A

Project Report

on

# Design and Development of Water Ionizer

Submitted to

**Sant Gadge Baba Amravati University, Amravati**

Submitted in partial fulfilment of

the requirements for the Degree of

Bachelor of Engineering in

Electronics and Telecommunication Engineering

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# Certificate

This is to certify that the project report entitled **"Design and Development of Water Ionizer"** is hereby approved as a creditable study carried out and presented by

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in a manner satisfactory to warrant of its acceptance as a pre-requisite in a partial fulfillment of the requirements for the degree of Bachelor of Engineering in Electronics & Telecommunication Engineering of Sant Gadge Baba Amravati University, Amravati during the Session 2022-23.

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# Abstract

The consumption of alkaline reduced water produced by domestic electrolysis devices was approved in Japan in 1965 by the Ministry of Health, Labour, and Welfare for the cure of gastro-intestinal disorders. Today, these devices are freely available in several countries and can be easily purchased without reserve. Recently, alkaline ionized water (AIW) generated by water electrolysis has received increasing attention because of its shown benefits in treatment and prevention of diseases. It was reported that intake of AIW has various beneficial effects such as removal of reactive oxygen species, improving constipation, suppressed accumulation of body fats, early expulsion of melamine, reduction of ultraviolet radiation-induced skin damage, modulation of immune response and ameliorating diabetes. The impact of AIW is believed to be related to its high concentration of liquid hydrogen and negative oxidation reduction potential. Due to its large hydrogen content, the primary function of AIW as an antioxidant has long been recognized. Inhaling hydrogen gas and consuming hydrogen water both showed signs of preventing oxidative illnesses. In this research, an electrolysis-based water ionizer that lowers total dissolved solids (TDS) and creates alkaline water was designed and tested. To keep the acidic and alkaline water from mixing, we used a two-stage electrolysis procedure with a bipolar membrane to divide the anode and cathode chambers. We assessed the ionized water's pH, TDS, and alkalinity and contrasted it with potable water. Our findings demonstrated that the ionized water had considerably lower TDS, higher pH, and alkalinity than tap water. Even though these devices are on the market, many people cannot purchase them due to their high price. In our endeavour, we'll focus on lowering the device's cost.

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# Acknowledgement

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# Abbreviations

| | |
|---|---|
| Wi-Fi | - Wireless Fidelity |
| UAV | - Unmanned Aerial Vehicle |
| AV Cable | - Audio Video Cable |
| BLDC | - Brushless DC |
| ESC | - Electronics Speed Controller |
| PMMC | - Permanent Magnet Moving Coil |
| GUI | - Graphical User Interface |
| LED | - Light Emitting Diode |
| IMU | - Inertial Measurement Unit |
| MEMS | - Micro Electro-Mechanical System |
| GPS | - Global Positioning System |
| CCTV | - Closed Circuit Television |
| RC | - Remote Control |
| LiPo | - Lithium Polymer |
| NiMH | - Nickel Metal Hydride |
| mAh | - milli Amperes hour |
| RPM | - Rotation Per Minute |
| PWM | - Pulse Width Modulation |
| PDB | - Power Distribution Board |
| BEC | - Battery Eliminator Circuit |
| MOSFET | - Metal Oxide Semiconductor Field Effect Transistor |
| MPU | - Micro Processor Unit |

| | |
|---|---|
| DOF | - Degrees of Freedom |
| IC | - Integrated Circuit |
| FC | - Flight Controller |
| CCD | - Charged Coupled Device |
| DVD | - Digital Versatile Disc |
| USB | - Universal Serial Bus |
| EEPROM | - Electrically Erasable Programmable Random Access Memory |

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Chapter 1

# Introduction

Nowadays considering the fast-paced lifestyle, it is essential to have a healthy and a balanced diet. Alkaline water is one of the important aspects to reduce the acidity, and improve the overall digestion and metabolism in the human body. Maintaining good health largely depends on keeping the pH level in your body in balance. This is the rationale behind the widespread advice to consume alkaline water. Alkaline water neutralizes the acid found in water, which is the primary distinction between it and regular water. The highly acidic tap water we obtain can cause a variety of health issues. While it's crucial to consume clean water to avoid getting sick, you should also check the pH level. To make water safe for ingestion, alkaline water filters balance the pH level.

In this study, we show a water ionizer system that first uses a reverse osmosis (RO) filter to reduce total dissolved solids (TDS) before producing acidic and alkaline water. Customers will receive high-quality drinking water from the system that is clear of contaminants and impurities. The motor-driven RO filtration system in the water ionizer system cleans the tap water of TDS and other impurities before it reaches the ionization chamber. Alkaline and acidic water are created in the ionization chamber through an electrolysis procedure, and they are then stored in different chambers. We included a pH sensor that gauges the pH of the ionized water to guarantee that the system produces water with the desired pH levels. Once the pH of the water has reached the intended range, a relay is used to automatically shut off the solenoid valve. This attribute reduces the need for a microcontroller and improves the usability of the device. The Blynk app integration in the water ionizer system enables users to track pH levels and other system metrics in real-time on their mobile devices. Users can easily modify the ionization process using this feature, if required.

Thus, we created the water ionizer device to offer users high-quality drinking water that is free of harmful impurities and contaminants. To create water with the desired pH levels, the system uses a pH sensor and relay along with a RO filter to filter out TDS and other impurities. The alkaline components support the health and wellness of the

body's organs while supporting their health. Additionally, the acidic water works well as an external cleaner for personal cleanliness. Real-time system monitoring and management are made simple for users thanks to the integration of the Blynk app.

### 1.1 Motivation

Water ionizers that produce alkaline and acidic water while reducing TDS using filtration offer a range of benefits, including improved health, environmental impact, convenience, taste, and cooking. These factors can motivate consumers to invest in a water ionizer and improve their overall quality of life. Water ionizers that produce alkaline water can boost the immune system, improve digestion, and reduce inflammation, while acidic water can help with skin problems and act as a natural disinfectant. TDS reduction through filtration improves water quality. Water ionizers also help reduce the use of bottled water, contributing to reducing environmental pollution and saving money. Water ionizers offer access to alkaline and acidic water at any time, without the need to run to the store. TDS reduction through filtration reduces the need for frequent filter replacements. Alkaline water enhances the flavor and texture of food and preserves nutrients, while acidic water tenderizes meat and cleans fruits and vegetables naturally.

### 1.2 Problem Statement

In today's world good hygiene and health has become the basic need of humanity. Tap water which we receive contains many impurities & bacteria and most of the time it affect our health. Even various water purification techniques which we use nowadays is not efficient because it removes all the minerals from water. This is basically stripping the water of near everything that is in it, that means all the bad stuff like bacteria, virus, toxins like heavy metals and chemicals like fluoride and chlorine, as well as pesticides, but it also strips all the healthy elements like minerals and trace elements that are vital for your health.It further decreases the pH of your water, and if you do not have a re-mineralizing filter in your Water Purifier, you are consuming unhealthy water of around pH 5-6. It is a contradictory system, as it claims to work for our health, but in its pursuit, it removes so much, it no longer aids our health, and may in fact lead to a more unhealthy body than if you consumed the toxins in the first place. Removing everything and getting zero TDS does not give healthy water as many believe. So there is need to have a proper water purify technique.

Not only does most of water purifier strip the water of all things, it also generates 1 gallon of wastewater per 4 gallons filtered (4:1), or 1 gallon per gallon filtered in high water pressure areas (1:1). This is very wasteful in today's water short society, and unless you consciously and consistently use this wastewater to either water your plants, wash your caror other household chores, you are on a large scale contributing to the water crisis of the world. This is why Invigorated Water chooses to not back this type of product. This project is being carried out due to the concerns that have been highlighted by differentwater filtration techniques. This is not in any way to criticize the various methods used for water filtration, but to build a device which will provide the best form of purified water.

### 1.3 Literature survey

The main purpose of this device is to purify the water and obtain the alkaline water which is highly advantageous to human body. This is done by using the principle of water electrolysis. By using this technique we can also separate out the acidic water which can be used for different useful applications.

Paper Title: Impact of Reverse Osmosis on Purification of Water

Lamma OAI*, Abubaker M. Outhman2, Lamma SA, Impact of reverse osmosis on purification of water "Journal of Pharmaceutical Biology", e-ISSN-2249-7560 Vol.5 Issue 2, 2015

**Reverse Osmosis (RO):** Reverse osmosis removes contaminants from unfiltered water, or feed water, when pressure forces it through a semi permeable membrane. Water flows fromthe more concentrated side (more contaminants) of the RO membrane to the less concentrated side (fewer contaminants) to provide clean drinking water. Although reverse osmosis system removes dissolved solids like arsenic and fluoride through the RO membrane it may also remove beneficial minerals like calcium and magnesium from water.As natural minerals are removed water gets de-mineralized as a result water taste affected, it becomes tasteless. Approximately much more water compared to filtered out water flushed down as waste water. Reverse osmosis may remove some bacteria, but bacteria could grow on the membrane and potentially enter your water supply. Hence we can conclude that RO is not the safest and beneficial water filtration technique.

**Ultraviolet (UV):** UV water purification systems purify water by using ultraviolet rays to kill microorganisms present in the water. UV rays completely kill water- borne microorganisms and prevent their reproduction by disrupting their DNA. It does kill almost99% of bacteria but UV technology does not remove any other contaminants from water such as heavy metals, salts, chlorine or man-made substances like petroleum products or pharmaceuticals. Other filtration methods should be employed with UV to ensure that all contaminants are removed from the water.

**Ultra filtration (UF):** Ultra filtration (UF) uses standard home water pressure to push water through a semi permeable membrane and remove any contaminants. Unlike reverseosmosis, ultra filtration retains minerals in the water, while filtering out bacteria, viruses, and parasites. The main drawback of the UF water purification procedure is that it cannotremove the dissolved salts in the 7water.

Paper Title: Study on Application of Activated Carbon in Water Treatment

Adenes Teixeira Alves I. Dimas José Lasmar1, Ires Paula de Andrade Miranda2, Jamal da Silva Chaarl. Jardson dos Santos Reis! Study on Application of Activated Carbon in Water Treatment "Advances in Bioscience and Biotechnology" Vol.12 No.6, June 2021

**Activated Carbon (AC) :** Activated carbon filters are generally employed in the process of removing organic compounds and/or extracting free chlorine from water, thereby making the water suitable for discharge or use in manufacturing processes. Activated Carbon (AC) filtration, as with any water treatment method, is not capable of removing every possible type of contaminant. For example, sodium, microbes, fluoride, and nitratescannot be removed with AC filtration. Water softening also cannot be achieved with AC filters. In addition, heavy metals, such as lead, can only be removed with a very specific kind of activated carbon water treatment, which is typically used only in residential point-of-use filters.

Paper Title: Process for producing improved alkaline drinking water and the product produced thereby.

Robert M. Abramowitz, Mercer Island, WA (US); George Amold, Seattle, WA (US). Process for producing improved alkaline drinking water and the product produced thereby .*"United States Patent*", Jun 3.2003

**Water Electrolysis (Ionization):** Ionized hydrogen water is produced through a process called electrolysis – where electric current is passed through the water to separate water into oxygen and hydrogen gas (or positive and negative ions). The electrolysis takes place in the electrolysis chamber containing oppositely charged electrode plates. The result is a collection of positive H+ ions and negative OH- ions ready to neutralize free radicals in your body. Ionization replaces soluble acids in your drinking water with trace minerals, calcium, potassium, magnesium, and sodium. Turns your drinking water into great tasting hydrogen water. It reduces the electron milivolt (mV) charge of your water which creates -ORP or negative oxidation-reduction potential. This turns your water into the highest antioxidant liquid on the planet. Works to make your cells stronger so sickness and diseases can be fought more effectively and efficiently by your immune system. The alkaline water is obtained which has many advantages for our human body.

## 1.4 Objectives

The objective of this project is to build an water ionizer that produces alkaline water and acidic water and gives a water of TDS that is suitable for drinking. These are the following objective:

**Hydrogen rich water** : Water that is Hydrogen rich has a high concentration of MolecularHydrogen (H2). Molecular Hydrogen acts as an efficient antioxidant that diffuses rapidly across cell membranes and can reduce free radicals, suppressing oxidative stress. Throughthe process of electrolysis, your tap water becomes Hydrogen rich Water.

