A

Project Report

ON

**"Automated Industrial Water Recycler"**

**BACHELOR OF TECHNOLOGY**

**IN**

ELECTRONICS AND COMMUNICATION

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# CERTIFICATE

This is to certify that project report entitled "**Automated Industrial Water Recycler**". Which is submitted by Piyush Verma (1634831033), Priyanka Nigam (1634831038), Rahul Goswami (1634831041), Shivani Diwakar (1634831053), Suraj Kumar Patel (1634831060) in partial fulfillment of the requirement for the award of degree B-Tech. in department of electronics and communication Engineering AKTU, is a record of candidate own work carried out under my supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

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# ACKNOWLEDGEMENT

I would like to make my deepest appreciation and gratitude to **Ms. Pratishtha Agnihotri (Assistant professor), Department of Electronics & Communication Engineering, PSIT College Of Engineering,** Kanpur for her invaluable guidance, constructive and encouragement during course of this project. Their sincerity, thoroughness and perseverance have been a constant source of inspiration for us. It is only their cognizant efforts that our endeavors have seen light of the day.

We also take the opportunity to acknowledge the contribution of **Ms. Pratishtha Agnihotri, Department of Electronics & Communication Engineering, PSIT College of Engineering, Kanpur for** providing the necessary opportunities for the completion of this project.

We also do not like to miss the opportunity to acknowledge the contribution of all faculties Members of the department for their kind assistance and cooperation during the development of our project. Last but not the least, we acknowledge our friends for their contribution in the completion of the project.


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# DECLARATION

I hereby declare that this submission in my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

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# ABSTRACT

Industrial water consist many chemical substances which are very detrimental for agriculture, human lives, animals due to which it is very imperative to remove the harmful chemicals to the wastage water. Water is always very decisive part for everyday life. This project based "water monitoring and purification system that measures wastage water quality and purification quality after purify the water.

Our project is based on idea that the quality of water can be important parameter when it comes for the use of industry because it consist very chemical components which is not needed for the work of industrial process. Water should be treated and reused in the industries because huge amount of water is converted into effluents and dump in to the river and that water can causes many diseases in human bodies, animal bodies as well as in plants. Due to the vast increase in global industrial output, rural to urban drift and the over-utilization of land and sea resources, the quality of water available to people has deteriorated greatly. The high use of chemicals in industries for the production and construction of machines have contributed immensely to overall reduction of water quality. BOD and COD are done to measure the oxygen requirement of the effluent.

We all know that water is an essential need for human survival and therefore there must be mechanism put in place to vigorously test the quality of water for the reuse purpose in the industries.

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# CHAPTER-1

## INTRODUCTION

### Overview

Water is not commercial product like any other but, rather, a heritage which must be protected, defended and treated as such. Water is basic necessity of man along with food and air. Fresh water resources usually available are rivers, lakes and underground water reservoirs. About 71% of the planet is covered in water, yet of all of that 96.5% of the planet's water is found in oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps and 0.001% in the air as vapor and clouds, only 2.5% of the Earth's water is freshwater and 98.8% of that water is in ice and groundwater. Less than 1% of all freshwater is in rivers, lakes and the atmosphere. Distillation is one of many processes available for water purification, and sunlight is one of several forms of heat energy that can be used to power that process.

The quantity of water had always been a concern for many people in the world. Population is increasing on an exponential scale which leads to a greater need for water reserves. Contaminated water can carry different types of waterborne diseases. Usage of water from untreated water can cause illness which leads to extreme pain. There are many areas in the world that need a solution to make their polluted water potable. Water purification system allows families to provide themselves with sufficient safe using of water that the body requires on daily basis. With a purification system, water sources that are normally too dangerous for consumption can now become useful. A system that is affordable can decrease the amount of preventable illnesses and deaths across the word.

The aim of this project is to recover pure water from waste water produced from industries by using filtration process and to reuse it.

The system will have three main properties which are given below:

1. The system must kill all microorganisms in the water to make it safe for consumption.
2. It must have a low construction cost and
3. It must provide a recovery of water for household purposes etc.

In recent years, it is inevitable that city authorities need to handle the larger amount of wastewater due to the growing population and meet the stringent legislation under a limited budget. Within the wastewater plant, excluding the cost of labor, maintenance and equipment, the chemical reagent forms the main part of the budget.

There are mainly several kinds of the chemical reagents used in the wastewater plant such as acid or base for the pH adjustment, coagulant for the coagulation, flocculation, chlorine or chlorine dioxide for the disinfection. Due to the high cost of the chemical reagents, it is significant to optimize the usage of the chemical reagents. Not only the municipal wastewater treatment plants but also the industrial plants currently seek ways to reduce the cost by either implementing the cost-efficient chemical reagents or adapting the new application of the chemical reagents.

In this project, we present an IOT design for water monitoring and control approach which supports internet based data collection on real time bases. With rapidly rising population in India, Fresh Water Management is very much essential which demands an increase in agricultural, industrial and other requirements. The Quality of Fresh Water is characterized by "chemical, physical and biological" content. We also measure the quality of water distributed to every industries working by deploying pH, turbidity and temperature sensors. Water quality monitoring system involves three steps namely water sampling, testing and investigation. Now with the use of Machine to Machine Communication which leads to devices communicating among themselves and accordingly analyzing the data intelligently, we here have developed an "Intelligent IOT based water quality monitoring and purification system" pertaining to storage tanks being used by residential areas. Fresh Water Management is very much essential which demands an increase in agricultural, industrial and other requirements.

Monitoring the water quality helps in detecting the pollution in water, toxic chemicals and contamination. Traditional method still in vogue entails collection of water samples, analyzing it in lab and advice for any water treatment and so forth. The advent of technology, automation can be brought in water quality monitoring system in taking action appropriately rather than relying on manual process. In automating the water quality monitoring some amount of technological innovation has creep in which would help in monitoring the quality of water rather than relying on manual process. With the upcoming of Machine to Machine communication leading to Internet of things which involves devices interacting among themselves without any human intervention, we here have developed an "Intelligent IOT based Water Quality Monitoring and purification system" where pH sensor, turbidity sensor, temperature sensor deployed for collecting the water parameters periodically from different types of water and checked their PH, turbidity and temperature of water. These collected water parameters are sent to the micro-controller and same sent by means of serial communication to Arduino UNO.

# CHAPTER-2

# Literature Study & Overview

The following literature review aims to introduce the reader to the different parts of the report. Information for this report has been collected through books, articles, reports, and websites and by talking to people.

It is important to be critical to the information found in literature. Books, articles, and reports can give incorrect information. New discoveries could always make a book out of date, but in some cases the fact will be the same for many years. It is easy to get information from Internet today and many companies use websites to sell their products. In these cases, companies will probably only provide information that gives them positive publicity. It is also easy to put information on the web, without proper reviewing.

The definition of wastewater and the categories of the wastewater such as domestic wastewater and industrial wastewater are introduced. The main facilities of the wastewater treatment plant are briefly presented including the coagulation and flocculation processed.

## 2.1 Wastewater

Wastewater is a complicated mixture that contains both inorganic and organic material. In the Cambridge dictionary, wastewater is defined as water that is not clean because it has already been used in homes, business, factories, etc.

### 2.1.1 Industrial Wastewater

The term of industrial wastewater can be defined as following: The water or liquid carries waste from an industrial process. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feedlots, poultry houses, or diaries. Even though the amount of the water consumed by the industrial factories is less than agriculture and domestic, it contains highly polluting substance once it releases complicated pollutants. Much significant emphasis is given to the prevention of the industrial pollution by many countries nowadays. Industrial wastewater can be classified basing on biodegradability and dissolved solids.

**TABLE 2.1.1: Source of chemicals from various industries (adapted from Chandrappa & Diganta et al.)**

| S.NO. | Chemical | Industry |
|---|---|---|
| 1. | Acetic acid | Acetate rayon |
| 2. | Acids | Acid manufacturing, chemical manufacturing involving acids, mine, textiles manufacture, plating |
| 3. | Alcohol | Breweries, distilleries |
| 4. | Alkaline | Wool scouring, cotton/straw kiering |
| 5. | Ammonia | Coke/gas and chemical manufacturing |
| 6. | Arsenic | Sheep dipping |
| 7. | Cadmium | Plating |
| 8. | Chromium | Alum anodizing, chrome tanning, plating |
| 9. | Chlorine | Health care establishments, leaching powder |
| 10. | Chloride | Fish processing, pickling |
| 11. | Citric acid | Citrus fruit processing and soft drinks |
| 12. | Copper | Copper pickling, copper plating |
| 13. | Cyanides | Gas manufacturing, metal cleaning, plating, steel hardening, electro polishing |
| 14. | Fats, oils, grease | Wool scouring, laundries, textile industry, food industries using oil/grease, vehicle servicing, petroleum |
| 15. | Fluorides | Scrubbing of flue glass, gases, etching |
| 16. | Formaldehyde | Synthetic penicillin and resins manufacture |
| 17. | Free chlorine | Textile bleaching, paper mills, laundry |
| 18. | Gold | Plating |
| 19. | Hydrocarbons | Rubber factories, petrochemical |
| 20. | Hydrogen sulphide | Petrochemical |
| 21. | Lead | Plating |

| | | |
|---|---|---|
| 22. | Iron | Iron and steel |
| 23. | Mercaptans | Oil refining, pulp |
| 24. | Nickel | Plating |
| 25. | Nitro compounds | Chemical works and explosives |
| 26. | Organic acids | Fermentation plants and distilleries |
| 27. | Pesticides | Pesticide manufacturing |
| 28. | Phenols | Gas and coke manufacturing, chemical plants |
| 29. | Phosphate | Soap and detergent |
| 30. | Radioactive material | Atomic power station, radioactive processing industry |
| 31. | Silver | Plating |
| 32. | Sodium | Fish processing, pickling |
| 33. | Starch | Food processing, textile industries |
| 34. | Sugars | Breweries, dairies, sweet industry, confectionaries, fruit juice, soft drink, sugar |
| 35. | Sulphides | Textile industry, tanneries, gas manufacture |
| 36. | Tannic acid | Tanning, sawmills |
| 37. | Tartaric acid | Wine, leather, chemical manufacture, dyeing |
| 38. | Tin | Electroplating |
| 39. | Zinc | Zinc plating, rubber process, galvanizing |

### 2.1.2 Domestic wastewater

In this section, the definition, characteristics of the domestic wastewater and the methods of measuring the degree of the domestic wastewater will be described briefly. According to the Finnish decree, domestic wastewater means wastewater originating from water closets of dwellings, offices, business premises and other facilities, and from kitchens, washing facilities and similar facilities and equipment, and wastewater with similar properties and composition originating from milk stores at dairy farms or resulting from other business operations.

