AQUARIUM pH CONTROL SYSTEM

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INTRODUCTION

A **pH meter** is an instrument used to measure the acidity or alkalinity of a solution - also known as pH. pH is the unit of measure that describes the degree of acidity or alkalinity. It is measured on a scale of 0 to 14.

The term pH is derived from “p,” the mathematical symbol for negative logarithm, and “H,” the chemical symbol for Hydrogen.

The quantitative information provided by the pH value expresses the degree of the activity of an acid or base in terms of hydrogen ion activity. The pH value of a substance is directly related to the ratio of the hydrogen ion [H+] and the hydroxyl ion [OH-] concentrations. If the H+ concentration is greater than OH-, the material is acidic; i.e., the pH value is less than 7. If the OH- concentration is greater than H+, the material is basic, with a pH value greater than 7. If equal amounts of H+ and OH- ions are present, the material is neutral, with a pH of 7. Acids and bases have free hydrogen and hydroxyl ions, respectively. The relationship between hydrogen ions and hydroxyl ions in a given solution is constant for a given set of conditions, either one can be determined by knowing the other.

pH meters range from simple and inexpensive pen-like devices to complex and expensive laboratory instruments with computer interfaces and several inputs for indicator and temperature measurements to be entered to adjust for the variation in pH caused by temperature. The output can be digital or analog, and the devices can be battery-powered or rely on line power. Some versions use telemetry to connect the electrodes to the voltmeter display device

Specialty meters and probes are available for use in special applications, such as harsh environments and biological microenvironments. There are also holographic pH sensors, which allow pH measurement colorimetrically, making use of the variety of

pH indicators that are available. Additionally, there are commercially available pH meters based on solid state electrodes, rather than conventional glass electrodes.

REQUIREMENTS

1.Arduino.

2.pH probe.

3.16x2 LCD module.

4.Mini breadboard.

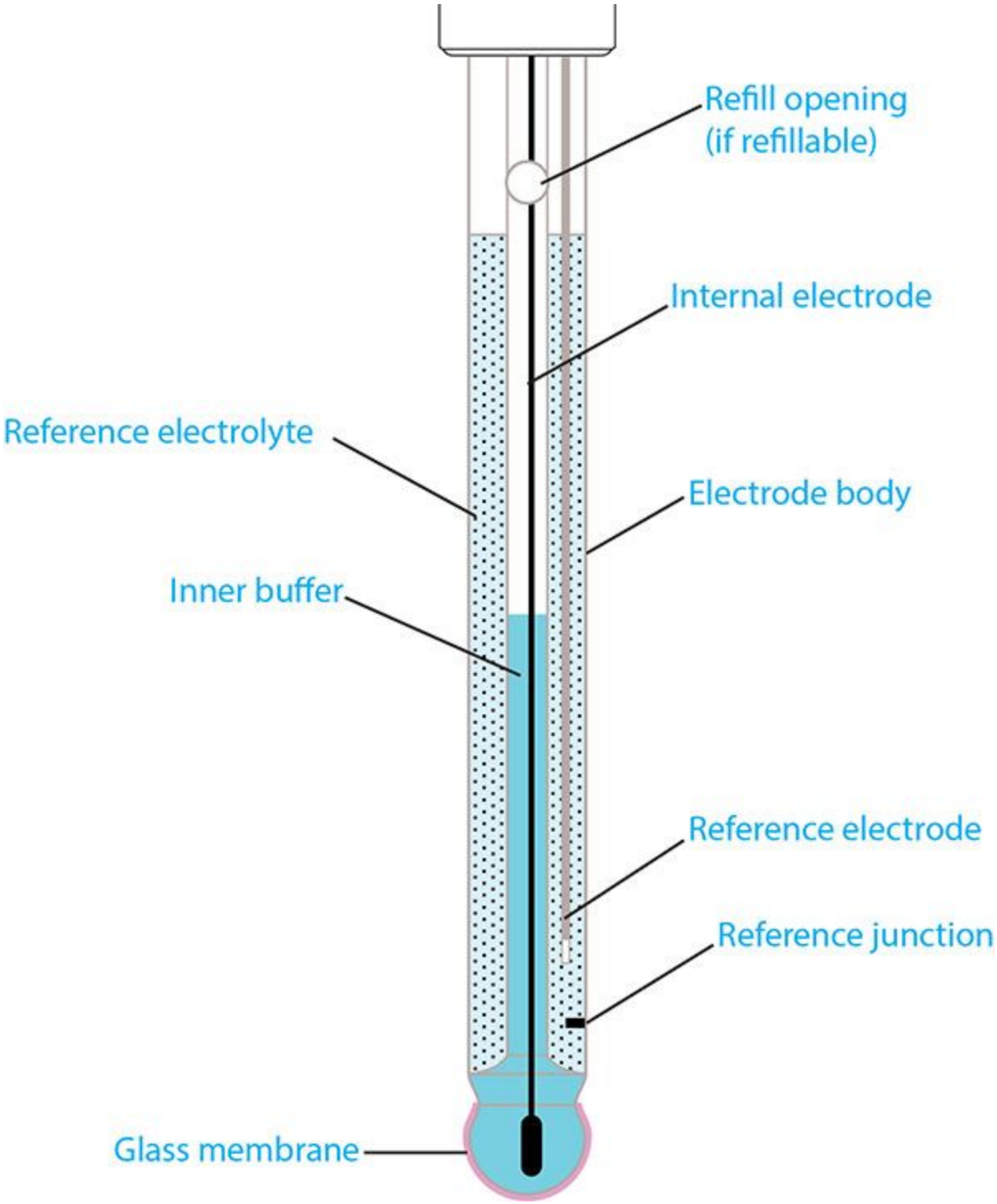
5.Jumper wires.