**Antioxidant**: Oxidation reactions in the body can produce free radicals, while antioxidants terminate these reactions. Elevated rates of oxidants and insufficient antioxidants in the body cause oxidative stress. A constant supply of external sources of antioxidants should be part of one's daily diet, to reduce oxidative stress and related damage. This is why everyone should not only care about the quantity of the water we drink, but also about thequality. Both are essential for our wellbeing. And water through electrolysis has a potentialto become the external source of antioxidant.

**Alkaline**: As with most things in life, optimal health begins with balance. Our bodies mustmaintain a pH balance of 7.365, which is slightly alkaline. A pH scale is used to determine whether a substance is acidic or alkaline. On this scale 7.0 is neutral. Anything above 7 is considered alkaline and anything below 7 is considered acidic. From electrolysis we can obtain water of various pH values according to our need.

**Negative ORP (Oxidation-Reduction Potential)**: Hydrogen rich water is characterized byexhibiting a negative ORP. A high ORP value (in positive numbers), indicates that a substance has a higher oxidizing potential. In generalized terms, for humans a positive or high ORP is better for the outside of the body (cleaning and sanitizing). A low ORP value (in negative numbers) indicates that a substance has a higher antioxidizing potential, and is preferred for oral consumption. Just like pH, ORP values are an important measurement for determining the quality ofwater. The objective of reducing TDS (Total Dissolved Solids) in water using filtration is to improve the quality of water by removing dissolved solids such as minerals, salts, metals, and other impurities that can impact the taste, odor, and safety of water. High TDS levels can also lead to scaling and corrosion in pipes and appliances, reducing their lifespan. By reducing TDS levels through filtration, water quality is improved, making it safer, healthier, and more pleasant to drink, while also protecting plumbing and appliances from damage.

**Water of Proper TDS:** TDS stands for Total Dissolved Solids and refers to the total amount of inorganic and organic substances present in water that can dissolve in it. These include minerals, salts, metals, and other particles. The optimal level of TDS in drinking water can vary depending on factors such as local regulations, water source, and personal preferences. However, generally, the recommended TDS level for drinking water is between 150-300 mg/L (or ppm). Water with TDS levels below 150 mg/L may taste flat or insipid, while water with TDS levels above 500 mg/L may taste salty or bitter and may have an unpleasant aftertaste.

Water with proper TDS levels is beneficial for human health as it provides essential minerals and electrolytes necessary for the body's functioning. Additionally, water with proper TDS levels can improve the taste and quality of food and beverages made with it. It is important to note that TDS alone does not determine water quality. Other factors such as pH, hardness, and the presence of contaminants like bacteria, pesticides, or

heavy metals should also be considered when evaluating water quality. These include minerals, salts, metals, and other particles. The optimal level of TDS in drinking water can vary depending on factors such as local regulations, water source, and personal preferences. However, generally, the recommended TDS level for drinking water is between 150-300 mg/L (or ppm).

Chapter 2

# Methodology

The methodology for design and development of water ionizers consists of basic three step process that are filtration, electrolysis and pH measurement.

## 2.1 Methodology for water filtration:

The methodology for water filtration can vary depending on the type of filtration system being used. However, the basic steps involved in water filtration include:

Pre-treatment: This step involves the removal of large particles and debris from the water. Depending on the quality of the water source, this may involve screening, sedimentation, or flocculation to settle suspended particles.

Filtration: Once pre-treatment is complete, the water is passed through a filtration system to remove any remaining impurities. Different types of filters can be used depending on the nature of the impurities being targeted. For example, sediment filters are effective at removing suspended solids, while activated carbon filters are effective at removing organic contaminants.

Disinfection: After filtration, the water may be treated with a disinfectant, such as chlorine or UV light, to kill any remaining bacteria, viruses, or other microorganisms.

Post-treatment: Depending on the specific filtration system, post-treatment may be necessary to adjust the pH or mineral content of the water, or to add additional disinfection measures.

Testing: Once the filtration process is complete, the water should be tested to ensure that it meets quality standards and is safe for consumption. Common tests include pH, turbidity, and microbiological analysis.

It is important to note that the methodology for water filtration can vary widely depending on the specific system being used and the quality of the water source. Proper

maintenance and monitoring are also essential to ensure that the filtration system continues to operate effectively over time.

We integrated the RO filtration system with a motor to pump the tap water into the filtration system. The motor was connected to the inlet of the sediment filter, and outlet of the storage tank was connected to a tap for dispensing the purified water. We evaluated the filtration performance of the RO system by measuring the TDS levels of the tap water and the purified water using a TDS meter. The developed RO filtration system effectively reduces TDS levels in tap water and improve the overall quality. The filtration system is then further integrated with the other water technology like the electrolysis to provide high quality to consumers.

**2.2 Methodology for basic Electrolysis Process:**

Electrolysis is a process that uses an electrical current to drive a non-spontaneous chemical reaction. The methodology for the electrolysis process can be summarized as follows:

Preparation of electrolyte: An electrolyte is a substance that can conduct electricity when dissolved in a liquid. The electrolyte is prepared by dissolving a suitable salt or acid in water to create a solution that can conduct electricity.

Selection of electrodes: Two electrodes, an anode and a cathode, are needed for the electrolysis process. The anode is positively charged and the cathode is negatively charged. The electrodes are usually made of a conductive material such as platinum or graphite.

Immersion of electrodes in the electrolyte: The electrodes are then immersed in the electrolyte solution, and a direct current (DC) voltage is applied across them. The anode is connected to the positive terminal of the power supply, and the cathode is connected to the negative terminal.

Electrolysis process: As the electrical current flows through the electrolyte solution, a chemical reaction occurs at each electrode. At the anode, positive ions in the electrolyte are attracted to the electrode and give up electrons, producing oxidizing agents such as chlorine or oxygen gas. At the cathode, negative ions in the electrolyte are attracted to the electrode and gain electrons, producing reducing agents such as hydrogen

gas.Collection of products: The products of the electrolysis process can be collected in separate containers for later use or analysis.

It is important to note that the specific conditions for the electrolysis process, such as the voltage and current applied, the concentration of the electrolyte solution, and the choice of electrodes, can affect the efficiency and selectivity of the process. Proper safety precautions should also be taken when working with electricity and chemicals.

Water ionizers transform regular tap water into ionized alkaline water with acid-fighting alkalinity and antioxidant potential using electromagnetic. Alkaline minerals and CO2 dissolved in carbonates make up plain water. The carbonate in tap water is separated from the alkaline minerals by a water ionizer. Separate streams of water are used to discharge the acidic carbonate and the alkaline minerals. A water ionizer gives you access to the naturally occurring alkalinity of your water's alkaline minerals like calcium and magnesium, which fights acidity by separating the alkaline elements in tap water from the acidic elements. These alkaline minerals acquire antioxidant potential and acid-fighting alkalinity once they are liberated from the carbonate. Water flows between charged plates that are separated by an air gap within a water ionizer.Ions—atoms and molecules that have an energetic charge—can pass through that membrane. Atoms and molecules with no net charge cannot pass through it. Water molecules cannot pass through the membrane because they have a neutral energy. As a result of their energetic charges, the alkaline mineral ions and carbonate ions in water are both permitted to pass through.

Alkaline minerals are thus separated from acidic carbonate in this manner. The positively charged ions that are created by the alkaline minerals in water are energetically positive. Like how acidic carbonate in water has a negative electrical charge, negatively charged ions are created by them. A water ionizer separates those ions using electromagnetically charged plates. The ions of alkaline mineral are positively charged, and they are drawn to the negative plates. The positively charged plates are drawn to the acidic carbonate. The negatively charged carbonate ions and the positively charged alkaline mineral ions can both flow through the ion-permeable membrane, which divides them into two compartments.

**2.3 Methodology for pH Measurement:**

pH measurement is the process of determining the acidity or basicity of a liquid or solution. The most common method for pH measurement is the use of a pH meter, which is a device that measures the electrical potential difference between a pH electrode and a reference electrode immersed in the solution. Here are the basic steps involved in the methodology for pH measurement:

Calibration: Before measuring the pH of a solution, it is important to calibrate the pH meter. This involves immersing the pH electrode and the reference electrode in standard buffer solutions with known pH values (usually pH 4.0, 7.0, and 10.0). The meter is then adjusted so that the readings match the known values of the buffer solutions.

Preparation of the solution: The solution to be measured is prepared and stirred to ensure that it is homogeneous.

Measurement: The pH electrode and the reference electrode are immersed in the solution, and the pH meter is turned on. The meter will display the pH value of the solution, which can be read and recorded.

Rinsing: After each measurement, the electrodes are rinsed with distilled water to remove any residual solution, and then dried with a tissue or a clean cloth.

Storage: The pH meter electrodes should be stored in a storage solution (usually a solution containing potassium chloride) to prevent the electrodes from drying out and to maintain their accuracy.

It is important to note that the accuracy of pH measurement can be affected by various factors, such as temperature, electrode condition, and calibration. Therefore, it is important to follow proper methodology and to calibrate the pH meter regularly to ensure accurate readings.

This system uses a pH sensor to find out the pH level of the water. The pH of the water is determined by this technique using a pH sensor. The finest pH sensor kit is used to measure many parameters, including water quality. It features a pH sensor, a BNC connector, an LED that serves as a power indicator, and a variable resistor that is used to calibrate the sensor interface circuit. The Signal Conversion Board (Transmitter) V2 and pH Probe are both included in the Ph Sensor Kit. They are both linked to one another.

The Ph meter is then interfaced with the Arduino Uno with the simple connections. Using NodeMCU we connect objects and let data transfer using the Wi-Fi protocol. Then the code is to be uploaded to the NodeMCUESP8266 wi-fi module for the further

process using the Arduino IDE. Once the code is uploaded, we can take the required tests for the ph. Measurements. The monitoring results will be forwarded to Cloud Blynk so that it can be viewed via a smartphone via the Blynk Android application.

Chapter 3

# Hardware & Software Requirements

## 3.1 Hardware Requirements

### 1) NodeMCU ESP8266 Wi-Fi Module

Figure 3.1: NodeMCU ESP8266 Wi-Fi Module

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop andflash it without any trouble, just like Arduino. It is also immediately breadboard friendly**.**

**Specifications**

- Voltage:3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Current consumption: 10uA~170mA.
- Flash memory attachable: 16MB max (512K normal).

- Integrated TCP/IP protocol stack.
- Processor: Tensilica L106 32-bit.
- Processor speed: 80~160MHz.
- RAM: 32K + 80K.
- GPIOs: 17 (multiplexed with other functions).
- Analog to Digital: 1 input with 1024 step resolution.
- +19.5dBm output power in 802.11b mode
- 802.11 support: b/g/n.
- Maximum concurrent TCP connections.

**Pin Definition**

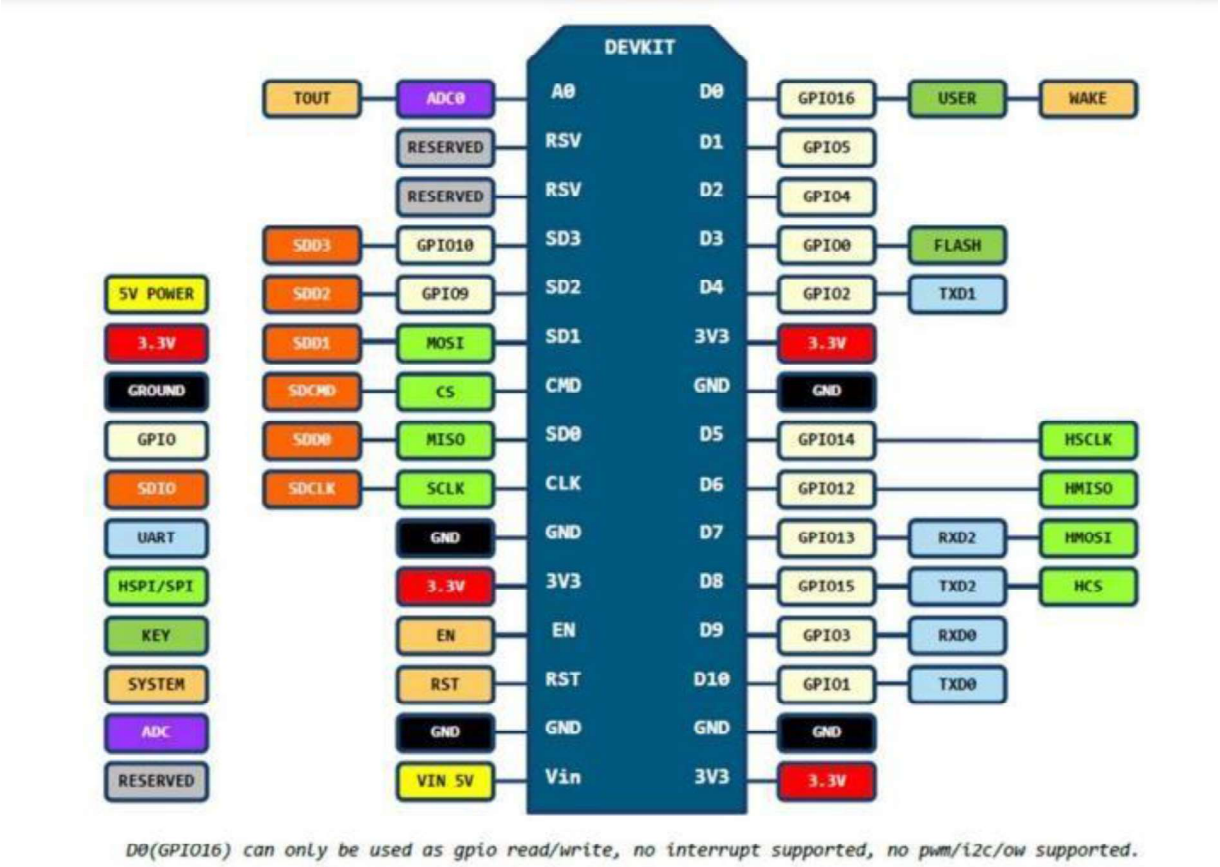



Figure 3.2: Pin Diagram for NodeMCU

The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a WiFi/Serial transceiver. However, this is not convenient.

