# TREATMENT OF WATER BY USING REACTOR OF NATURAL INGREDIENTS WITH APPLICATION OF IOT BASED SYSTEM

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***Keyw*ords:** pH, Alkalinity, Acidity, Turbidity, Hardness, water and IOT based sensors.

## Introduction

Water is one of the most basic needs of life; without it, life cannot exist. It is undoubtedly the most vital element among all natural resources. Water is used for several purposes by humans, but the level of purity of the water being consumed is very crucial since it has a direct effect on health. Germs, which enter the mouth through water and food, cause more than half of all illnesses and deaths in children.[1.]

Sources of water supply is either surface water or groundwater. Surface water requires more treatment than groundwater since it has a higher concentration of contaminants, implying that the water must be thoroughly treated before it can be used as a community's water supply. Physical, chemical, and biological factors are used to evaluate the quality of water intended for drinking, and its monitoring is crucial because long-term exposure to contaminated water has been shown to hasten the onset of many diseases. Before drinking water from any source, it must be purified in some way and various techniques are employed to make water safe and appealing to consumers.[1.]

Water quality is of concern to the populace. The acceptability of the water for uses include drinking, cooking, bathing, and laundering. Most municipally treated water is

safe and generally of good quality. Water from private or community wells can be contaminated. Contaminated water may have off- tastes, odours, or visible particles.[2.]

Due to improper water treatment many people are getting diseases. And shortage of water is more and for the surface water also we need the purification because it contains harmful chemical. Rural communities most often rely greatly on surface water provided that it is available in sufficient quantities. [2]

The need to treat water with natural coagulants became a common practice because the realization that the agencies saddled with the responsibility of providing potable water to the public cannot cope with the present demand, this often lead to scarcity and supply is rather epileptic. This scarcity is often attributed to several reasons such as power failure, lack of chemicals, and breakdown in operational system. Thus, the problem associated with this and its health implications are important.[2]

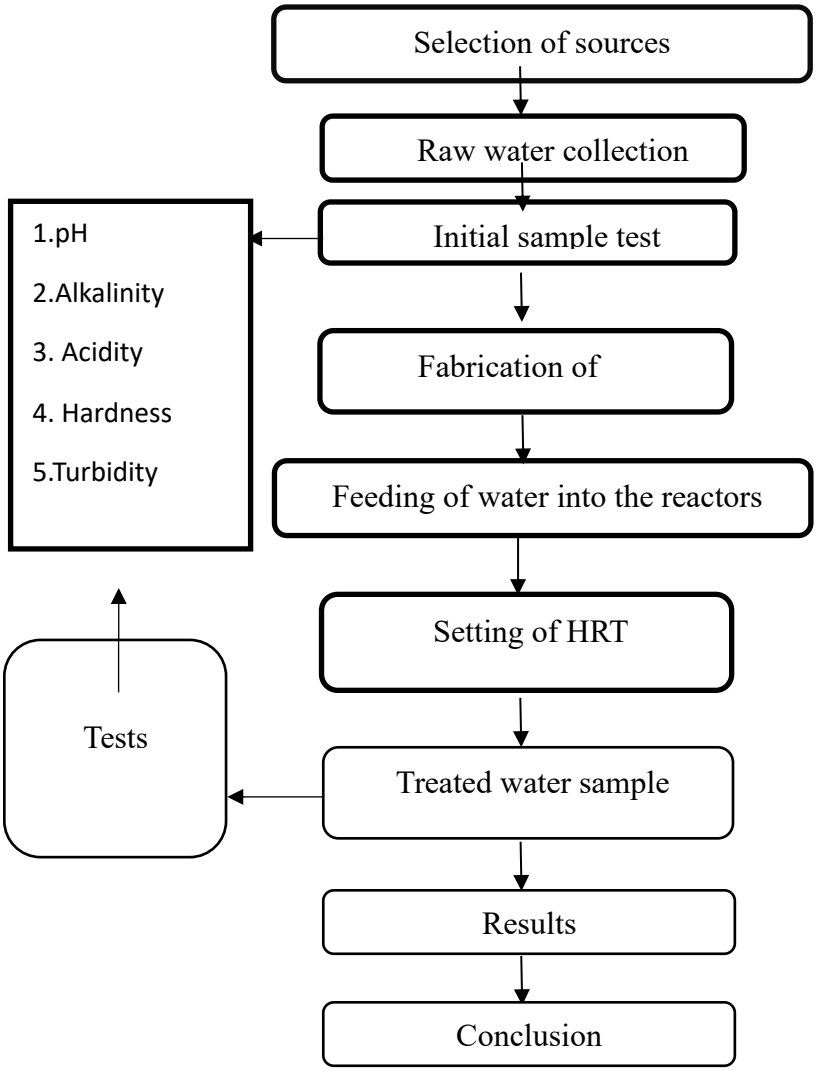
The conventional method of water purification using Aluminium Sulphate (Alum) and Calcium hypochlorite puts pressure on the nation's over-burdened financial resources since they are imported thereby making treated water very expensive in most developing countries and beyond the reach of most rural folks.Hence, they resort to the sources like dams, streams, rivers and lakes. Water from these sources is usually turbid and contaminated with microorganisms that cause many diseases.[2]