### 2.1.3 Characteristics of the domestic wastewater

The color of the wastewater can indicate the age of the wastewater because fresh wastewater is grey. After a certain time, the color turns into dark and eventually to black due to rotten substance in the wastewater. The smell of the wastewater varies from time to time especially when the wastewater becomes dark because the organic matter is decomposed. The acidity also varies from time to time because the fresh wastewater has around neutral pH value. When putrefaction happens and the acidic gases are released, the pH value of the wastewater declines. In the wastewater, dissolved and suspended particles only account 0.1% and the rest is water. About 50% of the particles in the wastewater are organic substance. Those organic substances have a large part which is microscopic living organisms.

### 2.1.4 Contaminants in wastewater

Wastewater contains a lot of microorganisms such as helminthes, parasitic protozoa, bacteria, and viruses. Helminthes are often known as parasitic worms. Protozoa are single-celled eukaryotes that are heterotrophic and usually larger than bacteria in size. Some protozoa are mobile by flagella, pseudopods or cilia, while others are immobile. Bacteria are single cell of prokaryotes which are shed by the human population in the sewer shed. Virus is very small infectious matter that needs a host cell to replicate and there are different viruses which infect almost all kind of organism including animals, plants and even bacteria. A variety of inorganic substances show their trace in the domestic wastewater, such as metals, nutrients, ox halides and salts. While the organic fraction is composed primarily of proteins, carbohydrates and fats, which reflect the diet of the community served by the treatment system. The carbohydrates have a general formula (C6H10O5) n. Glucose, sucrose and lactose are the most common sugars in the sewage, which represent a high portion of the BOD. The proteins in the wastewater can be decomposed into carbon, hydrogen, nitrogen, oxygen and many other trace elements. Phosphorus is found in the sewage in the form of orthophosphates, polyphosphate or as part of an organic complex. In the treatment of sewage, the amount of the phosphorus in the form of orthophosphate will account for 80% because of the decomposition of the polyphosphates and organic phosphorus. Fat is a term that can be used interchangeably with grease and lipids. Fats include all the fats, oils and waxes 8 associated with food. Because of the stability of the fats, the forms of the fats presenting in the sewage usually are palmate, oleic and stearic. These fats can contribute a significant BOD of wastewater (40- 100 mg/l). Nitrogen (N) exists in different forms in the sewage such as organic nitrogen, ammonia and oxidized nitrogen (nitrate and nitrite).

## 2.1.5 Wastewater plant

In this section, the basic units of the wastewater treatment will be introduced briefly. The following summarization is based on the book named Water Technology-An Introduction for Environmental Scientists and Engineers. According to the currently executed European Urban Waste Water Treatment Directive (91/271/EEC), the towns with a population equivalent excess of 2000 need to implement the secondary treatment when discharging the wastewater to the estuaries. Wastewater treatment can be divided into two main processes which are the physical unit processes as well as chemical unit processes. The treatment is the separation of suspended, settle able and soluble substrate from the water by various sorption processes to form the large particles to be removed from the wastewater by settlement. Different treatment of wastewater has different kind of combination of unit which is usually decided by the nature of the wastewater itself.

## 2.1.6 Turbidity of wastewater

Turbidity is the measure of the clarity of a liquid. It is contributed by both suspended solids and colloidal material in water. Most of the turbidity in surface water is due to the erosion of colloidal substances like clay, silt, rock fragments, and microbes and so on. The units of measurements are the Jackson Turbidity Unit (JTU), the Formazine Turbidity Unit (FTU) and the Nephelometry Turbidity Unit (NTU). The procedures/instruments for measuring each of these units vary considerably. The turbidity is mostly created by the suspended solid in water. Suspended solid means any substance suspended in water qualifies as a suspended solid. It is determined by filtration followed by weighing of filter paper after drying and subtracting the weight of the filter paper. It is represented as mg/l. The suspended solids are characteristics of surface water bodies and wastewater from domestic as well as industrial/trade effluents.

## 2.1.7 Stability of particles in water

The Brownian motion is when mobile particles are immersed in an ambient medium; the particles undergo an incessant and irregular motion. Stability is one of the characteristics of Brownian motion. The motion can persist if the particles remain suspended in the liquid. Particles in the wastewater can be categorized as hydrophobic (water repelling) and hydrophilic (water attracting). The fine particles in water have surface charge, which result to relative stability, causing a long period of detention of the particles suspended in water. There are four common kind of origination of the particle surface charge: Isomorphism Replacement (Crystal Imperfections), Structural Imperfections, Preferential Adsorption of Specific Ions and Ionization of Inorganic Surface Functional Groups. In the water, particles always have a negative surface. Figure shows that a fixed adsorption layer will form when a layer of cat ions binds tightly to the surface of a negatively charged particle. This adsorbed layer of cat ions, stick to the surface of particle by adsorption forces and electrostatic, is about 0,5nm thick and is known as the Helmholtz layer (interchangeably with Stern layer).

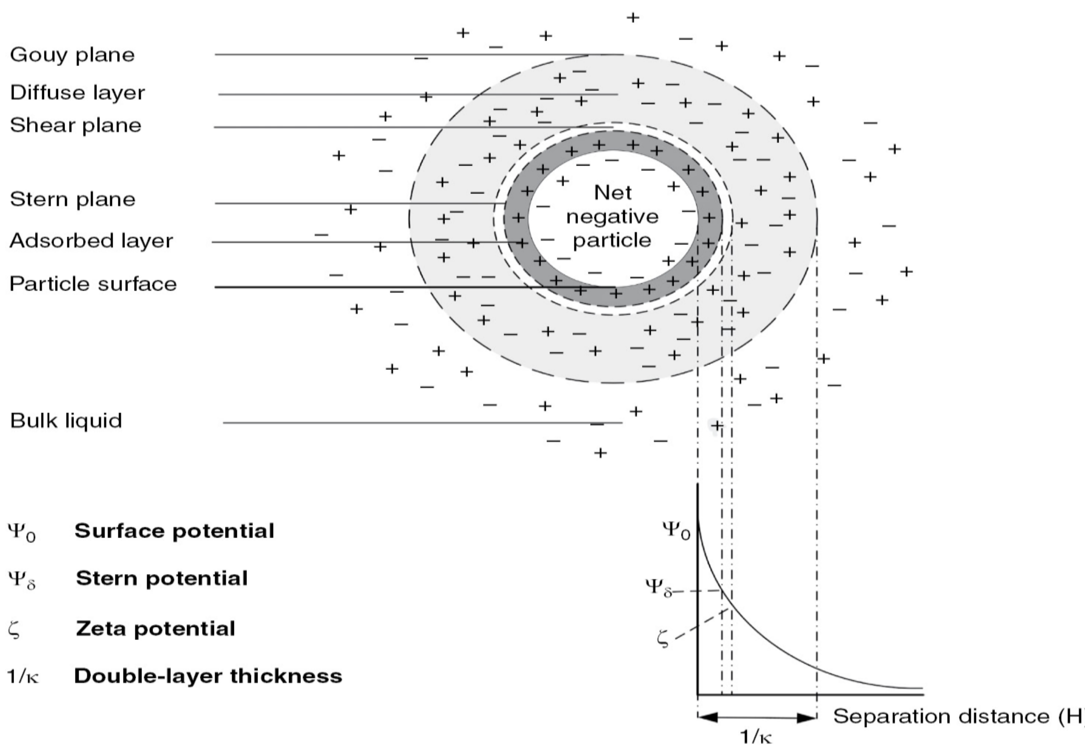



**Figure 2.1.7**

## 2.1.8 Sources and Types of Waste

A water treatment plant not only produces drinking water but is also a solids generator. The residues (solids or wastes) come principally from clarifier basins and filter backwashes. These residues contain solids which are derived from suspended and dissolved solids in the raw water, the addition of chemicals, and chemical reactions.

Depending on the treatment process employed, wastes from water treatment plants can be classified as alum, iron, or polymer sludge from coagulation and sedimentation; lime sludge and brine wastes from softening; backwash wastewater and spent granular activated carbon from filtration; and wastes from the iron and manganese removal process, micro strainers, and diatomaceous earth filters.