What we recommendis using the very cool Arduino ESP8266 project, which is a modified version of the Arduino IDE that you need to install on your computer. This makes it very convenient to use the ESP8266 chip.

**2) Arduino UNO Board**

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This boardcan be interfaced with other Arduino boards, Arduino shields, Raspberry Pi boards and cancontrol relays, LEDs, servos, and motors as an output.

Arduino UNO features AVR microcontroller Atmega328, 6 analogue input pins, and 14digital I/O pins out of which 6 are used as PWM output.


Figure 3.3: Arduino UNO

This board contains a USB interface i.e. USB cable is used to connect the board with thecomputer and Arduino IDE (Integrated Development Environment) software is used to program the board. The unit comes with 32KB flash memory that is used to store the number of instructionswhile the SRAM is 2KB and EEPROM is 1KB.

The operating voltage of the unit is 5V which projects the microcontroller on the board andits associated circuitry operates at 5V while the input voltage ranges between 6V to 20V and the recommended input voltage ranges from 7V to 12V.

**Arduino UNO Components**

The Arduino UNO board contains the following components and specifications:

**ATmega328:** This is the brain of the board in which the program is stored.

**Ground Pin:** there are several ground pins incorporated on the board.

**PWM:** the board contains 6 PWM pins. PWM stands for Pulse Width Modulation, using this process we can control the speed of the servo motor, DC motor, and brightness of theLED.

**Digital I/O Pins:** there are 14 digital (0-13) I/O pins available on the board that can be connected with external electronic components.

**Analogue Pins:** there are 6 analogue pins integrated on the board. These pins can read theanalogue sensor and can convert it into a digital signal.

**AREF:** It is an Analog Reference Pin used to set an external reference voltage.

**Reset Button:** This button will reset the code loaded into the board. This button is useful when the board hangs up, pressing this button will take the entire board into an initial state.

**USB Interface:** This interface is used to connect the board with the computer and to upload the Arduino sketches (Arduino Program is called a Sketch)

**DC Power Jack:** This is used to power up the board with a power supply.

**Power LED:** This is a power LED that lights up when the board is connected with the power source.

**Micro SD Card:** The UNO board supports a micro SD card that allows the board to storemore information.

**3.3V:** This pin is used to supply 3.3V power to your projects.

**5V:** This pin is used to supply 5V power to your projects.

**VIN:** It is the input voltage applied to the UNO board.

**Voltage Regulator:** The voltage regulator controls the voltage that goes into the board.

**SPI:** The SPI stands for Serial Peripheral Interface. Four Pins 10(SS), 11(MOSI), 12(MISO), 13(SCK) are used for this communication.

**TX/RX:** Pins TX and RX are used for serial communication. The TX is a transmit pin usedto transmit the serial data while RX is a receive pin used to receive serial data.

**Arduino UNO Pinout**

There is a range of Arduino boards available in the market but the Arduino UNO is the most common board used in the electronic industry. The following figure shows the Arduino UNO Pinout for better understanding:

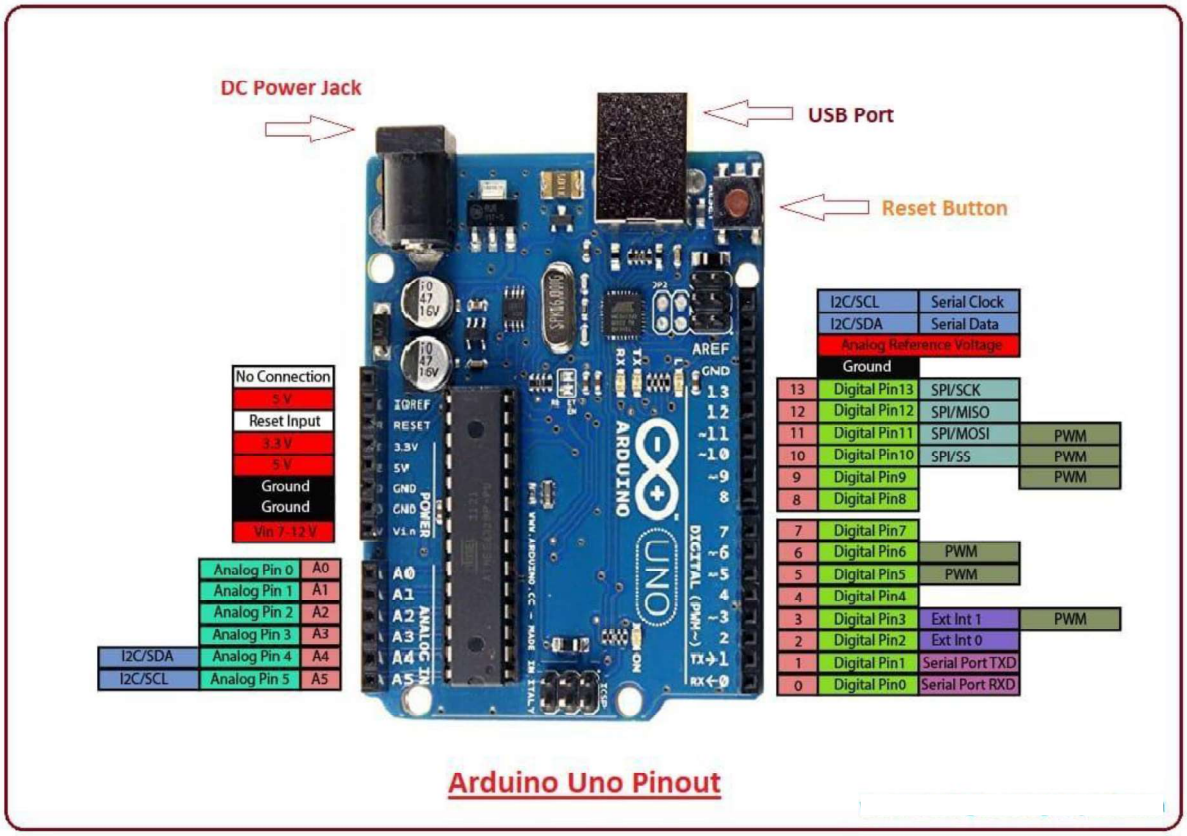



Figure 3.4: Arduino UNO Pinout

**3) pH Sensor Kit**

Analog PH Sensor Kit with PH Electrode Probe is Compatible for Arduino. The pH stands for the power of hydrogen, which is a measurement of the hydrogen ion concentration in the body. This is used in Water quality testing and Aquaculture. The total pH scale ranges from 1 to 14, with 7 considered to be neutral. A pH less than 7 is

said to be acidic and solutions with a pH greater than 7 are basic or alkaline. The PH electrode has a single cylinder that allows direct connection to the input terminal of a pH meter, controller, or anypH device which has a BNC input terminal. The pH electrode probe is accurate and reliablethat can give almost instantaneous readings.

This Kit is specially designed for Arduino controllers and has a built-in simple, convenient and practical connection and features. It has an LED which works as the Power Indicator, aBNC connector and PH2.0 sensor interface. To use it, just connect the pH sensor with BND connector, and plug the PH2.0 interface into the analog input port of any Arduino controller. If pre-programmed, you will get the pH value easily.

Figure 3.5: pH Sensor Kit

**Pin Description**

Out : The output of the pH sensor (-0.4 V to 0.4 V) amplified 2x. The mean value of the voltage of the pH sensor 0V (PH7) is shifted in the range of about 1V to 2.5 V using the potentiometer closer to the connector for the pH probe.

Gnd: GND (ground)

Vin+: 5V

**4) pH & TDS Meter**


Figure 3.6: pH & TDS Meter

A **pH meter** is a scientific instrument used to measure the acidity or alkalinity of a liquid or solution. pH is a measure of the concentration of hydrogen ions (H+) in a solution, and it ranges from 0 to 14, with 7 being neutral. A pH meter works by measuring the electrical potential difference between a pH-sensitive electrode and a reference electrode when they are immersed in a solution.

The pH-sensitive electrode is usually made of glass and contains a solution of potassium chloride with a known concentration. This electrode generates a voltage that is proportional to the pH of the solution. The reference electrode, on the other hand, is usually a silver/silver chloride electrode that provides a stable reference voltage.

By measuring the voltage difference between the pH-sensitive electrode and the reference electrode, the pH meter can calculate the pH of the solution. pH meters are commonly used in laboratories, research institutions, and industrial processes where accurate pH measurements are required for quality control and process optimization.

A **Total Dissolved Solids (TDS) meter** is a device that measures the concentration of dissolved substances in a liquid, usually water. These dissolved substances can include

minerals, salts, metals, and other organic or inorganic compounds. The TDS meter works by passing an electrical current through the liquid and measuring the conductivity, which is then converted into a TDS reading. TDS meters are commonly used in applications such as water quality testing, aquarium maintenance, hydroponics, and beverage production to ensure that the desired levels of dissolved solids are present.

**5) RO Membrane**

Reverse osmosis (RO) membrane is a specialized type of membrane used in water purification systems to remove impurities and contaminants from water. It is made of a thin layer of synthetic material, typically made of polyamide or cellulose acetate, with tiny pores that allow water molecules to pass through while blocking larger molecules such as salts, minerals, and other impurities. The RO membrane operates by using hydraulic pressure to force water molecules through the membrane, while the impurities are left behind and flushed away as waste. RO membranes are commonly used in desalination plants, residential and commercial water filtration systems, and industrial processes that require ultra-pure water.


Figure 3.7: RO Membrane

**6) Solenoid Valve:**

A solenoid valve is an electromechanical device that controls the flow of a liquid or gas by using an electric current to open or close a valve. It consists of a coil of wire that

generates a magnetic field when an electric current is passed through it, and a plunger or piston that is moved by the magnetic field to open or close a valve. Solenoid valves are commonly used in a variety of industrial applications, such as controlling the flow of water or gas in pipelines, controlling the flow of refrigerants in air conditioning and refrigeration systems, and controlling the flow of fuel in engines and turbines. They are also used in household appliances, such as washing machines and dishwashers, to control the flow of water.

Figure 3.8: Solenoid Valve

Solenoid valves can be used in both filtration and electrolysis processes to control the flow of liquids or gases. In filtration systems, solenoid valves can be used to control the flow of water through different stages of the filtration process, such as activating the backwash function or controlling the flow of water through different types of filters.
In electrolysis systems, solenoid valves can be used to control the flow of the electrolyte solution into the electrolysis cell, and to control the flow of gas generated by the electrolysis process. For example, in a hydrogen production system using electrolysis, a solenoid valve can be used to control the flow of hydrogen gas from the electrolysis cell to the collection vessel.

When selecting a solenoid valve for use in filtration or electrolysis systems, factors such as the type of fluid being controlled, the operating pressure and temperature range, and the required flow rate should be considered. Valves made of materials that are resistant

to corrosion or chemical attack may also be required, depending on the specific application.