**Objectives: -**

1. Setting of different hydraulic retention time.
2. To study the variation of pH of water with respect to different HRT'S
3. To study the variation of Alkalinity of water with respect to different HRTS
4. To study the variation of Acidity of water with respect to different HRT'S
5. To study the variation of Hardness of water with respect to different HRT'S
6. To study the variation of Turbidity of water with respect to different HRT'S

**Methodology**

**3.1.2 Flow Chart: -**




**Raw water**: -Raw water is the natural water (from rainwater, groundwater, surface water, well water, lakes and rivers) found in the environment that has not been treated nor had any minerals, ions, particles or organisms removed.[13.]

The source of raw water is selected from nearby village Belagavi.

**Fig No 3.1 raw water source**

### 3.2 Materials used for purifying the raw water are as follows

**3.2.1 Coconut shell charcoal**: -Coconut husk chips are used as capping material Coconut husk chip are easily available and it helps to tackle some additional flock loads. It improves quality of filtration with respect to bacterial measure. [14]

Coconut Shell Charcoal is obtained by burning the shell of fully matured coconuts with a limited supply of air so that they do not burn away to ash but are only carbonized. Good coconut shell charcoal is uniformly dark and snaps with a clean shining fracture and produces a metallic sound, when dropped on hard ground. Under burnt shells do not give a metallic sound and a clean fracture, while the overburnt ones are friable and the surface of the fracture sounds dull when dropped and easily crumbles. Coconut shell charcoal contains the highest percentage of fixed carbons of all the lignaceous charcoals. The average composition of good charcoal is moisture 6.24%, volatile 5.46 %, ash 0.54% and fixed carbon 87.76%. The shell charcoal powder is the waste product obtained during the processing of charcoal the quality standards for shell charcoal as per Asian and Pacific Coconut Community (APCC) are as follows:

1. Moisture - Less than 10%
2. Ash - Not more than 2%
3. Volatile matter - Not more than 15%

4. Fixed carbon - Not more than 75%
5. Foreign matter - Not more than 0.5%
6. Colour - Black
7. Size - Not more than 5%, shall pass a 0.63 cm mesh sieve [15.]

**Fig No 3.2.1 Activated Coconut shell charcoal**

**3.2.2 River pebbles**: -River Pebbles are a natural siliceous material composed of sub-angular, hard and durable composition used widely as a primary source of filtration material.Filtration through a pebble filter removes most of the impurities remaining in water after coagulation and sedimentation have taken place. river Pebbles is a small piece of stone with a particle size of 10 to 150 mm based on the scale of sedimentology. [15.]

**Fig No 3.2.2 River Pebbles**

**3.2.3 Laterite:** Laterite is a red coloured mineral rock, extensively found in various parts of the country.Rocks containing high ferromagnetism minerals give rise to thicker layers

of laterite having relatively higher concentration of iron.Iron (Fe) and aluminium (Al) content is higher than that of silicon content. Subsequently, natural laterite comprises minerals that are assemblages of goethite, hematite, Al hydroxide, kaolinite, and quartz.Laterite can be a potential adsorbent media due to its rich content of Fe and Al oxides for removing As from drinking water. [17]

**Fig No 3.2.3 Laterite soil**

**3.2.4 Lemon peel**: Lemon peel fruit-waste coagulant is a natural coagulant which able to remove turbidity and replace the synthetic, chemical coagulant which is commonly used in water treatment. The usage of lemon peels as fruit waste natural coagulant will reduce the production of non-biodegradable and toxic chemical sludge to the environment and lower the sludge handling and treatment costs. Besides, the uses of fruit waste natural coagulant in water treatment will increase the quality of treated water that reaches the consumer and also reduce the volume of fruit waste to be discarded to landfill. Lemon peels fruit waste coagulant is a non-toxic and non-corrosive product. Besides, this natural coagulant will decrease the volume of toxic sludge to be discarded to the environment. Hence, the use of this natural coagulant in water treatment plant will minimize the sludge management, handling and disposal costs.lemon skins were collected, thoroughly washed with water and dried in the oven at 110 °C for 24 h. The dried skins were then pulverized into small particles, sizes ranging from 200 to 400μm.