### 2.1.9 Waste Characteristics

The amount and composition of waste produced through each treatment process are unpredictable. Because of the wide variation in raw water quality and treatment operations, sludge's are different in their characteristics and quantities from time to time within the same treatment plant, and from plant to plant. Russelmann (1968) discussed general characteristics of water plant wastes. In addition, he addressed special characteristics of coagulation wastes, filter backwashes, ion-exchange brines, and screenings from a few water suppliers. He concluded that it is impossible to make generalizations concerning sludge production in terms of millions of gallons of water treated because sludge production is entirely dependent on raw water quality, the method of treatment, and efficiencies of the treatment processes. Sludges from water treatment plants may be divided into eight major categories (Westerhoff, 1978): pre-sedimentation sludge, coagulant sludge, lime sludge, iron and manganese removal sludge, ion-exchange sludge (brine waste), activated carbon wastes, spent diatomaceous earth, and sludge from saline water conversion. These categories, as well as filter backwash wastewater.

# CHAPTER-3

# COMPONENTS DESCRIPTION

## 3.1 Components for Water Quality Monitoring System

### 3.1.1 Temp LM35

| | |
|---|---|
| Local sensor accuracy (Max) (+/- C) | 0.5 |
| Operating temperature range © | -40 to 110, -55 to 150, 0 to 100, 0 to 70 |
| Supply voltage (Min) (V) | 4 |
| Supply voltage (Max) (V) | 30 |
| Supply current (Max) (uA) | 114 |
| Sensor gain (mV/Deg C) | 10 |

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the wafer level. The low-output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a −55°C to 150°C temperature range, while the LM35C device is rated for a −40°C to 110°C range (−10° with improved accuracy). The LM35-series devices are available packaged in hermetic TO transistor packages, while the LM35C, LM35CA, and LM35D devices are available in the plastic TO-92 transistor package. The LM35D device is available in an 8-lead surface-mount small-outline package and a plastic TO-220 package.

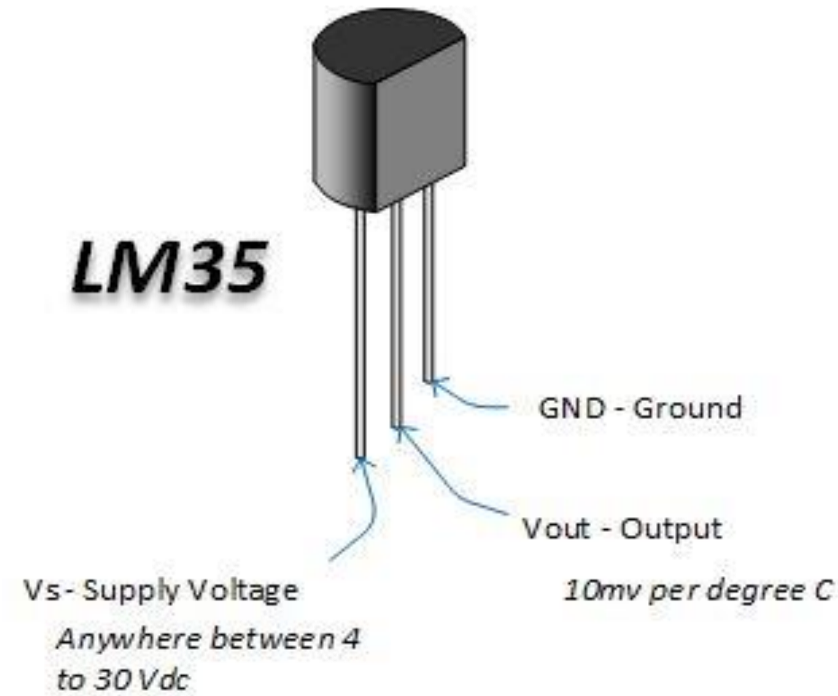



**Figure 3.1.1**

### 3.1.2 Arduino MEGA

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

The Arduino Mega2560 can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The Mega2560 differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter

## Specification of Arduino MEGA

- Microcontroller: ATmega2560
- Operating Voltage: 5 Volts
- Digital I/O Pins: 54
- Digital I/O Pins: 54(of which 14 provide PWM output)
- Analog Input Pins: 16
- Input Voltage: 7-12V
- Output Voltage: 6-20V
- Flash Memory: 256 KB of which 8 KB used by boot loader
- SRAM: 8KB
- EEPROM: 4KB
- Clock Speed: 16MHz

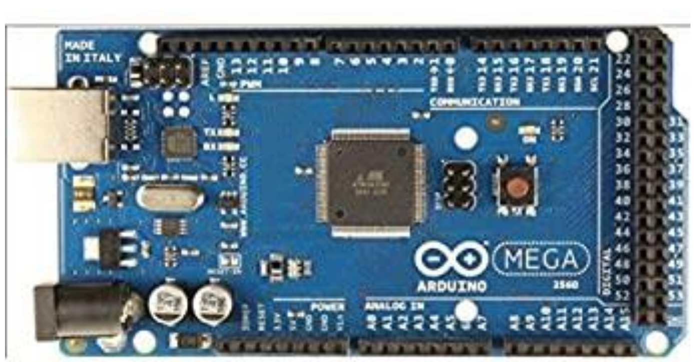



**Figure 3.1.2**

## General pin functions

Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

• **Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

• **External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2).** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

• **PWM: 0 to 13**. Provide 8-bit PWM output with the analogWrite() function.

• **SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS)**. These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Duemilanove and Diecimila.

• **LED: 13**. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

• **I 2C: 20 (SDA) and 21 (SCL)**. Support I2C (TWI) communication using the Wire library (documentation on the Wiring website). Note that these pins are not in the same location as the I2C pins on the Duemilanove.

The Mega2560 has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and analogReference() function. There are a couple of other pins on the board:

• **AREF**. Reference voltage for the analog inputs. Used with analogReference().

• **Reset**. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

### 3.1.3 PH Sensor

pH, commonly used for water measurements, is a measure of acidity and alkalinity, or the caustic and base present in a given solution. It is generally expressed with a numeric scale ranging from 0-14. The value 7 epitomizes neutrality. The numbers on the scale increase with increasing alkalinity, while the numbers on the scale decrease with increasing acidity. Each unit of change represents a tenfold change in acidity or alkalinity. The pH value is also equal to the negative logarithm of the hydrogen-ion concentration or hydrogen-ion activity.

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

pH is a unit of measure which describes the degree of acidity or alkalinity of a solution. It is measured on a scale of 0 to 14.

$pH = -\log[H+]$

A rough indication of pH can be obtained using pH papers or indicators, which change color as the pH level varies. These indicators have precincts on their accuracy, and can be difficult to understand correctly in colored or murky samples. More precise pH measurements are gotten by a digital pH meter. A pH tester system consists of three parts: a pH probe, a reference pH electrode, and a high input impedance meter.

The pH electrode can be supposed of as a battery, with a voltage that differs with the pH of the measured solution. The pH probe is a hydrogen ion sensitive glass bulb, with a millivolt output that varies with the vicissitudes in the relative hydrogen ion concentration inside and outside of the bulb.

The reference electrode output does not differ with the activity of the hydrogen ion.

The pH electrode has very high internal resistance, making the voltage change with pH difficult to measure. The input impedance of the pH meter and leakage resistances is therefore important factors.

The pH meter is basically a high impedance amplifier that exactly measures the minute electrode voltages and displays the results directly in pH units on either an analog or digital display.

In some cases, voltages can also be read for special applications or for use with ion-selective or Oxidation-Reduction Potential (ORP) electrodes.

**Figure 3.1.3**

## pH Electrodes

pH electrodes are constructed from a distinct composition glass which senses the hydrogen ion concentration. This glass is characteristically composed of alkali metal ions. The alkali metal ions of the glass and the hydrogen ions in solution undergo an ion exchange reaction, generating a potential difference.

In an amalgamation pH probe, the most extensively used variety; there are actually two electrodes in one body. One portion is called the measuring pH electrode, the other the reference electrode. The potential engendered at the junction site of the measuring portion is due to the free hydrogen ions present in solution.

The potential of the reference portion is formed by the internal element in contact with the reference fill solution. This potential is always constant. In summary, the measuring pH electrode conveys a varying voltage and the reference electrode delivers a constant voltage to the meter.

The voltage signal produced by the pH probe is a very small, high impedance signal. The input impedance requires that it be interfaced only with equipment with high impedance circuits.

pH electrodes are available in a variety of styles for both laboratory and industrial applications. All are composed of glass and are therefore subject to breakage.

Electrodes are designed to measure mostly aqueous media. They are not designed to be used in solvents, such as CCI4, which does not have any free hydrogen ions.

The pH electrode, due to the nature of its construction, needs to be kept moist at all times. In order to operate properly, glass needs to be hydrated.

Hydration is required for the ion exchange process to occur. If a pH sensor should become dry, it is best to place it in some tap water for a half hour to condition the glass.

pH electrodes have junctions which allow the internal fill solution of the measuring electrode to leak out into the solution being measured. This junction can become clogged by particulates in the solution and can also facilitate poisoning by metal ions present in the solution.

If a clogged junction is suspected it is best to soak the sensor in some warm tap water to dissolve the material and clear the junction. pH testers should always be stored in a moistened condition. When not in use it is best to store the electrode in either buffer 4.0 or buffer 7.0. Even if an electrode is not used it still ages. On the shelf, the pH probe should last approximately a year if kept in a moistened condition.

Electrode demise can usually be characterized by a sluggish response, erratic readings or a reading which will not change. When this occurs an electrode can no longer be calibrated. pH electrodes are fragile and have a limited lifespan. How long an electrode will last is determined by how well the probe is maintained and the pH application.