**7) Motor**

A motor is an electromechanical device that converts electrical energy into mechanical energy to produce motion. It typically consists of a rotor (the rotating part) and a stator (the stationary part) that contains coils of wire. When an electric current is passed through the coils in the stator, it creates a magnetic field that interacts with the magnetic field of the rotor, causing it to rotate. Motors come in a variety of types, including AC motors, DC motors, and stepper motors, and are used in many applications, such as industrial machinery, household appliances, vehicles, and robotics. They are essential components of many devices and systems that require mechanical motion, such as fans, pumps, conveyor belts, and electric vehicles.


Figure 3.9: Motor

The motor used in a filtration process plays a critical role in the performance and efficiency of the filtration system. The motor drives the pump that circulates water through the various stages of the filtration process, including pre-filters, carbon filters, reverse osmosis membranes, and post-filters.

Here are some key factors to consider when selecting a motor for a filtration system:

1. Power: The power of the motor should be appropriate for the size and flow rate of the filtration system. A motor that is too weak will not be able to generate enough pressure to push water through the various filters, while a motor that is too powerful may waste energy and cause excessive wear on the system.

2. Efficiency: The efficiency of the motor is a key factor in determining the overall energy consumption of the filtration system. A more efficient motor will use less energy to achieve the same flow rate and pressure, resulting in lower operating costs and a smaller environmental footprint.
3. Durability: The motor should be designed to withstand the harsh operating conditions of a filtration system, including exposure to water, chemicals, and temperature fluctuations. A durable motor will reduce maintenance costs and extend the lifespan of the filtration system.
4. Noise: The motor should operate at a reasonable noise level to avoid disturbing occupants in the vicinity of the filtration system. Noise can also be an indicator of motor wear or other mechanical issues.
5. Control: The motor should be designed for easy integration into the control system of the filtration system, including speed control, overload protection, and other safety features.
In summary, the motor used in a filtration system should be carefully selected based on factors such as power, efficiency, durability, noise, and control features to ensure optimal performance and reliability of the system.

**8) Relay**

In electronics and electrical engineering, a relay is an electromagnetic switch that is operated by a small electric current to control a much larger current or voltage. It consists of a coil of wire which generates a magnetic field when a current flows through it, and a set of contacts which are physically moved by the magnetic field to make or break a connection in an electrical circuit. Relays are commonly used in a variety of applications, such as in control circuits for industrial machinery, power distribution systems, automotive applications, and telecommunications equipment. They are an essential component in many electrical systems and offer a reliable and flexible way to control and switch high-power electrical loads.
A 4-channel relay module is an electronic device that is designed to switch multiple high-power circuits using a low-power signal. This module typically includes four independent relays, each with a normally open (NO) and a normally closed (NC) contact. The module is often used in automation projects to control various electrical devices such as lights, fans, motors, and other high-power circuits.

The module operates on a 5V DC power supply and can be easily controlled by a microcontroller or a digital output pin of a microcontroller. The input control signal voltage is usually 3.3V or 5V, making it compatible with most microcontrollers. The relay switches can handle high voltages and currents up to 250V AC and 10A DC, making it suitable for industrial and home automation applications.

The module is designed to be compact and easy to use, with screw terminals for connecting wires to the relay contacts. Each relay has an LED indicator that shows the status of the relay switch, making it easy to check whether the relay is on or off.

Overall, a 4-channel relay module is a useful device for switching multiple high-power circuits using a low-power signal, making it an essential component in many automation projects.

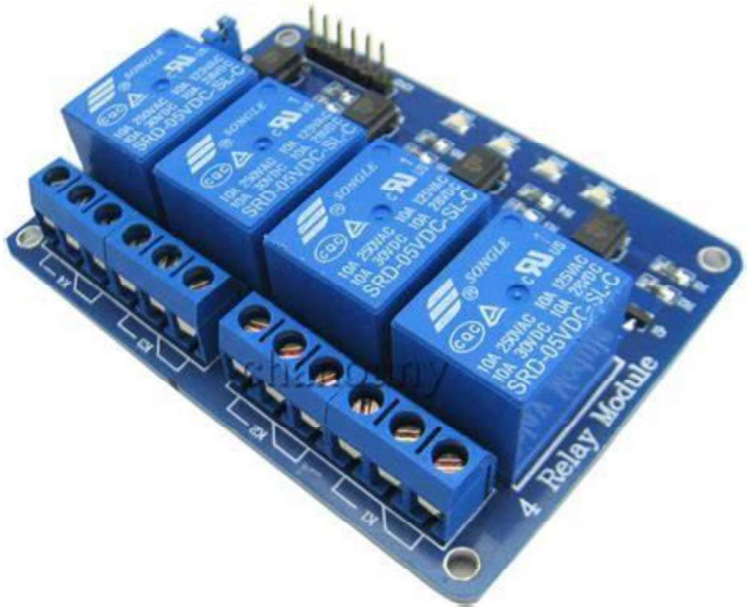



Figure 3.10: 4 channel relay module

**9) BC547 NPN Transistor**

The BC547 transistor is an NPN transistor. A transistor is nothing but the transfer of resistance which is used for amplifying the current. A small current of the base terminal of this transistor will control the large current of emitter and base terminals. The main

function of this transistor is to amplify as well as switching purposes. The maximum gain current of this transistor is 800A.

**BC547 Transistor Pin Configuration**

The BC547 transistor includes three pins which include the following.

Pin1 (Collector): This pin is denoted with symbol 'C' and the flow of current will be through the collector terminal.

Pin2 (Base): This pin controls the transistor biasing.

Pin3 (Emitter): The current supplies out through emitter terminal

A Transistor works as an amplifier while functions in the active region to amplify voltage, current, and power at various configurations. The amplifier circuit uses three configurations which include the following.

- Common emitter (CE) amplifier
- Common collector (CC) amplifier
- Common base (CB) amplifier

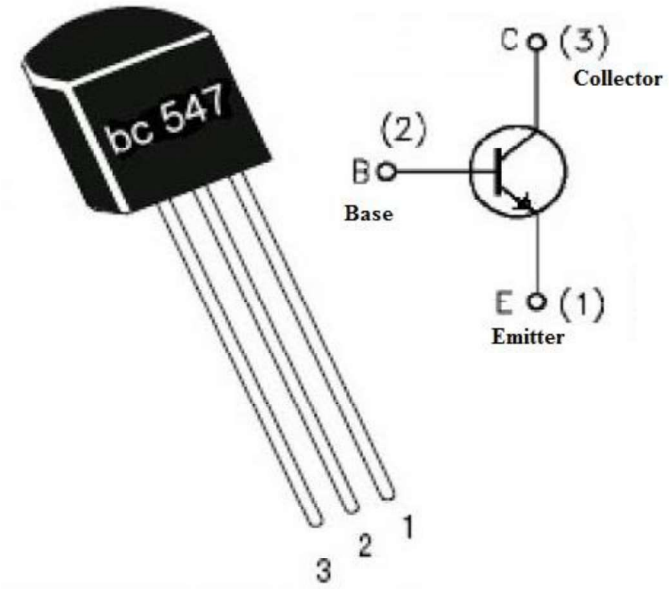



Figure 3.11: BC547 NPN Transistor

**10) Containers**

Figure 3.12: Containers

**11) Stainless Steel plates**

Stainless steel is a versatile metal alloy composed of iron, carbon, and a minimum of 10.5% chromium. It was first developed in the early 20th century and has since become an essential material in various industries, including construction, automotive, aerospace, and medical. The high chromium content in stainless steel gives it its unique properties, including corrosion resistance, high-temperature strength, and durability. Other elements such as nickel, molybdenum, and titanium are also added to improve its mechanical and physical properties.

Stainless steel is available in different grades, each with its own unique properties and composition. The most commonly used grades include 304, 316, 430, and 410. These grades have different levels of corrosion resistance, weldability, and strength, making them suitable for different applications. Stainless steel is widely used in the production of household appliances, cookware, cutlery, sinks, and kitchen equipment due to its durability, hygienic properties, and easy maintenance. It is also used in the construction of buildings, bridges, and infrastructure due to its high strength and corrosion resistance.

In conclusion, stainless steel is a versatile and durable metal alloy that has revolutionized various industries. Its unique properties make it a popular choice for a wide range of applications, from household appliances to heavy industries.

Stainless steel plates are commonly used in the production of alkaline water through electrolysis. Stainless steel is a type of steel alloy that contains at least 10.5%

chromium, which makes it highly resistant to corrosion and staining. It is also durable, easy to clean, and has a smooth surface that facilitates efficient electrolysis.

In the process of electrolysis, stainless steel plates are used as electrodes in an electrolytic cell. The electrodes are typically coated with a layer of platinum or titanium to increase their conductivity and improve the efficiency of the electrolysis process. The electrodes are placed in a solution of water and a small amount of electrolyte, such as sodium hydroxide or potassium hydroxide. When an electric current is passed through the electrodes, the water molecules are split into their constituent ions: hydrogen ions (H+) and hydroxide ions (OH-).

The stainless steel plates play an important role in the electrolysis process by providing a surface for the electrodes and serving as a source of metal ions. When the electric current is passed through the electrodes, some of the metal ions are released into the electrolyte solution, which can affect the pH and mineral content of the resulting alkaline water.

Stainless steel plates are preferred for electrolysis because they are corrosion-resistant, durable, and easy to clean. The smooth surface of the plates facilitates efficient electrolysis by minimizing resistance and maximizing contact between the electrodes and the electrolyte solution. Additionally, stainless steel is a safe and reliable material for use in food and beverage applications, making it a suitable choice for the production of alkaline water for human consumption.

In summary, stainless steel plates are commonly used in the production of alkaline water through electrolysis because they are durable, corrosion-resistant, easy to clean, and provide a smooth surface for efficient electrolysis. The use of stainless steel plates helps to ensure the quality and safety of the resulting alkaline water.

**12) 12 volt, 2A DC Adapter**

A 12 volt 2A DC adapter is a power supply device that provides a constant 12-volt direct current (DC) output with a maximum current of 2 amps. This type of adapter is commonly used to power a variety of electronic devices that require a stable and reliable power source, such as LED light strips, routers, switches, surveillance cameras, and other small electronic devices. The 12V 2A DC adapter typically features a compact size and lightweight design, making it easy to transport and use in different locations.

The adapter consists of a plug that connects to the electronic device and a power cord that connects to a standard AC outlet.

When the adapter is plugged into an AC outlet, it converts the AC voltage to DC voltage and provides a constant output of 12 volts and a maximum current of 2 amps. The adapter is designed with built-in protection features, such as over-current protection, over-voltage protection, and short-circuit protection, to prevent damage to the electronic device in case of any voltage irregularities or power surges.

In summary, a 12 volt 2A DC adapter is a reliable and efficient power supply device that provides a constant DC output of 12 volts and a maximum current of 2 amps. It is commonly used to power small electronic devices that require a stable and consistent power source.

**13) 24V SMPS**

**3.2) Software Requirements**

**1) Arduino IDE**

The Arduino IDE is an open-source software, which is used to write and upload code to theArduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++.Here, IDE stands for Integrated Development Environment. The program or code written in the Arduino IDE is often called as sketching. We need toconnect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

The Arduino IDE will appear as:

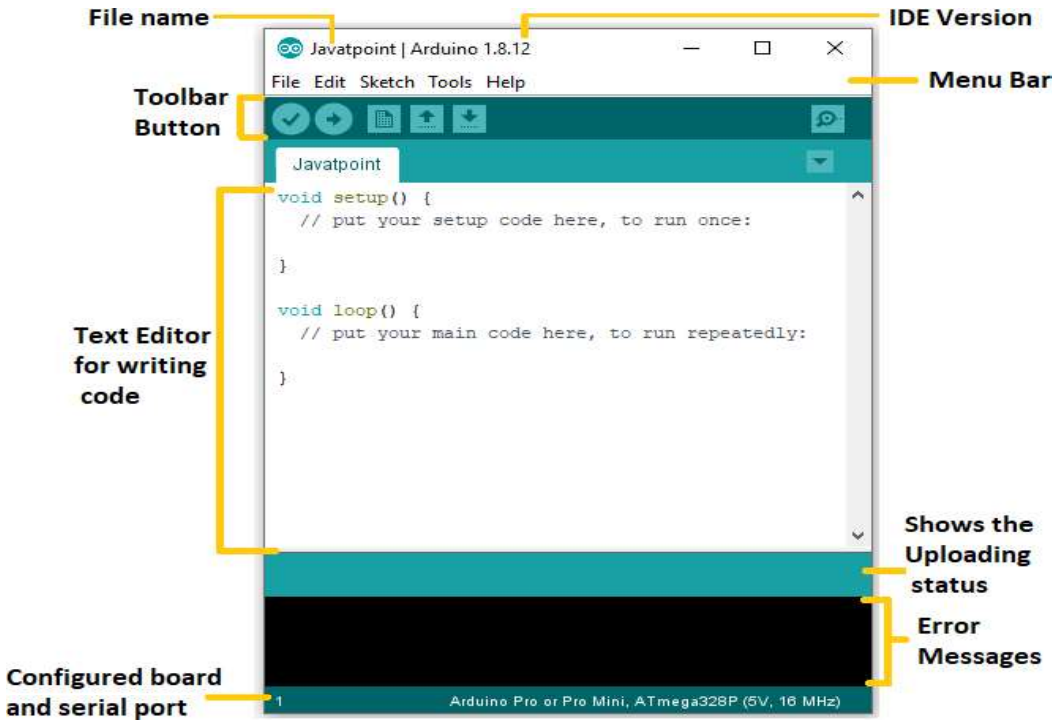



Figure 3.13.: Arduino IDE Interface

We have used Arduino IDE to display pH of processed water using **Blynk** app.