6.220 ohms resistor.

7.1k ohms resistor

8.pH sensor.

THEORY


Refill opening
(if refillable)
Internal electrode
Reference electrolyte
Electrode body
Inner buffer
Reference electrode
Reference junction
Glass membrane

The ph Probe measures the potential difference between two electrodes, both in the same solution, however one of the electrodes has an enclosure. This enclosure is usually filled with glass tube with a metal such as lithium, sodium, potassium, boron, calcium and so on. The inside and outside of the ph Probe is coated with a hydrated gel and the inside is a neutral solution of potassium chloride.

When we place a probe into an acidic solution, hydrogen ions will diffuse into the gel on the external side. Inside of the silicon dioxide glass, we have metal cations, let's say sodium that had some mobility inside the glass. So when we put the probe into a solution, the excess of hydrogen ions on the outside, force the sodium ions to diffuse from one region of activity to another. So if we, with sufficient accuracy and measure the voltage crossed in and out the solution, we'll get an increased positive voltage as the effective concentration of hydrogen ions increases.

For neutral solution the hydrogen ions balances. So we have no net diffusion of sodium and also no charge.

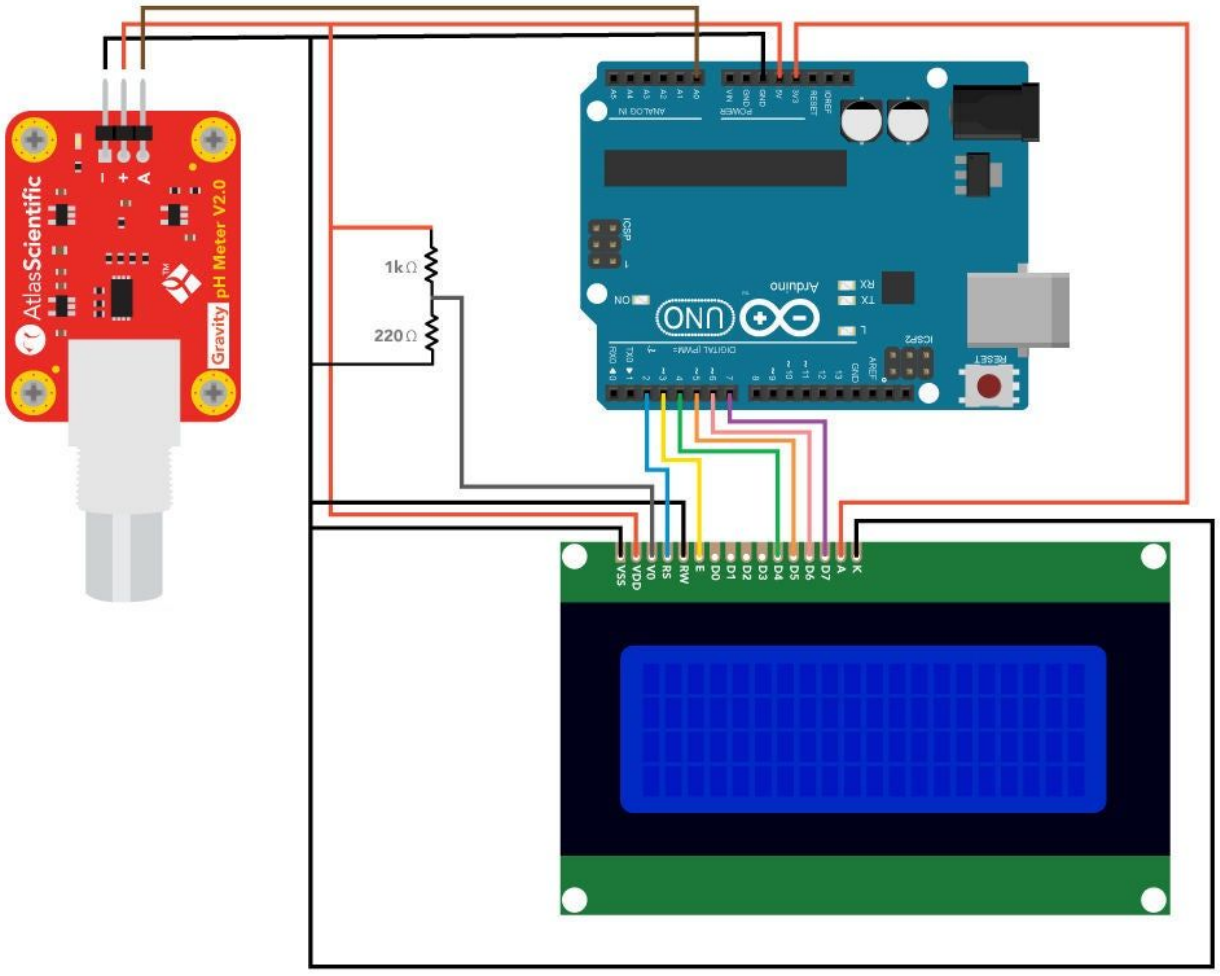
For basic solution we get an opposite diffusion and so we get a negative voltage.