The harsher the system, the shorter the lifespan. For this reason it is always a good idea to have a back-up pH sensor on hand to avoid any system down time.

Calibration is also an important part of electrode maintenance. This assures not only that the electrode is behaving properly but that the system is operating correctly.

## pH meter calibration

pH electrodes are like batteries; they run down with time and use. As an electrode ages, its glass changes resistance. This resistance change alters the electrode potential. For this reason, electrodes need to be calibrated on a regular basis.

Calibration in pH buffer solution corrects for this change. Calibration of any pH equipment should always begin with buffer 7.0 as this is the "zero point." The pH scale has an equivalent mV scale. The mV scale ranges from +420 to -420 mV. At a pH of 7.0 the mV value is 0. Each pH change corresponds to a change of ±60 mV. As pH values become more acidic the mV values become greater.

For example, a pH of 4.0 corresponds to a value of 180 mV. As pH values become more basic the mV values become more negative; pH=9 corresponds to -120 mV. Dual pH calibration using buffers 4.0 or 10.0 provides greater system accuracy.

## Buffer Solutions

Buffers are solutions that have constant pH values and the ability to resist changes in that pH level. They are used to calibrate pH measurement systems (electrode and meter). There can be small differences between the output of one electrode and another, as well as changes in the output of electrodes over time. Therefore, the system must be periodically calibrated. Buffers are available with a wide range of pH values, and they come in both premixed liquid form or as convenient dry powder capsules. Most pH testers require calibration at several specific pH values. One calibration is usually performed near the isopotential point (the signal produced by an electrode at pH 7 is 0 mV at 25°C), and a second is typically performed at either pH 4 or pH 10. It is best to select a buffer as close as possible to the actual pH value of the sample to be measured.

## 3.1.4 Turbidity Sensor

Global Water's Turbidity Sensor is a highly accurate submersible instrument for in-situ environmental or process monitoring. Applications for the turbidity sensors include: water quality testing and management, river monitoring, stream measurement, reservoir water quality testing, groundwater testing, water and wastewater treatment, and effluent and industrial control.
In accordance with USEPA Method 180.1 for turbidity measurement, the Turbidity Sensors are a 90 degree scatter nephelometer. The turbidity sensor directs a focused beam into the monitored water. The light beam reflects off particles in the water, and the resultant light intensity is measured by the turbidity sensor's photodetector positioned at 90 degrees to the light beam. The light intensity detected by the turbidity sensor is directly proportional to the turbidity of the

water. The turbidity sensors utilize a second light detector to correct for light intensity variations, colour changes, and minor lens fouling.
For environmental or process monitoring, simply place the turbidity sensor directly in the water and position it where the turbidity is to be monitored. Since the turbidity sensor uses light to detect the water's turbidity ensure that the minimum amount of external light possible is exposed to the monitoring site.

## Turbidity Meter

The Global Water Turbidity Meter combines the turbidity sensor (described above) with a handheld meter that has a six digit LED screen, 4-button control panel, and an internal 9V battery. The handheld portable turbidity meter can be used for environmental or process sites that do not require permanent monitoring. The turbidity meter will display readings directly in either nephelometric turbidity units (NTU) or parts per million (PPM). The turbidity meter also includes an automatic shutoff feature to conserve battery power.

## Turbidity Sensor Cleaning and Use

To maintain accurate readings with your turbidity sensors the lenses should be cleaned a minimum of once per week. Depending on the monitoring site, the turbidity sensor's lenses may need to be cleaned as much as once per day. The turbidity sensor has been designed for harsh field conditions and uses the latest manufacturing design technology.

## Specification of Turbidity Sensor

- Range: Sensor=0-50 NTU and 0-1000 NTU; Meter= 0-50 NTU or 0-1000 NTU
- Accuracy: ±1% of full Scale
- Meter Resolution:12 bit
- Output: 4-20mA (Sensor, both ranges), LED screen (Meter)
- Method: Nephelometer with correction
- Operating Voltage: 10-36 VDC @ 40 MS (Sensor); Internal 9VDC battery (Meter)
- Maximum Pressure: 30 psi
- Light Source: Infrared LED, (880nm)
- Weight: 1lb (454 g) (Sensor); 2lbs (907 g) (Meter+sensor)

**Figure 3.1.4**

## 3.1.5 Relay

Relays are the switches which aim at closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an electronic circuit. When the relay contact is open (NO), the relay isn't energizing with the open contact. However, if it is closed (NC), the relay isn't energize given the closed contact. However, when energy (electricity or charge) is supplied, the states are prone to change.

Relays are normally used in the **control panels, manufacturing and building automation** to control the power along with switching the smaller current values in a control circuit. However, the supply of amplifying effect can help control the large amperes and voltages because if low voltage is applied to the relay coil, a large voltage can be switched by the contacts.
If preventive relays are being used, it can detect overcurrent, overload, undercurrent, and reverse current to ensure the protection of electronic equipment. Last but not the least; it is used to heat the elements, switch on audible alarms, switch the starting coils, and pilots the lights.


**Figure 3.1.5**

## Relay Types

In addition to the electromechanical and electromagnetic relay, there is a wide variety of relays with different working principles; principles of operation and polarity.

- Electro thermal Relay – When two different materials get in contact, bimetallic strip is formed, and when it is energized, it bends. This bending allows the users to make contact connections
- Electromechanical Relay – When different mechanical parts are connected on the basis of the electromagnet, contact connection is established
- Solid State Relay –This relay uses semiconductor devices to make a connection to ensure the effectiveness, efficiency, and easiness of the switching speed. This is commonly used for two reasons; faster-switching process and durability
- Hybrid Relay – It is the name given to the solid-state and electromechanical relays

## Relay Types as Per the Polarity

- Polarized Relay – These relays are identical to electromechanical relays except for the presence of electromagnet and a permanent magnet. With this relay, the armature movement is based on the input polarity applied to the coal and is commonly applicable in telegraphically purposes

- Non-polarized Relay – There are no polarities in this relay, and it executes no change with the alteration of the input signal

We all are aware of the TV remotes on which we can press one button to make a function, relays work similarly to that. Relays are used to eliminate the direct link of users with electronic equipment to protect them for expected high voltages. If the vast industries are focused, they are using the bigger capacity relays to optimize the motors and pumps operation.
The common purpose of relays can be understood by analysing the headlight turn on. The headlight switching button can be found on the car dashboard, and if moved, they supply the small value of current to the coil which results in contactor switching on. Then, relay comes into action by controlling the high power load (headlights). There are many other common examples of relays from our daily life.

Everyone has a fridge at their home and relays control the equipment responsible for working and production of cold temperature. Traffic lights are another application of relays where they are used as the switching component. The movement and direction of automatic garage doors are also utilizing the relays for optimal switching contacts.

It is safe to state that relays are responsible for energizing the electronic equipment and work on their functioning to ensure the optimal operation. These have eased our lives by bringing in automation factors along with the safe and smooth running of electronic equipment. This means that there are no threats involved regarding the high voltage as there will be no contact at the time of an electronic breakdown.

## Function of Relay

We have added the relay diagram in the section below to ensure the clear indulgent of relay wiring and relay circuits along with their working.

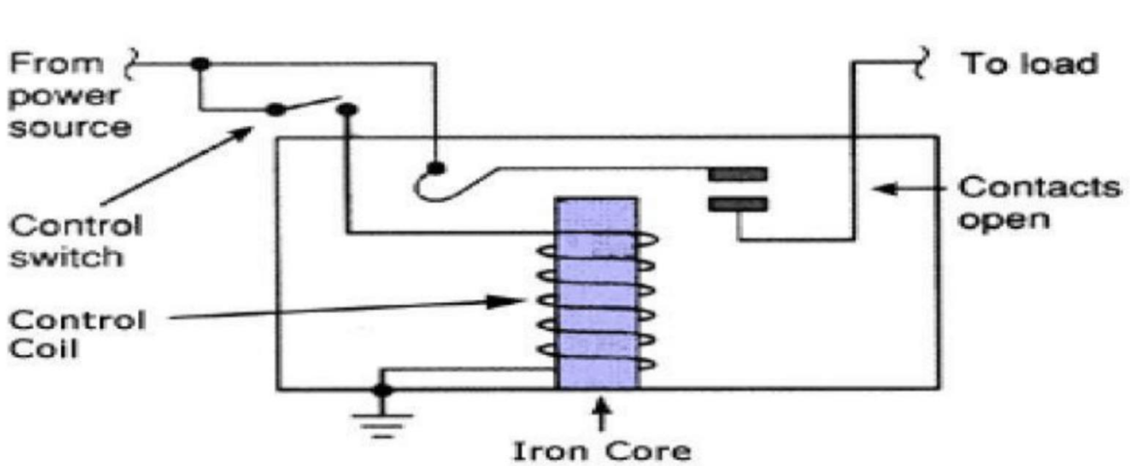



**Figure 3.1.5 a**

The Figure 3.1.5 a sheds focuses on the internal section of the relay in the circuit. There is an iron core delimited with the control coin. The power source connects with electromagnet through load contacts and a control switch. When energy is supply to the circuit through the control coil, magnetic fields intensifies given the commencement of energizing. This way, upper contact arms gets attracted by the lower fixed arm which closes the contacts leading to the short circuit. However, if the relay was de-energized, an open circuit is created with the opposite movement of the contact.