**2) Blynk Mobile App**

The Blynk is a mobile front end builder and signalling relay (MQTT). The cloud gets interconnected with the project on your phone within the Blynk app. The local side of theproject is hosted on the Big Clown Raspian which has all the necessary components prepared for interconnection. After creating the GUI‟s there is a option to turn on and offthe relay, switch the LED strip on and off, change the light intensity using slider and alsoyou would be able to watch the ph (and other values collected) accompanied by graph.

Setup Blynk app : The very first step needed is to install and configure the application on your mobile device. In order to interconnect things you would have to create an account. The Blynk app gives you two options either create account by email or use OAuth2 loginof Facebook. Then the required number of GUI are to be created.

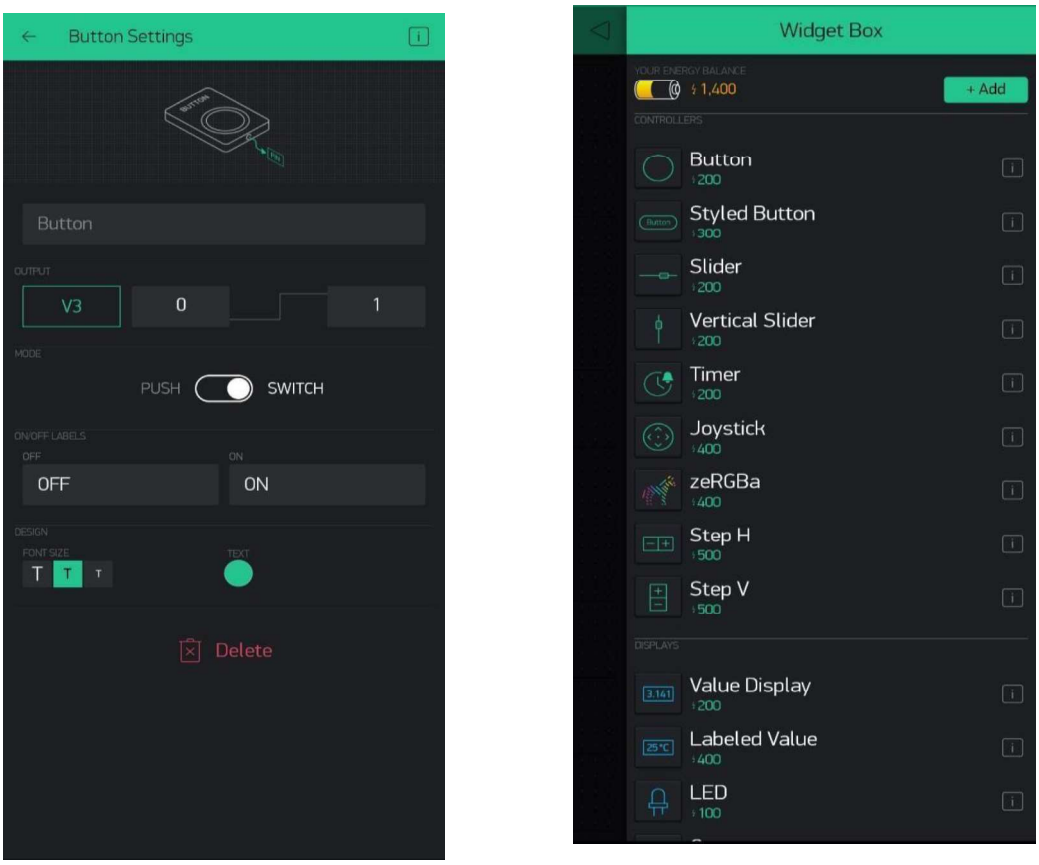



Figure 3.14:Blynk App Interface

Blynk is a mobile app that allows users to control various devices and projects through their smartphones. Here are some key features of the Blynk app:

1. User-Friendly Interface: The Blynk app features an intuitive and easy-to-use interface that allows users to control their devices with a few simple taps. The app is designed to be user-friendly for people with different levels of technical knowledge.

2. Customizable Widgets: Blynk offers a variety of customizable widgets that allow users to create their own control panels for their devices. The widgets include buttons, sliders, graphs, gauges, and more, which can be customized with different colors, fonts, and styles.

3. Cloud Connectivity: Blynk offers cloud connectivity that allows users to remotely access and control their devices from anywhere with an internet connection. The app is compatible with a wide range of devices and platforms, including Arduino, Raspberry Pi, ESP8266, and more.

4. API Integration: Blynk offers an open API that allows developers to integrate their own devices and services into the Blynk ecosystem. This allows for greater flexibility and customization of the app for different users' needs.

5. Security: Blynk is designed with security in mind, with features such as secure cloud hosting, data encryption, and two-factor authentication. This ensures that users' data and devices are protected from unauthorized access.

6. Collaboration: Blynk allows users to share their projects and collaborate with others on the Blynk community platform. This allows for knowledge sharing and learning from other users' projects.

In summary, the Blynk app offers a user-friendly interface, customizable widgets, cloud connectivity, API integration, security features, and collaboration opportunities, making it a versatile and powerful tool for controlling devices and projects from a mobile device.

# Design

## 4.1) Proposed System

Water ionizers work by using electromagnetism to change ordinary tap water into ionizedalkaline water with acid-fighting alkalinity and antioxidant potential. Plain water is a mix of alkaline minerals and carbonate – dissolved CO2. A water ionizer separates the carbonate from tap water from the alkaline minerals. The alkaline minerals, and the acidiccarbonate are discharged in a separate streams of water. By separating the alkaline elements in tap water from the acidic elements, a water ionizer enables you to get the benefit of the natural acid-fighting alkalinity the alkaline minerals in your water like calcium and magnesium. These alkaline minerals, once freed of the carbonate, gain antioxidant potential and acid fighting alkalinity.

A special attachment redirects tap water out of the faucet into the water ionizer unit. Insidethe unit, the water is first filtered which helps to remove common pollutants found in city water. Then this filtered water passes into a chamber equipped with platinum-coated titanium electrodes. Here is where the electrolysis takes place. Water is separated into acidic and alkaline parts. Water is splitted into OH- (hydroxid ions) and H+ (hydrogen ions).

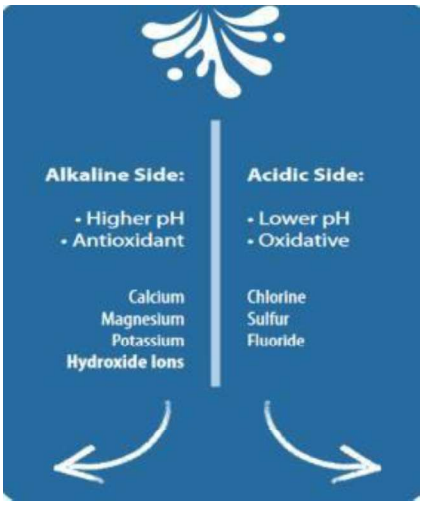



Figure 4.1:Proposed System

The reduced **ionized water** comes out of the faucet, and the oxidized water comes out of aseparate hose. You can use the reduced water for drinking or cooking. The

oxidation potential of the oxidized water makes it a good sterilizing agent, helpful for washing your hands, cleaning food or kitchen utensils, and treating minor wounds and eczema

### 4.2) Block Diagram

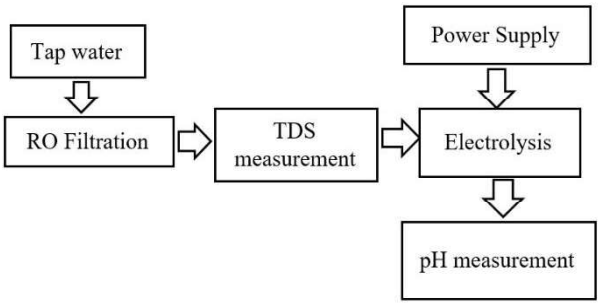



Figure 4.2: Workflow

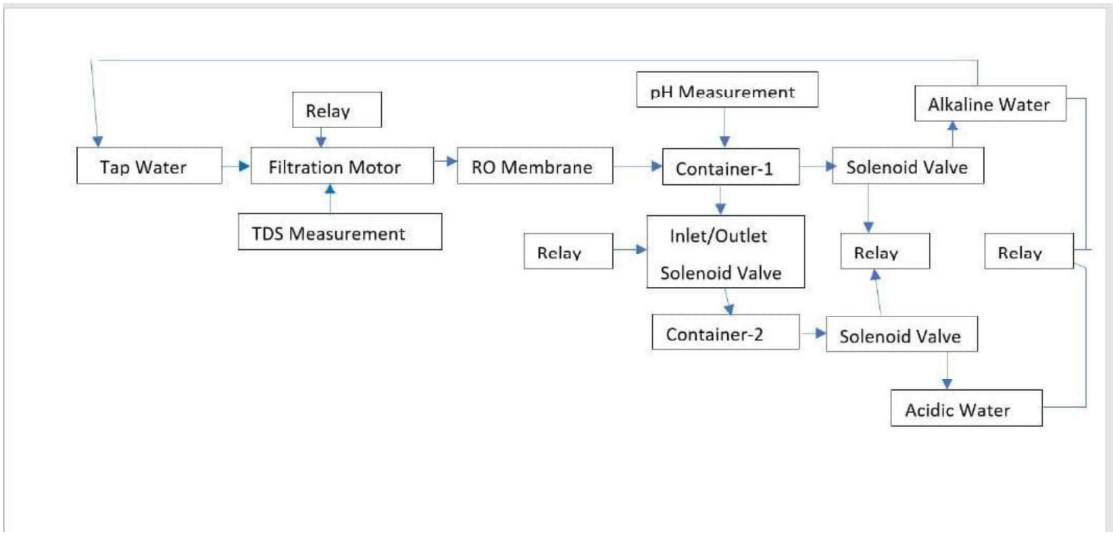



Figure 4.3: Overall Flow of working

### 4.3) Filtration Process

Filtration is a physical process that involves the use of a porous material, such as a filter, to separate particles and impurities from a liquid. In the context of TDS reduction, filtration is used to remove dissolved solids and other contaminants from water.The filtration process typically involves passing water through a filter medium, such as activated carbon, reverse osmosis membranes, or other types of filter media. As the

water flows through the filter medium, particles and impurities are trapped and removed from the water.

The traditional method of filtration involves passing water through a porous material, such as sand, gravel, or activated carbon, to remove impurities. This method has been used for centuries and is still widely used today in many parts of the world. The basic process of traditional filtration involves three stages: pre-filtration, sedimentation, and filtration.

1. Pre-filtration: This stage involves removing large particles and debris from the water. The water is typically passed through a screen or mesh to remove larger particles, such as leaves, twigs, and insects.

2. Sedimentation: This stage involves allowing the water to settle in a tank or basin to allow any remaining particles to settle to the bottom. This process can take several hours, depending on the quality of the water.

3. Filtration: This stage involves passing the water through a porous material to remove any remaining impurities. The most commonly used materials for filtration include sand, gravel, and activated carbon. The water is typically passed through several layers of these materials, with the finest layers at the top to remove the smallest particles.

The traditional method of filtration is effective at removing larger particles and some types of bacteria and viruses. However, it is not always effective at removing smaller particles, dissolved solids, or contaminants such as pesticides and heavy metals. In addition, traditional filtration can be slow and inefficient, especially when dealing with large volumes of water.