**Fig No 3.2.4 Lemon Peel**

## 3.3 SENSORS USED TO DETERMINE THE TURBIDITY

### 3.3.1 ARDUINO UNO: -

Arduino is an open-source programmable circuit board that can be integrated into a wide variety of makerspace projects both simple and complex. This board contains a microcontroller which is able to be programmed to sense and control objects in the physical world. By responding to sensors and inputs, the Arduino is able to interact with a large array of outputs such as LEDs, motors and displays.Because of its flexibility and low cost, Arduino has become avery popular choice for makers and makerspaces looking to create interactive hardware projects.

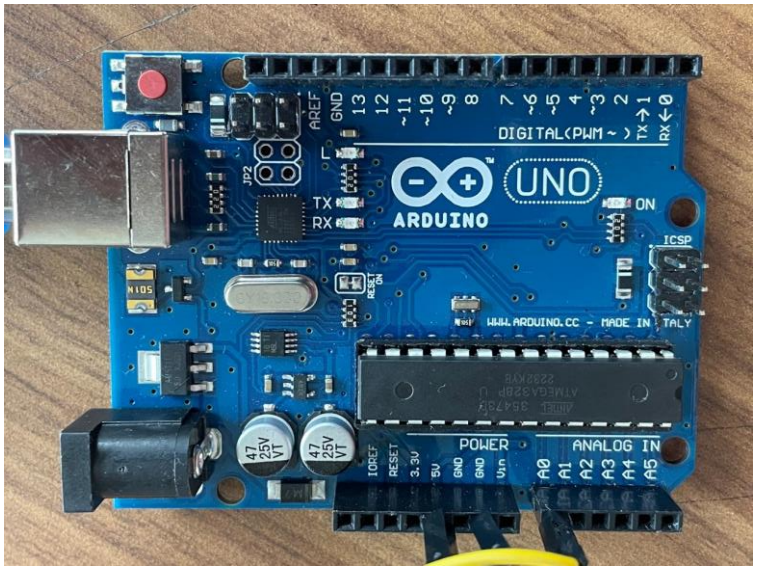



**Fig No:-3.3.1Arduino Uno**

### 3.3.2 TURBIDITY SENSOR: -

sensor that measures turbidity. They are highly useful and effective instruments to identify the clarity and particle content in a solution, like water. Turbidity sensors are used to reduce waste, improve yields, and analyse water quality in a wide range of industries.