Once the coil current goes off, a movable armature is force back to the initial position, and the force is equal to half of the magnetic force and electric strength. The main reasons behind this force include gravity and spring.

The relays perform two basic functions, such as high voltage application and low voltage application. In the case of high voltage, arcing is reducing while in the low voltage applications, overall circuit noise is reducing to a minimum.

## 3.2 COMPONENTS FOR WATER PURIFICATION SYSTEM

### 3.2.1 RO Filter

Reverse Osmosis is very effective in treating brackish, surface and ground water for both large and small flows applications. Some examples of industries that use RO water include pharmaceutical, boiler feed water, food and beverage, metal finishing and semiconductor manufacturing to name a few.

Reverse Osmosis (RO) filtration is one of the most popular and best water filtration methods available. In simple terms, reverse osmosis works as water is forced across a semi-permeable membrane, leaving contaminants behind that are flushed down the drain. The clean drinking water collects in a holding tank.

The RO membrane removes dissolved salts; the UV chamber makes sure the water is free from bacteria and virus. Also, there is a charcoal filter for the further cleansing of water.

This RO water purifier has the capacity to clean up to 285L of water in a day & there is no waste water. The TDS level up to 1800ppm and the storage tank capacity of the water purifier is 7 litre.

RO is an operative and established technology to yield water that is apt for many industrial applications that require demineralized or deionized water.


**Figure: 3.2.1**

## Reverse Osmosis

**Reverse Osmosis**, commonly referred to as **RO**, is a process where you demineralize or deionize water by pushing it under pressure through a semi-permeable Reverse Osmosis Membrane.

### Osmosis

To understand the purpose and process of Reverse Osmosis you must first understand the naturally occurring process of **Osmosis**.

Osmosis is a naturally occurring phenomenon and one of the most important processes in nature. It is a process where a weaker saline solution will tend to migrate to a strong saline solution. Examples of osmosis are when plant roots absorb water from the soil and our kidneys absorb water from our blood.

Below is a diagram which shows how osmosis works. A solution that is less concentrated will have a natural tendency to migrate to a solution with a higher concentration. For example, if you had a container full of water with a low salt concentration and another container full of water with a high salt concentration and they were separated by a semi-permeable membrane, then the water with the lower salt concentration would begin to migrate towards the water container with the higher salt concentration.

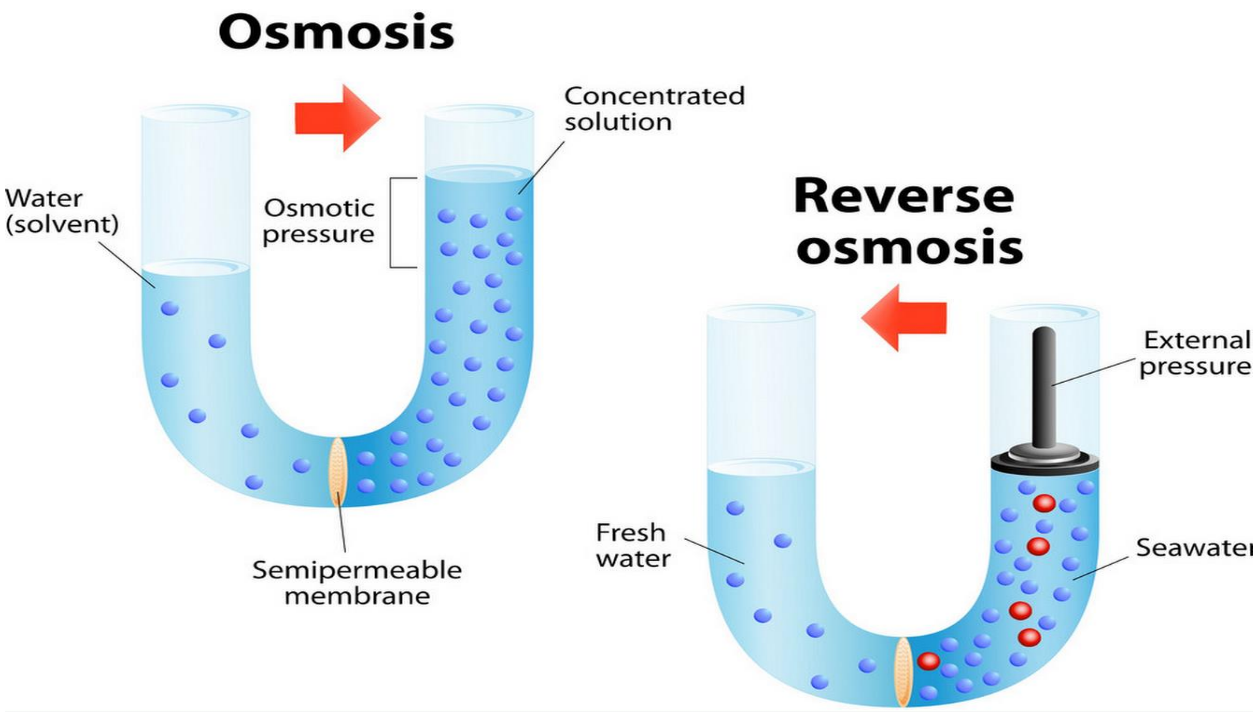



**Figure 3.2.1 a**

A **semi-permeable membrane** is a membrane that will allow some atoms or molecules to pass but not others. A simple example is a screen door. It allows air molecules to pass through but not pests or anything larger than the holes in the screen door. Another example is Gore-Tex clothing fabric that contains an extremely thin plastic film into which billions of small pores have been cut. The pores are big enough to let water vapour through, but small enough to prevent liquid water from passing.

**Reverse Osmosis is the process of Osmosis in reverse**. Whereas Osmosis occurs naturally without energy required, to reverse the process of osmosis you need to apply energy to the more saline solution. A reverse osmosis membrane is a semi-permeable membrane that allows the passage of water molecules but not the majority of dissolved salts, organics, bacteria and pyrogens. However, you need to 'push' the water through the reverse osmosis membrane by applying pressure that is greater than the naturally occurring osmotic pressure in order to desalinate (demineralize or deionize) water in the process, allowing pure water concluded while holding back a majority of contaminants.

When pressure is applied to the concentrated solution, the water molecules are forced through the semi-permeable membrane and the contaminants are not allowed through.

## How does Reverse Osmosis work?

Reverse Osmosis works by using a high pressure pump to increase the pressure on the salt side of the RO and force the water across the semi-permeable RO membrane, leaving almost all (around 95% to 99%) of dissolved salts behind in the reject stream. The amount of pressure required depends on the salt concentration of the feed water. The more concentrated the feed water, the more pressure is required to overcome the osmotic pressure.

The desalinated water that is demineralized or deionized, is called permeate (or product) water. The water stream that carries the concentrated contaminants that did not pass through the RO membrane is called the reject (or concentrate) stream.

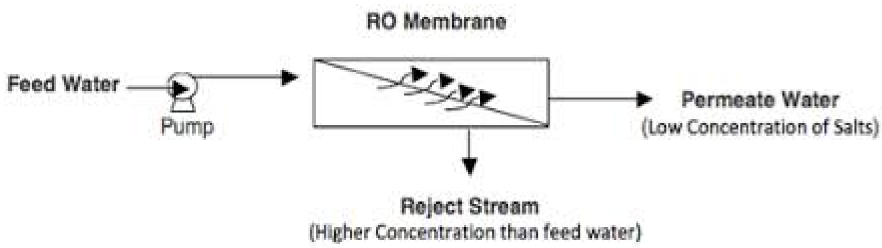



**Figure 3.2.1 b**

As the feed water enters the RO membrane under pressure (enough pressure to overcome osmotic pressure) the water molecules pass through the semi-permeable membrane and the salts and other contaminants are not allowed to pass and are discharged through the reject stream (also known as the concentrate or brine stream), which goes to drain or can be fed back into the feed water supply in some circumstances to be recycled through the RO system to save water. The water that makes it through the RO membrane is called permeate or product water and usually has around 95% to 99% of the dissolved salts removed from it.

It is important to understand that an RO system employs cross filtration rather than standard filtration where the contaminants are collected within the filter media. With cross filtration, the solution passes through the filter, or crosses the filter, with two outlets: the filtered water goes one way and the contaminated water goes another way. To avoid build-up of contaminants, cross flow filtration allows water to sweep away contaminant build up and also allow enough turbulence to keep the membrane surface clean.

## What contaminants will Reverse Osmosis remove from water?

Reverse Osmosis is capable of removing up to 99%+ of the dissolved salts (ions), particles, colloids, organics, bacteria and pyrogens from the feed water (although an RO system should not be relied upon to remove 100% of bacteria and viruses). An RO membrane rejects contaminants based on their size and charge. Any contaminant that has a molecular weight greater than 200 is likely rejected by a properly running RO system (for comparison a water molecule has a MW of 18). Likewise, the greater the ionic charge of the contaminant, the more likely it will be unable to pass through the RO membrane. For example, a sodium ion has only one charge (monovalent) and is not rejected by the RO membrane as well as calcium for example, which has two charges. Likewise, this is why an RO system does not remove gases such as $CO_2$ very well because they are not highly ionized (charged) while in solution and have a very low molecular weight. Because an RO system does not remove gases, the permeate water can have a slightly lower than normal pH level depending on $CO_2$ levels in the feed water as the $CO_2$ is converted to carbonic acid.

### 3.2.2 Sediment Filter

Sediment is any particulate matter that can be transported by fluid flow and which eventually is deposited as a layer of solid particles on the bed or bottom of a body of water or other liquid.