Despite its limitations, traditional filtration remains an important method of water treatment in many parts of the world, especially in rural areas and developing countries where more advanced water treatment technologies may not be available or affordable.

The filtration process that reduces the TDS (Total Dissolved Solids) of water typically involves a combination of different types of filters and media. Here's how it generally works:

Sediment Filter: The first stage of filtration usually involves a sediment filter, which removes large particles such as sand, dirt, and rust from the water. This filter is typically

made of pleated or spun polypropylene, and its purpose is to protect the other filters from clogging.

Carbon Filter: The second stage of filtration often involves a carbon filter, which removes chlorine, volatile organic compounds (VOCs), and other chemicals that affect the taste and odor of water. The carbon filter is typically made of activated carbon, which is porous and has a large surface area that can absorb contaminants.

Reverse Osmosis (RO) Membrane: The third stage of filtration often involves a reverse osmosis (RO) membrane, which removes dissolved solids such as minerals, salts, and metals from the water. The RO membrane is a semi-permeable membrane that allows water molecules to pass through while rejecting dissolved solids. The rejected solids are typically flushed away as wastewater.

Post-Filter: After the RO membrane, the water passes through a post-filter, which may be a carbon filter or a polishing filter. This filter removes any residual tastes or odors from the water, and it may also add beneficial minerals back to the water.

The combination of these filters and media reduces the TDS of water by removing dissolved solids and other contaminants. The TDS of water is typically measured in parts per million (ppm), and the goal of the filtration process is to reduce the TDS to a desirable level for drinking water, which is generally below 500 ppm. Activated carbon filters work by adsorbing dissolved solids and other impurities onto the surface of the carbon. The activated carbon has a large surface area and a porous structure, which allows it to trap and remove impurities from the water. Reverse osmosis (RO) membranes, on the other hand, use a semi-permeable membrane to filter out dissolved solids, minerals, and other contaminants from the water. The RO process uses pressure to force water through the membrane, leaving behind contaminants that are too large to pass through.

Other types of filter media may be used in TDS reduction, including sediment filters, ceramic filters, and ion exchange resins. These filters work by trapping and removing impurities from the water as it passes through the filter media.Overall, the filtration process is an effective way to reduce the TDS in water by removing dissolved solids and other impurities. The specific type of filter media used will depend on the quality of the source water and the desired level of TDS reduction. It is important to regularly

maintain and replace filter media to ensure the continued effectiveness of the filtration system.

### 4.4) Electrolysis Process

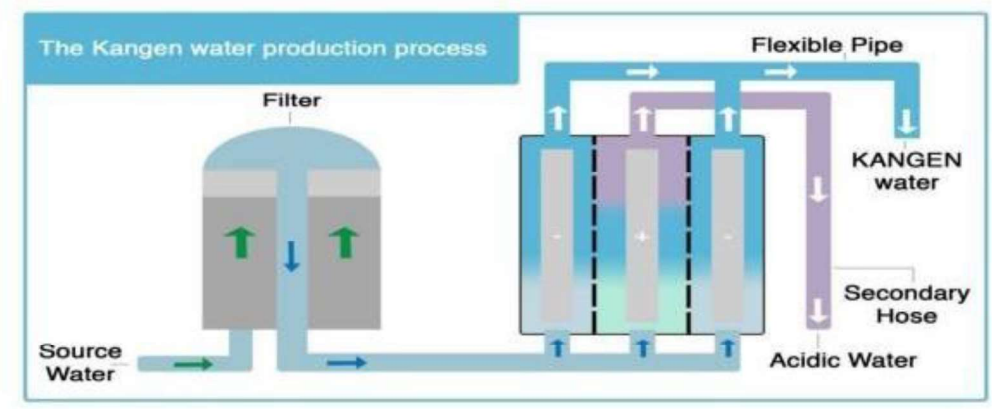



Figure 4.4: Kangen water production process

Electrolysis is a chemical process that involves the use of an electric current to break down water molecules into hydrogen ions (H+) and hydroxide ions (OH-). This process is used in the production of alkaline water.

In alkaline water production, a water ionizer device is used, which typically consists of two chambers separated by a membrane. The chambers are filled with water and electrodes, one negatively charged (the cathode) and one positively charged (the anode), are inserted into the water.

The basic electrolysis of water involves the use of an electrical current to split water molecules into their constituent parts: hydrogen and oxygen. The process involves the use of two electrodes, usually made of metal, which are immersed in water and connected to a source of electrical power.

When an electrical current is applied to the electrodes, hydrogen ions (H+) are attracted to the negative electrode (cathode), while oxygen ions (O2-) are attracted to the positive electrode (anode). At the cathode, the hydrogen ions combine with electrons from the electrical current to form hydrogen gas (H2):

$2H^+ + 2e^- \rightarrow H_2$

At the anode, the oxygen ions lose electrons to the electrical current and form oxygen gas (O2):

$2O2^- \rightarrow O2 + 4e^-$

The overall chemical reaction is:

$2H2O \rightarrow 2H2 + O2$

This reaction is endothermic, meaning that it requires energy to occur. The amount of energy required is equal to the energy released when the hydrogen and oxygen gases are recombined to form water. This means that if you run an electrical current through water to electrolyze it and collect the hydrogen and oxygen gases, you can then use the gases as a source of energy by recombining them to produce water and release the energy that was stored during the electrolysis process.

The basic electrolysis of water has many applications, including the production of hydrogen gas for use as a fuel, the purification of water, and the generation of electricity using fuel cells.When an electric current is applied to the electrodes, water molecules are split into hydrogen ions ($H^+$) and hydroxide ions ($OH^-$). The positively charged hydrogen ions are attracted to the negatively charged electrode (the cathode) and combine with electrons to form hydrogen gas ($H_2$). Meanwhile, the negatively charged hydroxide ions are attracted to the positively charged electrode (the anode) and combine with electrons to form oxygen gas ($O_2$).

The water molecules that remain in the ionization chamber are rich in hydroxide ions ($OH^-$), which gives the water a high pH and makes it alkaline. The water is then separated into two streams, one containing alkaline water and the other containing acidic water, through the use of the membrane in the ionization chamber.The pH of the alkaline water produced by electrolysis depends on the strength of the electric current used, the composition of the electrodes, and the water's mineral content. Typically, alkaline water has a pH between 7.5 and 9.5, which is higher than the pH of regular tap water (around 7).

In summary, electrolysis is used in the production of alkaline water by splitting water molecules into hydrogen ions and hydroxide ions using an electric current. The hydroxide ions in the ionization chamber give the water a high pH, making it alkaline and suitable for consumption.

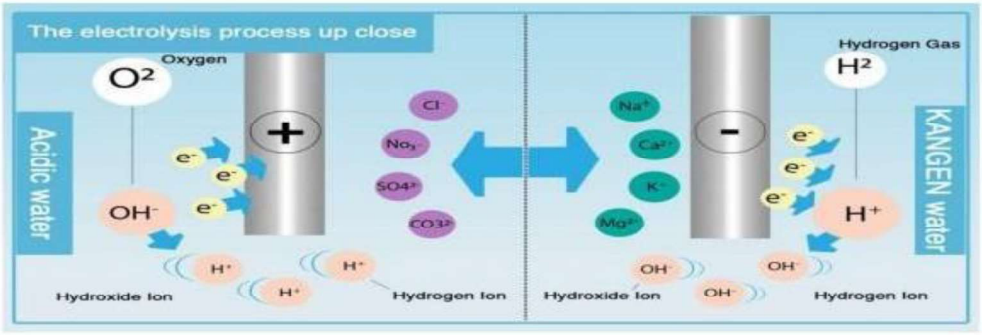



Figure 4.5: Electrolysis Process

Solenoid valves can be used in both filtration and electrolysis processes to control the flow of liquids or gases. In filtration systems, solenoid valves can be used to control the flow of water through different stages of the filtration process, such as activating the backwash function or controlling the flow of water through different types of filters. In electrolysis systems, solenoid valves can be used to control the flow of the electrolyte solution into the electrolysis cell, and to control the flow of gas generated by the electrolysis process. For example, in a hydrogen production system using electrolysis, a solenoid valve can be used to control the flow of hydrogen gas from the electrolysis cell to the collection vessel.

When selecting a solenoid valve for use in filtration or electrolysis systems, factors such as the type of fluid being controlled, the operating pressure and temperature range, and the required flow rate should be considered. Valves made of materials that are resistant to corrosion or chemical attack may also be required, depending on the specific application.

**4.5) Ph Measurement Process**

pH measurement is the process of determining the acidity or alkalinity of a solution. pH is a measure of the concentration of hydrogen ions (H+) in a solution, and is expressed on a scale of 0 to 14. A pH of 7 is considered neutral, while a pH below 7 is acidic and a pH above 7 is alkaline.

There are several methods for measuring pH, but one of the most common methods is the use of a pH meter. A pH meter consists of a pH electrode, which is a glass electrode that responds to changes in pH, and a meter that measures the voltage produced by the electrode.

To measure pH using a pH meter, the pH electrode is first rinsed with distilled water to remove any residual contaminants. The electrode is then immersed in the solution being tested, and allowed to equilibrate for a few minutes. The pH meter is then turned on and calibrated using standard buffer solutions with known pH values. The electrode is rinsed with distilled water between each calibration point. Once the pH meter is calibrated, the pH of the sample can be measured by immersing the pH electrode in the solution being tested and reading the pH value on the meter. The pH value is usually displayed digitally and can be recorded manually or electronically.

There are several factors that can affect the accuracy of pH measurements, including temperature, electrode contamination, and calibration errors. It is important to follow proper procedures for electrode maintenance and calibration to ensure accurate pH measurements.

In addition to pH meters, there are other methods for measuring pH, including pH test strips and colorimetric methods. pH test strips work by changing color in response to changes in pH, and can provide a rough estimate of pH. Colorimetric methods involve adding a reagent to the sample that changes color in response to changes in pH, and can be used to measure pH in a specific range.

Overall, pH measurement is an important process in a variety of industries, including water treatment, food and beverage, and pharmaceuticals. Accurate pH measurement is essential for maintaining quality control and ensuring the safety of products and processes.

# Working Principle

Firstly, we filter the water. The water is taken by the motor via pipe and then is passed to the filter that reduces the TDS of water. One relay is connected to the motor that will automatically stop taking the tap water once the container is filled. Then the process of electrolysis takes place as the water has been cleaned of contaminants. Calcium carbonate and magnesium sulphate, two mineral compounds that dissolve in tap water, fly over the pristine stainless steel. The electron charge that binds the mineral compounds together is split in half by a process known as. The negatively charged plate, also known as the cathode, is attracted towards by positively charged ions including calcium, magnesium, and potassium.

Sulphate and carbonate ions, among other negatively charged ions, are driven towards the anode, a positively charged plate. The separated ions then travelled across an ion permeable membrane, which allows the ions to pass through but prevents them from returning. The alkaline ions and acidic ions on either side [of the membrane] only last on their own for a brief period before interacting chemically with water molecules. The alkaline ions and the water molecules form mineral hydrates. On the other side the acidic ions combine with water molecules to create aqueous acids. We then use a solenoid valve where relay is connected. Once we get the desired value of pH on the pH meter then the solenoid valve will stop automatically and transistors are also used for this process. The valve keeps the acidic and alkaline water separate and also prevent mixing of ions.

Once the electrolysis process is done, the process of the pH measurement takes place. The pH sensor kit can be used with a GSM or NodeMCUesp8266 wi-fi module for remote notifications and is utilized in water quality monitoring devices, fish aquariums, and water tanks. We join the wire to the Arduino's 5v and the blue wire to the Analog pin A0 of the Arduino. The Arduino's Pins 2 and 3 are connected to the TX and RX pins of the NodeMCUESP8266 wi-fi module. as seen in the illustration above. The Arduino IDE is then used to programmed the NodeMCUESP8266 wi-fi module to carry out the task of uploading the data to the cloud.

The pH sensor is often made of glass and has a rod-like construction with a bulb at the

bottom that houses the sensor. A glass bulb that is specifically made to be selective to hydrogen-ion concentration is present in the glass electrode used to measure ph. Hydrogen ions in the test solution swap places with other positively charged ions on the glass bulb upon immersion in the solution under test, creating an electrochemical potential across the bulb. The electrical potential difference between the two electrodes created during the test is detected by the electronic amplifier, which transforms it to pH units. As we need to access the data which is sent over the cloud by NodeMCUESP8266 wi-fi module, therefore we use the Blynk Application. First, we open the application and enter pH meter as the Project name. Next, we on the NodeMCUESP8266 wi-fi module. Once the connection type is set to wi-fi and the create button is pressed, an authentication token will be delivered to the email address associated with your account. You can then use this token in programming by simply copying it and decide pasting it there. Then we search for the suitable widget to display the results.