IMPLEMENTATION

The pH probe is connected to the pH sensor via a BNC connector, which gives out an analog voltage depending on the pH value of the solution in which the probe is kept. This analog value is then read by the analog pin of the Arduino.

Further, an LCD panel is connected to the arduino along with two resistors of 1kΩ and 220Ω each. These resistors are connected on a breadboard to distribute the Arduino's 5V and ground pins. The two resistors are used to set the screen contrast.

CIRCUIT DIAGRAM

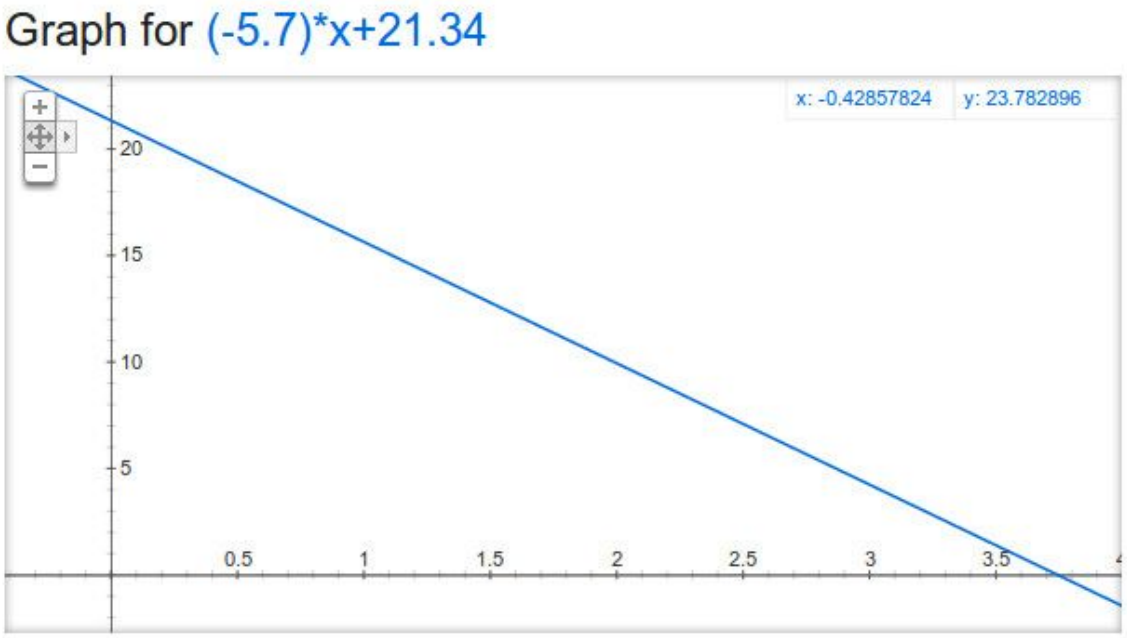


CALIBRATING THE SENSOR

As we can see, there are two potentiometers on the sensor. The one which is closer to the BNC connector of the probe is the offset regulation, the other is the pH limit.