Sedimentation is the deposition by settling of a suspended material. In a water plant these particles may be rust flakes from the water pipes, sand grains, and small pieces of organic matter, clay particles, or any other small particles in the water supply.


**Figure 3.2.2**

### 3.2.3 Carbon Filter

Carbon filtering works by adsorption, in which pollutants in the fluid to be treated are trapped inside the pore structure of a carbon substrate. The substrate is made of many carbon granules, each of which is itself highly porous.


**Figure 3.2.3**

### 3.2.4 Rice Husk

Rice husks are resources that should be recycled in a sustainable way, thus creating a win-win relationship between stakeholders, consumers, and society. Silica is a very valuable material and used for many industrial purposes. A Rice husk contains 20% of silica by weight, and can therefore be considered a biological silica ore. To recycle rice husks in a sustainable way, the ash produced from burning rice husks must also be used as a resource. In this study, based on the concept that rice husk ash should be recycled as silica fertilizer, we compared the economic feasibility of two recycling systems: Heat recovery from hot water and generation of electricity from hot water. Questionnaires were also conducted regarding farmers' expectations of silica fertilizer made from rice husk ash. We found that the system involving heat recovery from hot water was sustainable; however, generating electricity from hot water was cost-prohibitive. It must be noted that the validity of this result might be limited to Japan, where electricity generation is highly regulated. On the other hand, areas that already struggle to dispose of their rice husks should consider using rice husks to produce energy.

## Rice plants and silica

Rice plants need silica for healthy, continuous growth. Although it may not be essential, a shortage of silica has a tremendous negative effect on rice plants, and its presence benefits the plants. Silica provides rice plants with disease control, resistance to drought and salt, and metal toxicity control.

In Japan, the study of the effects of silica on rice plants began in the late 1930s. The study was conducted in a hydroponic culture and showed that silica was needed to improve crop yields and resistance to pest invasion. However, the results were not confirmed in actual fields because people thought that rice plants would not face a silica deficit there due to the existing abundance of silica in soil. Since continuous cultivation of rice is possible in paddy fields but not in dry-fields, Japan prefers paddy field cultivation for rice because it is a staple crop for Japanese people. Moreover, Japan is a small island and has limited areas for rice production. However, a large volume of irrigation water passes through paddy fields, which flushes away dissolved silica. Moreover, silica is reduced in anaerobic conditions in paddy fields and dissolves into water, where it is also flushed away. Consequently, silica availability became low; causing rice plants to sometimes lose condition and became affected by pests in fall.

The silica taken up by rice plants is amorphous and in a colloidal state in water. The silica in rice husks is therefore also amorphous. To use rice husk ash for fertilizer, it is critical that the silica is in an amorphous state. It is impossible to distinguish amorphous and crystalline silica by visual observation; X-ray diffraction (XRD) analysis is required. The solubility of silica into 1 N NaOH is a reliable indicator of the state of silica in the ash. Generally, it can be said that the higher the percentage of solubility is (more than 50%), the better quality the silica is. Solubility is also expressed by the Silica Activity Index. Many studies have been conducted on how to produce better ash, including how to burn rice husks. These studies mainly focused on combustion temperature. Other studies focused on energy recovery from rice husk burning concentrating only on energy production and did not consider the quality of ash. A further study investigated using different types of incinerators such as fluidized bed, cyclonic furnace, and rotary kiln to burn rice husks. To make better ash, the formation of carbon black particles in the ash was investigated with the goal of reducing the amount of carbon black particles produced. In the 1980s, researchers assessed the growth of crystalline silica in rice husk ash and the thermal decomposition characteristics of rice husks. Rice husks have many industrial applications including insulators, lithium battery anodes, fuels, cement and concrete, wastewater adsorbents, and fertilizer and soil amendment.

### 3.2.5 Tamarind Seeds

Tamarind seed kernel powder, discarded as agricultural waste, is an effective agent to make turbid municipal and industrial wastewater clear. The present practice is to use aluminium salt to treat such water. It has been found that alum increases toxic metals and ions in treated water and could cause diseases like the Alzheimer's. Kernel powder, compared to alum, is not-toxic and biodegradable.

### 3.2.6 Drumstick Seeds

Drumstick seeds are also known as Moringa Oleifera. The water-clarifying ability of Moringa powder was found to be due to a positively-charged protein called the Moringa Oleifera Cationic Protein (MOCP). When you crush the seeds and add them to water, this protein will kill some of the microbial organisms and cause them to clump together and settle to the bottom of the container.

However, the dried seed powder alone is not idyllic for water purification because the organic matter from the seed will remain in the water, providing a food source for any bacteria that have not been killed. As a result, water treated with this seed does not remain safe to drink after some time in storage.

In 2012, Velegol and a team of Penn State researchers published a paper showing that MOCP can easily be attached to grains of sand. When the sand is mixed with unsafe water, bacteria stick to the sand and are killed. The newly-clean water can then be removed and stored for later use. Then the sand can be rinsed to remove the organic matter and “recycled” for another round of purification.

In Velegol’s most recent study, published in the April edition of Langmuir, she, along with chemical engineering assistant professor Manish Kumar and chemical engineering students Kevin Shebek, Kathleen Lauser, Allen Schantz and Ian Sines, used a combination of cryogenic electron microscopy and fluorescence examines to discover that the cationic protein secluded from Moringa seeds kills water-borne bacteria by causing their cell membranes to fuse.

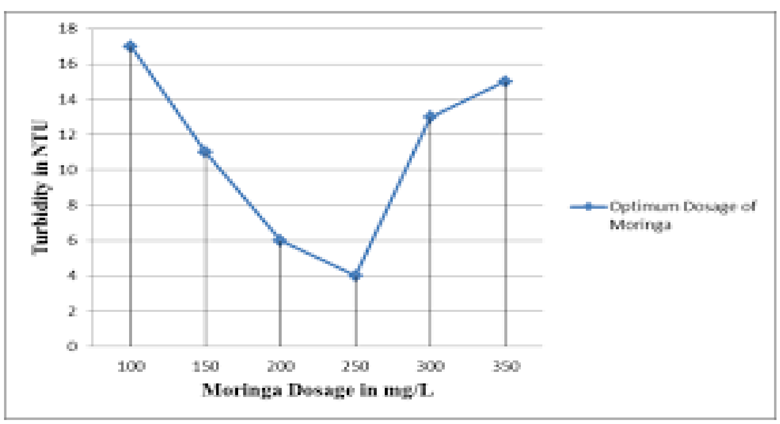
This study revealed the mechanism by which MOCP turns polluted water into safe drinking water. “One of the biggest challenges in using Moringa seeds for cleaning water is that people don’t know which seeds work and don’t work,” Velegol says. This is a problem because if people use the wrong seeds, they will think their water is clean when, in fact, it’s not.

So the researchers teamed up with Bashir Abubakar, a botanist from Ahmadu Bello University in Zaria, Nigeria. Abubakar brought four kinds of seeds of different maturity levels and harvest times from Nigeria to Penn State. The researchers then studied their mass, oil content and ability to kill bacteria and clarify water. They found that the extracted protein of mature dried seeds collected in the rainy season is most effective, followed by mature dried seeds collected in the dry season.

Abubakar, a native of Nigeria where about 66 million people do not have access to safe drinking water (UNICEF), foresees benefits to using Moringa that go beyond providing clean water to poor communities.

**Table 1: Ideal Dosage of Moringa Oleifera**

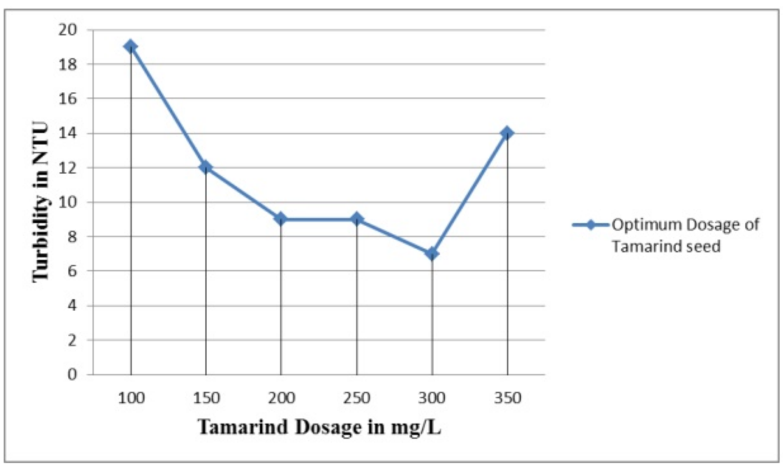
| S.NO. | Coagulant Dosage | Turbidity in NTU |
|---|---|---|
| 1 | 100 | 17 |
| 2 | 150 | 11 |
| 3 | 200 | 6 |
| 4 | 250 | 4 |
| 5 | 300 | 13 |
| 6 | 350 | 15 |




