically about 7.5*
Distilled reverse osmosis water	*5 to 7*
Common bottled waters	*6.5 to 7.5*
Bottled waters labeled as alkaline	*8 to 9*
Ocean water	*About 8*
Acid rain	*5 to 5.5*

Table 2: Values measured

6. Conclusion

Thus it allows to pass impure water through the system and after passing through the filters it gives pure and drinkable water at the outlet. Turbidity and hardness is removed using respective filters to get pure water at the outlet. System is made portable so that it can be carried anywhere. Waste water is collected at the another output of the system. Percentage of impurity is displayed on the LCD which is interfaced with microcontroller 8051.

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