- **Offset:** The average range of the probe oscillates between negative and positive values. The 0 represents a pH of 7.0. In order to be able to use it with Arduino this sensor 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 we will force a pH of 7.0 by disconnecting the probe from the circuit and short-circuiting the inside of the BNC connector with the outside. With a multimeter measure the value of P0 pin and adjust the potentiometer to be 2.5V.
- **pH Limit:** This potentiometer used to set a limit value of the pH sensor circuit that causes the red LED to light up and the D0 pin signal to turn ON.

In addition we have to calculate the voltage conversion that will give us the pH sensor so we will need two 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 in powders, there are also in liquid but it is easier to preserve the powders. These solutions are sold in different values but the most common are pH 4.01, pH 6.86 and pH 9.18.



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

CODE

The code consists of taking 10 samples of the analogue input A0, ordering them and discarding the highest and the lowest and calculating the mean with the six remaining samples by converting this value to voltage in the variable pHVol, then using the equation that we have calculated with the pH reference values we convert pHVol to pHValue and send it to the serial port and LCD display.

```
#include <LiquidCrystal.h>
```

```
const int analogInPin = A0;
int sensorValue = 0;
unsigned long int avgValue;
float b;
int buf[10],temp;
LiquidCrystal pH_lcd(2, 3, 4, 5, 6, 7);
void setup() {
 Serial.begin(9600);
 pH_lcd.begin(16, 2);
 pH_lcd.setCursor(0, 0);
 pH_lcd.print("pH Reading");

}

void loop() {
 for(int i=0;i<10;i++)
 {
  buf[i]=analogRead(analogInPin);
  delay(10);
 }
 for(int i=0;i<9;i++)
 {
  for(int j=i+1;j<10;j++)
  {
   if(buf[i]>buf[j])
   {
    temp=buf[i];
    buf[i]=buf[j];
    buf[j]=temp;
   }
  }
 }
 avgValue=0;
 for(int i=2;i<8;i++)
 avgValue+=buf[i];
 float pHVol=(float)avgValue*5.0/1024/6;
 float phValue = -5.70 * pHVol + 21.34;
 Serial.print("sensor = ");
```

```
 Serial.println(phValue);
 pH_lcd.setCursor(0, 1);
 pH_lcd.print(phValue);
 delay(1000);
}
```

RESULT

Substance	pH approximate
Lemon juice	2.4 – 2.6
Cola drink	2.5
Vinegar	2.5 – 2.9
Orange or apple juice	3.5
Coffee	5.0
Tea	5.5
Milk	6.5
Water	7.2
Soap	9.0 - 10.0

CONCLUSION AND SCOPE

A pH meter is an electronic instrument used for determining the pH of liquid substances.

We exploited the properties of this indicator to determine with precision the acidity or alkalinity of various substances. pH meter is more useful than pH indicators because it gives an accurate reading .

Like many laboratory instruments, pH meters have evolved beyond all recognition over the last several decades. However, experts predict a gradual evolution rather than a revolution in the design of pH meters during the coming years. It seems likely that the product hardware will continue its trend towards miniaturization, while software will undoubtedly become easier to develop and use. Although its form and function may change little in the immediate future, it seems certain that the pH meter will continue to enjoy its status as one of the most ubiquitous pieces of laboratory equipment.

NOVELTY AND INNOVATION

While pH meters are a little more difficult to use because they must be calibrated and maintained, once they are properly calibrated, they measure more accurately than a test strip or other method of pH measurement. The number of hydrogen ions is quantified by the meter, which is essentially a voltmeter and is a lot more sensitive than other methods.

Using a pH indicator can be messier than using a pH meter. Using a pH meter, you can insert the probe into the liquid you are measuring. Using an indicator requires you to remove an aliquot of liquid and place it into the measuring device to which you add chemicals.

A pH meter determines the pH by using the electrical potential of pH-sensitive electrodes as a measurement signal. The disadvantages of visual and photometric methods are not present with potentiometric methods. Potentiometric determination of pH can be used in almost any application, as potentiometric sensors are very sensitive and selective.

pH meters are used for soil measurements in agriculture, water quality for municipal water supplies, swimming pools, environmental remediation; brewing of wine or beer; manufacturing, healthcare and clinical applications such as blood chemistry; and many other applications.