**Graph of Ideal dosage of Moringa Oleifera**

**Table 2: Ideal Dosage of Tamarind Seed**

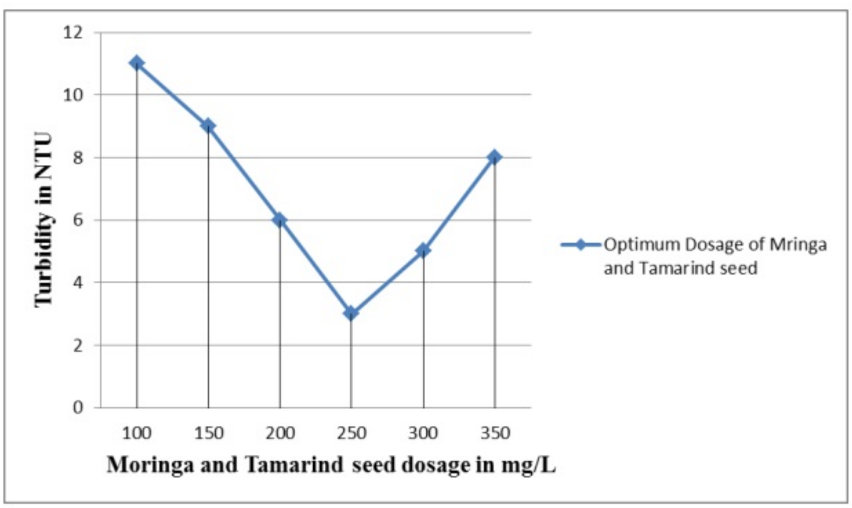
| S.NO. | Coagulant Dosage | Turbidity in NTU |
|---|---|---|
| 1 | 100 | 19 |
| 2 | 150 | 12 |
| 3 | 200 | 9 |
| 4 | 250 | 9 |
| 5 | 300 | 6 |
| 6 | 350 | 14 |




**Graph of Ideal dosage of Tamarind seed**

**Table 3: Ideal dosage of Moringa and Tamarind seeds**

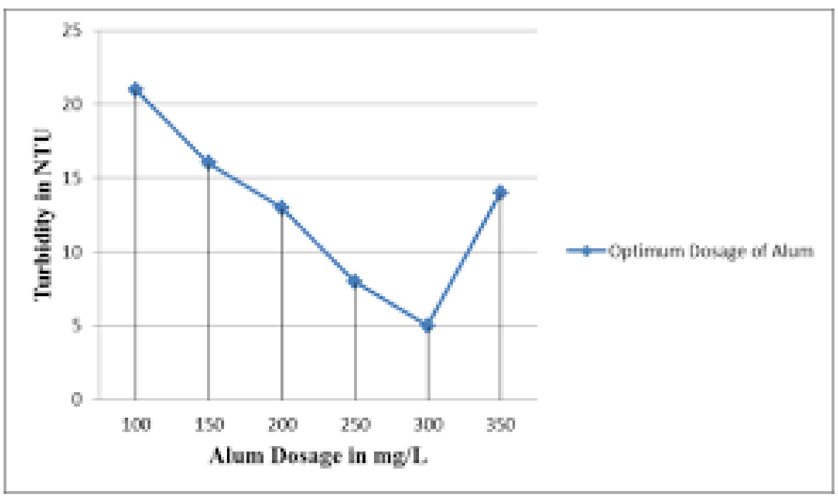
| S.NO. | Coagulant Dosage | Turbidity in NTU |
|---|---|---|
| 1 | 100 | 11 |
| 2 | 150 | 9 |
| 3 | 200 | 6 |
| 4 | 250 | 3 |
| 5 | 300 | 5 |
| 6 | 350 | 8 |




**Graph of ideal dosage of combined use of moringa and tamarind seeds**

**Table 4: Ideal dosage of Alum**

| S.NO. | Coagulant Dosage | Turbidity in NTU |
|---|---|---|
| 1 | 100 | 21 |
| 2 | 150 | 16 |
| 3 | 200 | 13 |
| 4 | 250 | 8 |
| 5 | 300 | 5 |
| 6 | 350 | 14 |




**Graph of Ideal dosage of Alum**

**Table 5: Initial Parameters of Wastewater**

| S.NO. | Parameters | Initial value |
|---|---|---|
| 1 | Odour | Objectionable |
| 2 | Colour | Brownish |
| 3 | pH | 8.8 |
| 4 | Turbidity | 320 NTU |
| 5 | Total Chlorides | 215 mg/L |
| 6 | Alkalinity | 245.50 mg/L |
| 7 | Acidity | 15 mg/L |

**Table 6: Test results of pH after treatment**

| S.NO. | Coagulant | Dosage(mg/L) | pH |
|---|---|---|---|
| 1 | Alum | 100 | 7.7 |
| | | 150 | 7.6 |
| | | 200 | 7.5 |
| | | 250 | 7.3 |
| | | 300 | 7.3 |
| | | 350 | 7.2 |
| 2 | Moringa Oleifera | 100 | 7.6 |
| | | 150 | 7.6 |
| | | 200 | 7.5 |
| | | 250 | 7.3 |
| | | 300 | 7.2 |
| | | 350 | 7.2 |
| 3 | Tamarind Seed Powder | 100 | 7.7 |
| | | 150 | 7.6 |
| | | 200 | 7.5 |
| | | 250 | 7.4 |
| | | 300 | 7.3 |
| | | 350 | 7.3 |
| 4 | Combined use of Moringa oleifera and Tamarind seed powder | 100 | 7.4 |
| | | 150 | 7.4 |
| | | 200 | 7.3 |
| | | 250 | 7.3 |
| | | 300 | 7.2 |
| | | 350 | 7.2 |

**Table 7: results of Turbidity after Treatment**

| S.NO. | Coagulant | Dosage(mg/L) | Turbidity(NTU) |
|---|---|---|---|
| 1 | Alum | 100 | 15 |
| | | 150 | 13 |
| | | 200 | 12 |
| | | 250 | 12 |
| | | 300 | 9 |
| | | 350 | 14 |
| 2 | Moringa Oleifera | 100 | 12 |
| | | 150 | 11 |
| | | 200 | 10 |
| | | 250 | 7 |
| | | 300 | 9 |
| | | 350 | 13 |
| 3 | Tamarind Seed Powder | 100 | 12 |
| | | 150 | 11 |
| | | 200 | 9 |
| | | 250 | 7 |
| | | 300 | 7 |
| | | 350 | 11 |
| 4 | Combined use of Moringa oleifera and Tamarind seed powder | 100 | 10 |
| | | 150 | 9 |
| | | 200 | 8 |
| | | 250 | 5 |
| | | 300 | 8 |
| | | 350 | 12 |

**Table 8: Test results of Total Chlorides after Treatment**

| S.NO. | Coagulant | Dosage(mg/L) | Total Chlorides (mg/L) |
|---|---|---|---|
| 1 | Alum | 100 | 170 |
| | | 150 | 169 |
| | | 200 | 167 |
| | | 250 | 166 |
| | | 300 | 164 |
| | | 350 | 163 |
| 2 | Moringa Oleifera | 100 | 140 |
| | | 150 | 136 |
| | | 200 | 134 |
| | | 250 | 133 |
| | | 300 | 129 |
| | | 350 | 126 |
| 3 | Tamarind Seed Powder | 100 | 138 |
| | | 150 | 136 |
| | | 200 | 135 |
| | | 250 | 134 |
| | | 300 | 131 |
| | | 350 | 128 |
| 4 | Combined use of Moringa oleifera and Tamarind seed powder | 100 | 116 |
| | | 150 | 115 |
| | | 200 | 113 |
| | | 250 | 112 |
| | | 300 | 109 |
| | | 350 | 107 |