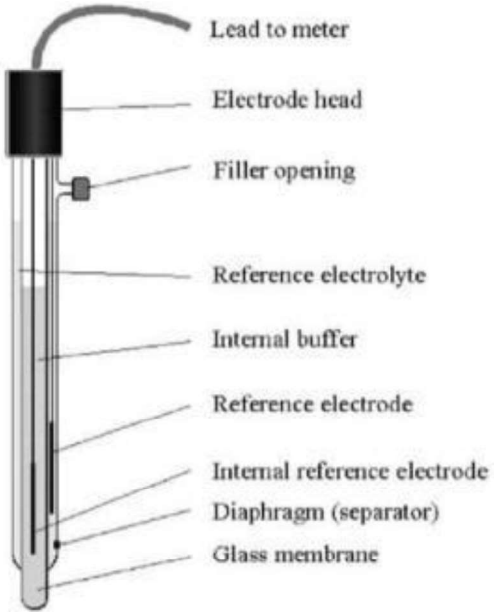



Figure 5.1: Glass Electrode

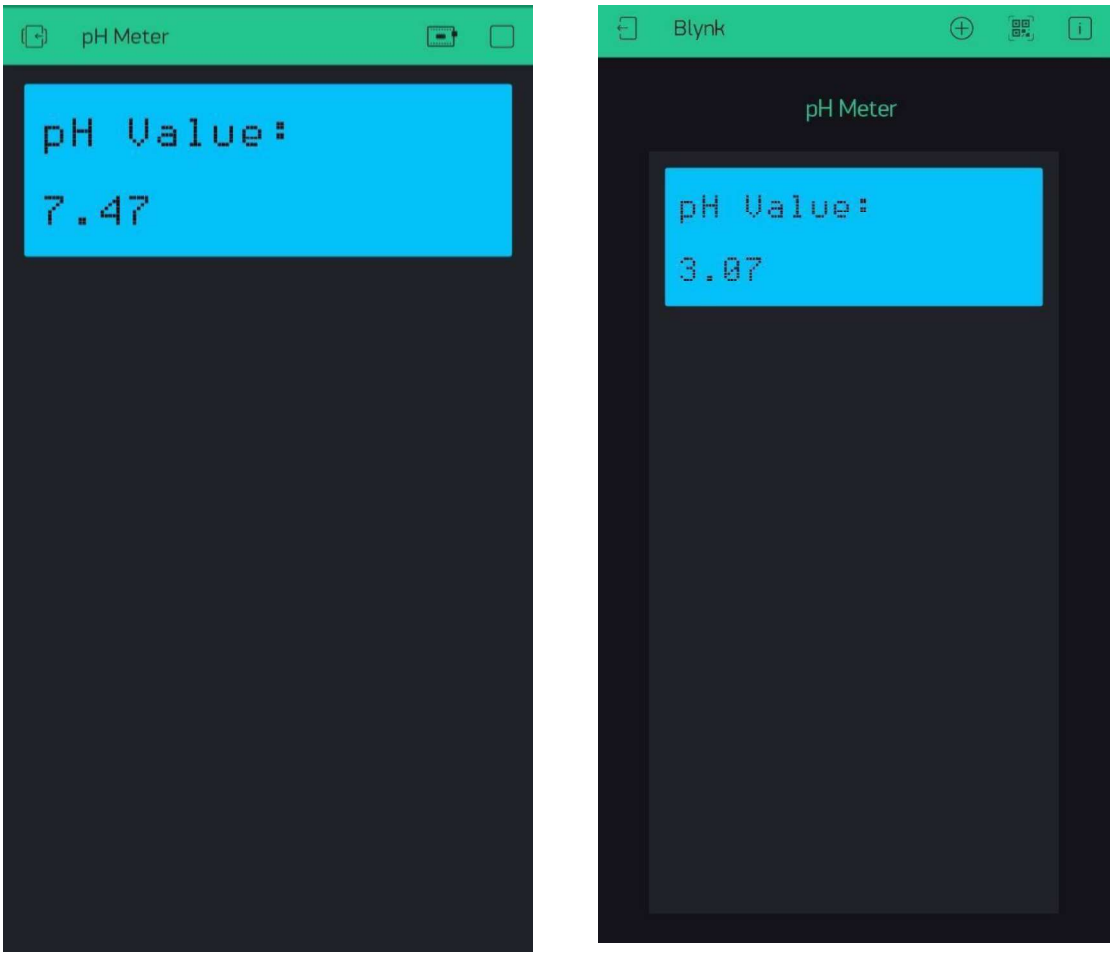



Figure 5.2: Blynk App Results

The above picture shows the results of ph measurement of the lime water when tested, using the pH sensor. Similarly, we can find out pH results for the alkaline water and whichcould be used for drinking as well as other beneficiary purposes

# Benefits of Alkaline Water

In the present pandemic situation, it is very much important to have a good immune system. Having a balanced and nutritious diet is one of the keys for boosting the immunity. Thus, proper digestion and metabolism of the food is very essential. Alkaline water is good source for maintaining the pH level of the body and further enhancing the over wellness of the organs. The acidic water too, has its own benefits which can be used the hygiene-based functions.

Thus, the water ionizer will provide us the alkaline water as well as the acidic water separately by passing the stream of water through the built system.

The following are benefitting Alkaline water:

1: Balances pH level of your Body

Your body tries to maintain the pH level naturally. However, if your body is too acidic, your systems need to work extra hard to maintain the pH balance. When your body is tooacidic, it affects the pH level of your body. When your body is too acidic, you are more vulnerable to diseases. As compared to plain water, drinking alkaline water helps you maintain pH level in your body and avoid diseases.

2: Helps in Detoxification

One of the main benefits of drinking alkaline water is detoxification. Alkaline water flushesout toxins from the body that lead to several health problems. In addition to eating a lot of fruits and vegetables, you also need to drink at least 8 glasses of alkaline water to detoxify your body. The reason is alkaline water raises the pH level of your urine, thereby improving your kidney function and detoxifying your body.

3: Improves Immune System

Regular intake of alkaline water plays an important role in boosting the immune system. When your body is in the alkaline state, it boosts your immune system. Alkaline water naturally neutralized the free radicals, thereby cleansing the toxins present in your body. Drinking alkaline water regularly will significantly improve your immune system and alsoprovide long-term health benefits.

4: Helps Lose Weight

Another benefit of using an alkaline water filter on a daily basis is it helps you lose weight. Junk foods have become a part of our diet; however, unhealthy junk food

significantly increases acidity in your body. To neutralize this acidity, your body produces 13 more fat cells resulting in weight gain. Drinking alkaline water on a daily basis neutralizes acidity inyour body and avoid weight gain.

5: Neutralizing acid in the body

Some proponents of alkaline water claim that it can help neutralize acid in the body, which is associated with a range of health problems. However, there is little scientific evidence to support this claim.

6: Hydration

Drinking water, in general, is important for staying hydrated, and alkaline water is no exception.

7: Antioxidant properties

Some studies have suggested that alkaline water may have antioxidant properties, which could potentially help protect the body against damage from free radicals. However, the evidence is limited, and more research is needed.

8: Digestive health

There is some evidence to suggest that alkaline water may help reduce acid reflux symptoms in some people. However, more research is needed to confirm this.

9: Athletic performance

Some athletes and fitness enthusiasts believe that drinking alkaline water can improve their performance and reduce muscle fatigue. However, there is little scientific evidence to support this claim.

Overall, while there are some potential benefits of alkaline water, there is currently limited scientific evidence to support these claims. It is important to drink enough water to stay hydrated, but the best type of water for your health will depend on a variety of factors, including your individual needs and preferences.

There are two main types of water ionizers: electric and non-electric.

**Electric Water Ionizers:** Electric water ionizers are devices that use electricity to ionize water. They typically use a process called electrolysis to split the water molecules into hydrogen and oxygen ions. The hydrogen ions are then collected and separated from the oxygen ions to produce alkaline and acidic water.

**Non-electric Water Ionizers:** Non-electric water ionizers are devices that use natural minerals and other materials to ionize water. These devices typically use a process

called mineralization or mineral ionization, where water flows over natural minerals such as tourmaline, coral, or silica, which infuse the water with alkaline minerals.

Both types of water ionizers produce alkaline and acidic water, which can be used for different purposes such as drinking, cooking, or cleaning. It's important to note that while water ionizers are marketed as health devices, their benefits are not yet fully supported by scientific research, and they should not be considered as a substitute for medical advice or treatment.

The cost of water ionizers can vary depending on several factors such as the brand, features, and quality. Here are some reasons why water ionizers can be expensive:

Materials and Components: Water ionizers are typically made of high-quality materials such as titanium or platinum-coated plates, which are expensive. These materials are used to ensure the longevity of the ionizer and the quality of the water it produces. In addition, the ionizers often have advanced filtration systems, which can add to the cost.

Technology and Features: Many water ionizers use advanced technology such as electrolysis or mineralization to produce alkaline water. These technologies are expensive to develop and incorporate into the ionizers. In addition, some ionizers have additional features such as adjustable pH levels, touchscreens, and voice prompts, which can also add to the cost.

Research and Development: Developing and testing water ionizers involves significant research and development, which can add to the cost. Manufacturers invest in research and development to ensure that their ionizers produce high-quality, safe, and effective alkaline water.

Brand Recognition: Some water ionizer brands have established a reputation for producing high-quality and effective ionizers. These brands may charge a premium for their products because of their reputation and brand recognition.

In summary, the cost of water ionizers can be attributed to the quality of the materials and components used, advanced technology and features, research and development, and brand recognition. However, it's important to note that the cost of a water ionizer does not necessarily indicate its effectiveness, and consumers should do their research before making a purchase.

The main material used in water ionizers is typically platinum-coated titanium plates. The platinum coating on the plates is used to ensure that the plates are durable, corrosion-resistant, and can withstand the high current used in the electrolysis process.

Titanium is used as the base material for the plates because it is a strong and lightweight metal that is also resistant to corrosion. The combination of titanium and platinum makes the plates ideal for use in water ionizers.

In addition to the plates, water ionizers may also contain other materials such as activated carbon, ceramic, or mineral stones for the filtration and ionization process. The type of material used in the filtration process can vary depending on the brand and model of the water ionizer. It's important to note that the quality of the materials used in the water ionizer can affect the quality and longevity of the ionizer. Therefore, it's important to choose a water ionizer from a reputable manufacturer that uses high-quality materials to ensure the effectiveness and durability of the ionizer.

Using stainless steel plates instead of platinum-coated titanium plates in water ionizers can significantly reduce the cost of the ionizer. However, stainless steel plates are not as effective in the ionization process as titanium plates because they do not conduct electricity as well.

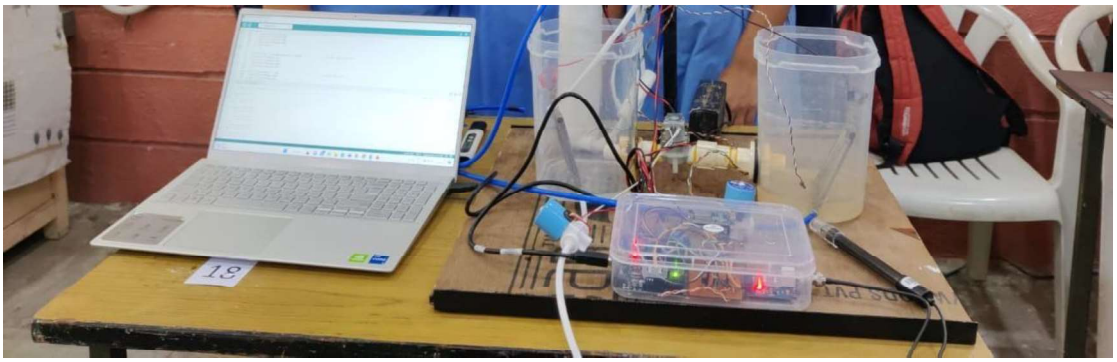
Stainless steel is a durable and corrosion-resistant material that is commonly used in the food industry and medical equipment. However, it is not as suitable as titanium for use in water ionizers because it is not as conductive, and it may not produce as high-quality alkaline water.

Water ionizers that use stainless steel plates may be less expensive than those that use titanium plates, but they may not produce the same quality of alkaline water. The pH level and the antioxidant potential of the alkaline water produced by stainless steel plates may not be as high as those produced by titanium plates. In addition, stainless steel plates may not last as long as titanium plates and may require more frequent replacement.

Overall, while using stainless steel plates in water ionizers may reduce the cost of the ionizer, it may also affect the quality and effectiveness of the ionizer. It's important to consider the trade-offs between cost and quality before making a purchase.

Chapter 7

# Experimental Setup



Chapter 8

# Experimental results

The described system enables water purification, ionization, pH measurement, and remote monitoring. After the water is filtered to remove contaminants, it enters the ionization chamber. The dissolved mineral compounds, such as calcium carbonate and magnesium sulfate, undergo electrolysis, breaking the electron charge that holds them together.

During electrolysis, positively charged ions (calcium, magnesium, potassium) are attracted to the negatively charged plate (cathode), while negatively charged ions (carbonate, sulfate) are drawn to the positively charged plate (anode). The separated ions then pass through an ion permeable membrane, which allows them to pass through but not cross back. On each side of the membrane, alkaline ions and acidic ions exist briefly on their own before chemically combining with water molecules. The alkaline ions and water molecules form mineral hydrates, while the acidic ions combine with water molecules to create aqueous acids. A mechanical valve is used to keep the acidic and alkaline water separate, preventing the mixing of ions. Once the electrolysis process is complete, the pH measurement takes place.

For pH measurement, a pH sensor kit is used, typically employed in water quality monitoring equipment. The pH sensor is connected to an Arduino board, with the sensor's glass electrode submerged in the solution to be tested. Hydrogen ions in the solution exchange with other positively charged ions on the glass bulb, creating an electrochemical potential across the bulb. An electronic amplifier detects the potential difference between the two electrodes and converts it to pH units.

| Unfiltered Water TDS | Filtered Water TDS |
|---|---|
| 346 ppm | 32 ppm |

Table 7.1: TDS Values

| Alkaline Water pH | Acidic Water pH |
|---|---|
| 6.72 | 5.92 |
| 6.8 | 5.66 |
| 6.95 | 5.88 |
| 7.2 | 5.53 |
| 7.32 | 4.56 |
| 7.5 | 4.84 |

Table 7.2 : Water pH values

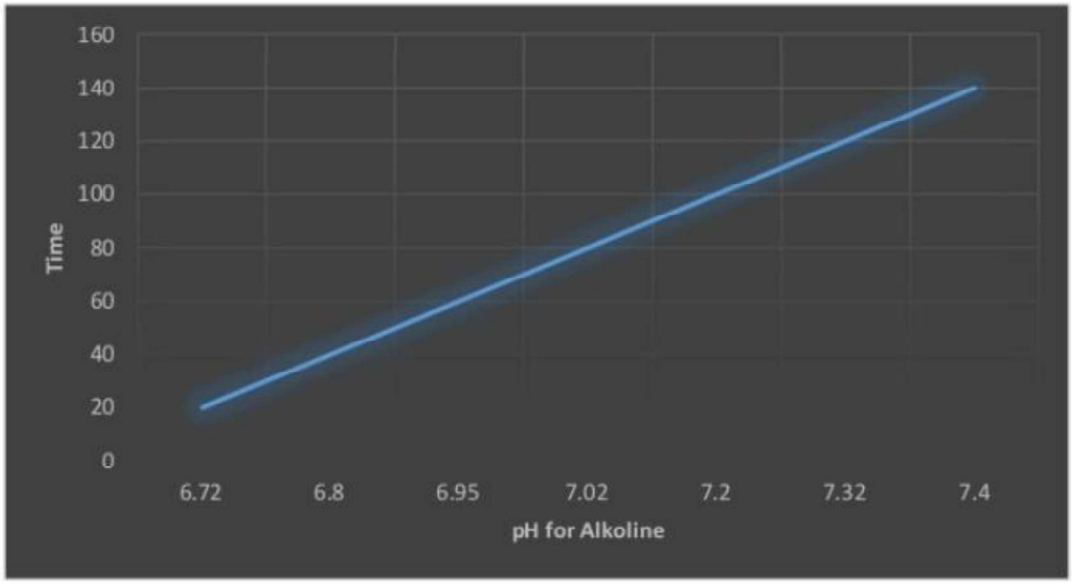



Figure 7.1 : Increasing pH values for alkaline

To access the data sent over the cloud by the NodeMCU ESP8266 Wi-Fi module, the Blynk Application is utilized. The application is opened, and a project named "pH meter" is created, with the device selected as the NodeMCU ESP8266 Wi-Fi module. The connection type is set to Wi-Fi, and an authentication token is obtained and used

in the programming to establish the connection. Suitable widgets are then chosen within the application to display the pH measurement results.

The system provides real-time pH monitoring remotely, allowing users to keep track of water quality in various applications such as water tanks and fish aquariums. The pH measurement results obtained through the described setup offer valuable insights into water acidity levels, enabling timely actions to maintain optimal conditions for different purposes.

# Conclusion and Future Scope

The Water-Ionizer Market is a dynamic and constantly evolving industry, with new products and technologies being introduced at a rapid pace. This presents both opportunities and challenges for businesses operating in the market. This report discusses about top industry segments by type (Counter Top Water-Ionizer , Under Counter Water-Ionizer ), applications (Household , Hospital , Commercial , Others ) and regions. To succeed in this competitive landscape, companies must stay ahead of the curve and be able to adapt quickly to changing consumer preferences and market trends. The global Water-Ionizer market research report provides valuable insights and analysis to help businesses navigate this complex landscape and make informed decisions about product development, marketing, and overall business strategy. With its comprehensive coverage of market size, segmentation, and growth trends, this report is an essential resource for any business looking to succeed in the Water-Ionizer Market. The future scope of water ionizers is promising, as there is growing interest in health and wellness, eco-friendly technologies, and sustainable living. Water ionizers are devices that use electrolysis to alter the pH level of water, making it more alkaline or acidic. Here are some potential future developments and trends in the field of water ionizers:

1. Improved Technology: Future water ionizers may feature enhanced electrolysis systems that can produce water with a wider range of pH levels and higher antioxidant potential. Advancements in materials and manufacturing processes may lead to more efficient and durable ionization chambers.

2. Integration with Smart Home Systems: With the rise of smart home technologies, water ionizers could be integrated into these systems. Users may be able to control and monitor their ionizers remotely through mobile apps, adjust pH levels, and receive real-time data on water quality and usage.

3. Customized Water Settings: Future ionizers may offer personalized settings to cater to individual preferences and health needs. This could include adjustable pH levels, varying levels of ionization, and the ability to add specific minerals or electrolytes to the water.

4. Compact and Portable Designs: As demand increases, manufacturers may develop more compact and portable water ionizers. This would allow people to have access to ionized water wherever they go, promoting hydration and wellness on the move.

5. Integration with Filtration Systems: Water ionizers often include built-in filtration systems to remove impurities. Future advancements may result in more efficient and effective filtration mechanisms, ensuring the delivery of clean, purified water along with ionization.

6. Environmental Sustainability: Eco-friendly features could become more prominent in future water ionizers. This may include energy-efficient designs, minimal water wastage during the ionization process, and the use of sustainable materials in manufacturing.

7. Scientific Research and Validation: Continued research on the health benefits of ionized water and its effects on the body may lead to further validation and acceptance of water ionizers in mainstream health and medical communities. Scientific studies may explore the potential applications of ionized water in various fields, such as sports performance, skin health, and disease prevention.

It's important to note that these potential developments are speculative, and the actual future of water ionizers will depend on various factors such as technological advancements, market demand, and consumer preferences.

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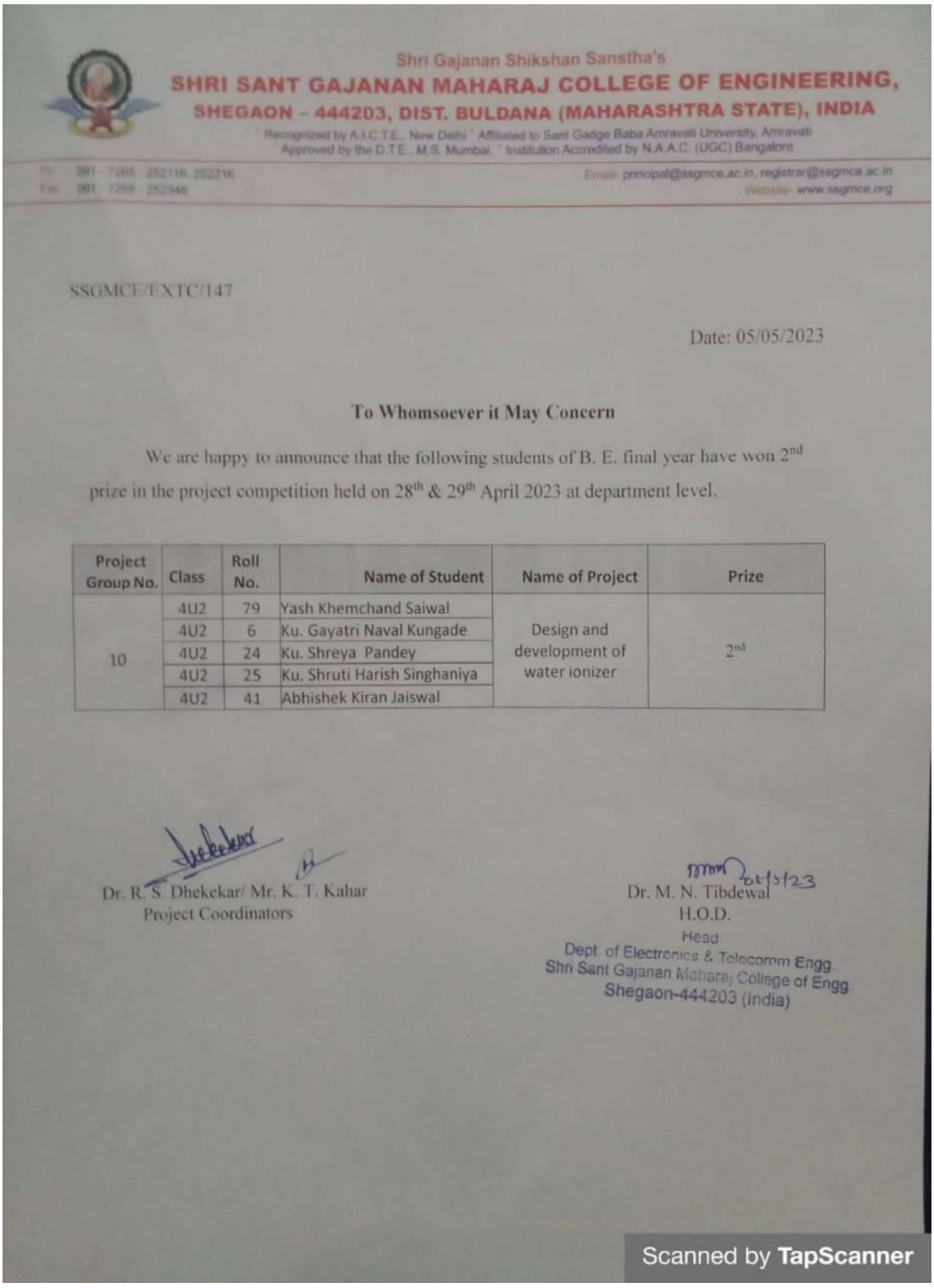

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Date: 05/05/2023

**To Whomsoever it May Concern**

We are happy to announce that the following students of B. E. final year have won 2nd prize in the project competition held on 28th & 29th April 2023 at department level.

| Project Group No. | Class | Roll No. | Name of Student | Name of Project | Prize |
|---|---|---|---|---|---|
| 10 | 4U2 | 79 | Yash Khemchand Saiwal | Design and development of water ionizer | 2nd |
| | 4U2 | 6 | Ku. Gayatri Naval Kungade | | |
| | 4U2 | 24 | Ku. Shreya Pandey | | |
| | 4U2 | 25 | Ku. Shruti Harish Singhaniya | | |
| | 4U2 | 41 | Abhishek Kiran Jaiswal | | |

Dr. R. S. Dhekekar/ Mr. K. T. Kahar
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in the IEEE National Students' Conference on Innovation In Rural Development organized by IEEE Students' Branch, Shri Sant Gajanan Maharaj College of Engineering, Shegaon held on 20th - 21st April 2023.

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