# CHAPTER-4

## Methodology

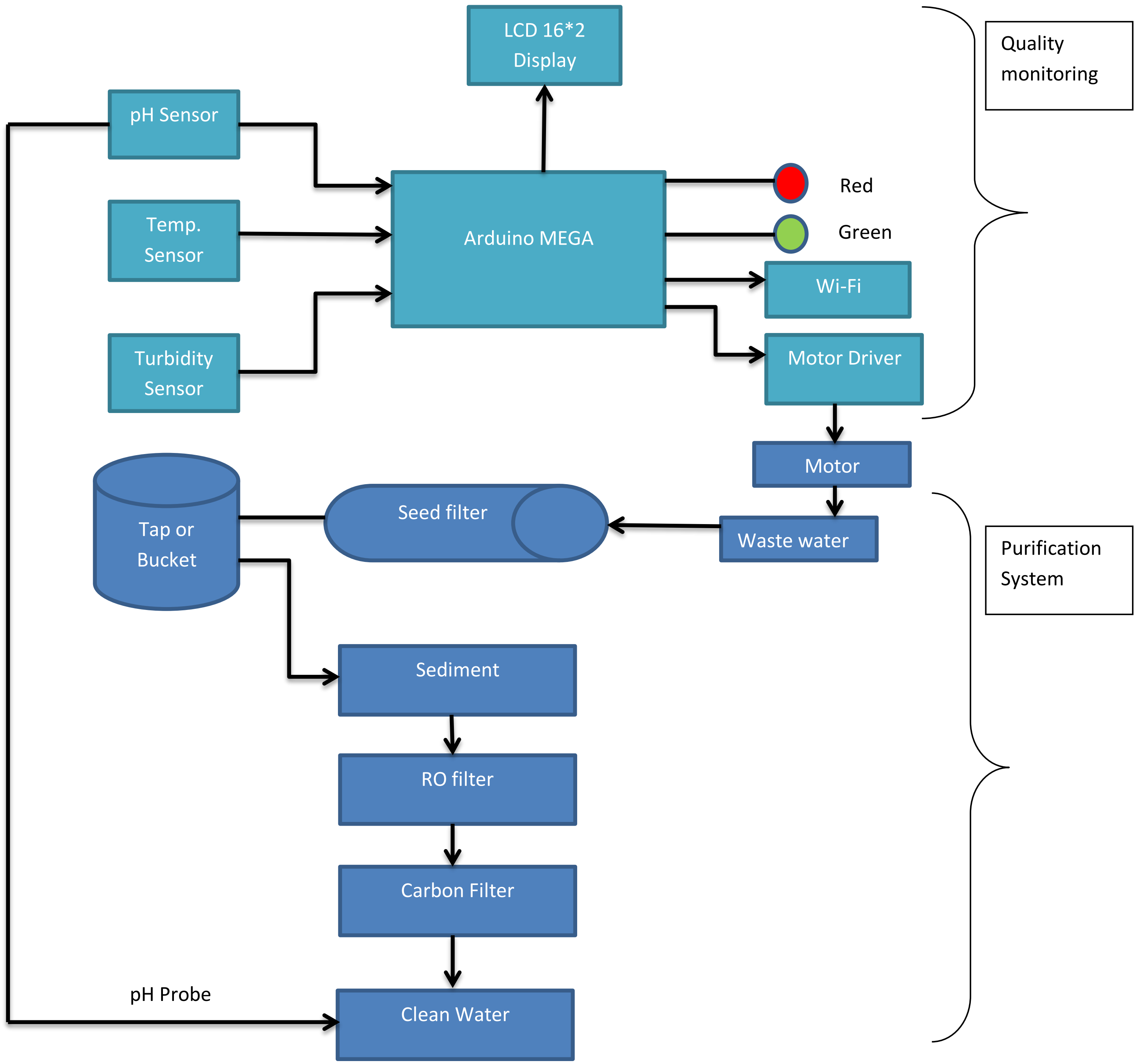
Wasteful usage of water, climatic changes and Urbanization has further depleted the resource. Conversation and management of the resource must be given utmost importance. We present an IOT based design for water monitoring and control approach which supports internet based data collection on real time bases. We are monitoring PH, temperature and turbidity of water (wastage water and purified water). After monitoring them, if it will be above from the requirement of normal water which is used for industrial purpose then the buzzer will work as well as we will got a message on the registered phone number. After completing the monitoring process we will go for the purification process. In this process, we will remove the poisonous material present in the wastage water by following one by one step involved in the purification process. First of all we will use the rice husk for removing some chemical substances after that the Tamarind seeds will used for the remaining substances present in the water and at last we used the drumstick seeds for which those substances will be removed which could not remove by the other two coagulants. For shortcoming of the existing models for a ubiquitous usage of wireless systems for smart quality monitoring and purification.

## 4.1 Coagulants used

The seeds were harvested when they were fully matured. This is determined by observing if there are any cracked pods on the plants. The pods that were plucked were cracked to obtain the seeds which were air-dried at 40°C for two days. The shells surrounding the seed kernels were removed using knife and the kernels were pounded using laboratory mortar and pestle into powder and sieved using a strainer with a pore size of 2.5 mm 2 to obtain a fine powder. This method is a slight modification of the one proposed by Ghebremichael (2004). This was the coagulant prepared from Moringa. The aluminium sulphate (alum) used in the study was obtained from the Bolgatanga branch of Ghana Water Company.

## 4.2 Sample preparation

Fifty (50) litres of sample was fetched from a pond situated behind the Navoro Hall of the Navrongo Campus, University for Development Studies. This was further dispensed into 33 beakers. The volume of sample in each beaker was 1000 ml. five different concentrations of the stock solutions for the loading dose were prepared by weighing 4.0, 6.0, 8.0, 10.0 and 12.0 g of alum and Moringa powder separately into a beaker containing 1000 ml of distilled water. The mixtures in the beakers were stirred using a glass rod to obtain a clear solution. A 1000 ml of distilled water with no alum or Moringa powder was kept as the control treatment.




**Block Diagram**

## 4.3 pH measurement

The pH of the sample was read using a calibrated Crison pH meter Basic C20. A volume of 200 ml of the supernatants obtained from the beakers containing the treatments was measured into a beaker. The pH meter probe was then inserted making sure it did not touch the beaker. The pH reading was then taken from the LCD display after it had stabilized.

## 4.4 Conductivity measurement

The samples used for the pH measurements were used for the conductivity test. A calibrated Crison Conductimeter Basic C30 was used. The conductivity meter probe was then inserted making sure it did not touch the beaker. The reading was recorded from the LCD display after it had stabilized.

## 4.5 Turbidity measurement

This was carried out on supernatants obtained after the treatments have been administered into the beakers containing the pond water using a HACH DR/2000 Direct reading spectrophotometer from Ghana Water Company Limited, Bolgatanga Branch. This is a multipurpose spectrophotometer. It was configured to read turbidity at the wavelength of 750 nm specified for measuring turbidity. Distilled water was first poured into a 25 ml cuvette and inserted into the spectrophotometer. The calibration button was pressed and the instrument was then calibrated. Each of the samples to be read was poured into a 25 ml cuvette and inserted into the spectrophotometer. The turbidity of the samples was displayed on the LCD panel of the instrument in Nephelometric Turbidity Units (NTU). After each reading, the spectrophotometer was calibrated again with the distilled water before being used on the next sample.

## 4.6 Stock Solution of Natural Coagulants

Moringa oleifera seed pods are allowed to mature and dry naturally to a brown color on the tree. The seeds were removed from the pods, kept for sun dry, and external shells were removed. Mature seeds showing no signs of discoloration, softening, or extreme desiccation were used. The seed kernels were ground to fine powder using a kitchen blender to make it of approximate size of 600 $\mu$m to achieve solubilization of active ingredients in the seed. The grains of powder were maintained approximate size less than 600 $\mu$m to achieve solubilization of active ingredients in the seed. Mature seeds of *Dolichos lablab* were used in the study. After sun dry, external shells were removed and seed kernel were obtained. Using grinder, fine powder achieved from seed kernel.

Distilled water was added to the powder to make 1% suspension of it. The suspension was vigorously shaken for 45 minutes using a magnetic stirrer to promote water extraction of the coagulant proteins, and this was then passed through filter paper. The filtrate portions were used for required dose of natural coagulants.

# CHAPTER-5

## SOFTWARE

### Coding

```
void getData(Data* data){
  Serial.println(F("Hello I am getting your DATA!!! :)"));
  int Navg =20 ;
  uint16_t datatemperature = 0;
  uint16_t datapH = 0;
  uint16_t dataDO = 0;



  for(int i=0; i<Navg; i++){ //take 10 readings and then average them
   datatemperature += analogRead(pinTemperature);
   datapH += analogRead(pinPH);
   dataDO += analogRead(pinDO);
  }
  datatemperature = datatemperature/Navg;
  datapH = datapH/Navg;
  dataDO = dataDO/Navg;

  if( dataDO >= 703) {
    dataPH = 703; //limit the maximum to 703
    }

   randomSeed(analogRead(5));
```

data->temperature = 30.34;

data->pH = 7.0;

data->DO = 5.01;

data->temperature = random(0, 30);

data->pH = random(0, 14);

data->DO = random(0, 100);

pH value

4-20mA, 0-14 pH, Accuracy: 2% of full scale, -5 to +55°C, http://www.globalw.com/products/wq201.html

using a 220ohm resistor, we get 0.88-4.4V full scale

subtract 0.88 to get 0-3.52V

divide by 3.52 and multiply with 14 to get pH value

data->pH = (datapH*(5.0/1023.0)-0.88)/3.52*14.00;

if (data->pH <0) data->pH = 0;

DO value

4-20mA, 0-8ppm, 0-100%, Accuracy: ±0.5% of full scale, 10 seconds warm up time, -40 to +55°C, http://www.globalw.com/products/wq401.html

using a 220ohm resistor, we get 0.88-4.4V full scale

subtract 0.88 to get 0-3.52V

divide by 3.52 and multiply with 100 to get DO value

data->DO = (dataDO*(5.0/1023.0)-0.88)/3.52*100.00;

if (data->DO <0) data->DO = 0;

```
  Temperature value
  4-20mA, -50 to +50°C, ±0.1°C, 5 seconds minimum, -50 to +100°C,
http://www.globalw.com/products/wq101.html
  using a 220ohm resistor, we get 0.88-4.4V full scale
  subtract 0.88 to get 0-3.52V
  subtract by 1.76 to get -1.76 - 1.76
  divide by 1.76 and multiply with 50 to get Temperature value in degree Celsius
  data->temperature = ((datatemperature*(5.0/1023.0)-0.88)-1.76)/1.76*50;


}


void printData(Data* data){
  Serial.print(F("Temperature is: "));
  Serial.println(data->temperature);
  Serial.print(F("pH is: "));
  Serial.println(data->pH);
  Serial.print(F("DO is: "));
  Serial.println(data->DO);
}
```

# CHAPTER-6

## RESULTS AND CONCLUSION

### 6.1 Future Scopes

- In Future, IoT based Water Quality monitoring system can be extended not just for Storage tank but also for deciding on Ponds, rivers and water pipes to.
- The same work can be extended by looking into other water parameters rather than just PH and TDS and accordingly control the flow of water based on water quality.
- In future we can use more advanced IoT based concept in such project.
- Detecting the more parameters for most secure purpose.
- Increase the parameters by addition of multiple sensors.
- By interfacing relay we control the supply of water.

### 6.2 Conclusion

Iot based "Automated Industrial Water Recycler" is beneficial for industries because of many reasons like cheap, easy to install, less time taken etc. Now a day, recycling of industrial waste is main problem for industries because of its cost which is very high. Due to cost many industries has been closed and employment is also gone. This project will help industries to recycle their waste in low cost. Small industries will get the benefit by using this project.

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