**Fig No 3.3.2 Turbidity Sensor**

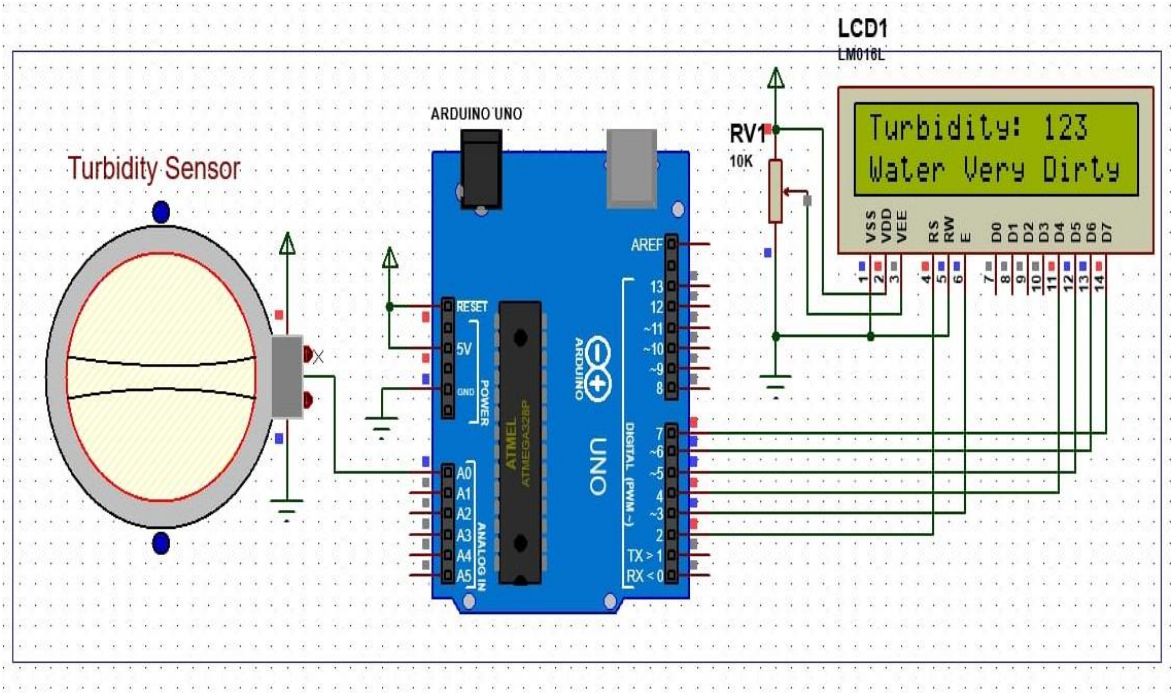



**Fig No 3.4 Circuit diagram of turbidity sensor**

## TESTING METHODS

### 4.1 DETERMINATION OF pH ( By pH meter)

**AIM:** To determine the pH, using pH meter for the given water sample.

**APPARATUS:** pH meter, Borosil glassware, glass rods etc.

**REAGENTS:** Buffer solutions of 4, 7 & 9.2 pH.

**THEORY:**

► **pH:** The pH value of water is defined as the log of reciprocal of hydrogen ion concentration in water. Mr. Sorensen gave the expression for pH in the year 1909A.D. In pH symbol “p” indicates potential difference between two electrodes and “H” denotes hydrogen ion concentration. pH is a chemical parameter, without units. By virtue of its logarithmic nature, pH is a dimensionless quantity.

pH = log 10 (1/ H+)

It follows that if the pH value is found to be less than 7 (when hydrogen ions predominate) it will become acidic in nature, and if its value is found to be more than 7 (when hydroxyl ions predominate) then it will become alkaline in nature. pH of 7 is for neutral water or distilled water [when H+=OH-]. The permissible pH values for public supplies may range in between 6.5 to 8.5 (as per BIS: 10500-2012). pH below 4 gives the water a sour taste and becomes corrosive in nature corroding water distribution pipes and above 8.5 gives a bitter taste and causes incrustation (deposition of alkali salts) in water distribution pipes. Normal rainwater has a pH of 5.6.

**PROCEDURE:** For pH

1. Give the identification numbers for the water samples whose pH is to be determined.

2. Check the electrical connections and attach the electrodes to the instrument and rinse them in distilled water thoroughly.

3. Perform the calibration of the pH instrument with buffer capsules of 4, 7, & 9.2 pH, if “Calibration Due” message is observed on the display screen, otherwise continue with next step.

4. Take sufficient quantity of water sample in clean glass beaker and place it below the electrode and start the magnetic stirrer. Adjust the speed of magnetic stirrer to medium speed. Rinse the electrode with distilled water between one sample to another to avoid interference and wipe it with a tissue paper.

5. Note down the pH of water sample.

## 4.2 DETERMINATION OF ALKALINITY(By Titrimetric method)

**AIM:** To find the Alkalinity of given water sample.

**APPARATUS**: Titration apparatus.

**REAGENTS:**

a) Standard Sulfuric acid (H2SO4) of 0.02 N – Titrant.

b) Phenolphthalein – Indicator.

c) Methyl orange – Indicator.

d) Sodium thiosulfate (Na2S2O3.5H2O) of 0.1 N.

**THEORY:** Alkalinity is a measure of ability of water to neutralize acids [acid neutralizing capacity – ANC]. The major portion of alkalinity in natural waters is caused by bicarbonates ($HCO_3^-$), carbonates ($CO_3^-$) and hydroxides ($OH^-$) of calcium ($Ca^+$) and magnesium ($Mg^+$). However, when water becomes too alkaline, it may taste like soda and could have a drying effect on the skin. Moreover, it becomes "hard." Carbonate rocks, such as limestone, are the main sources to turning water alkaline. In the pH scale from zero to 4.2 there will be no alkalinity, from 4.2 to 8.2 alkalinity is due to bicarbonates ($HCO_3^-$), from 8.2 to 11 alkalinity is due to carbonates ($CO_3^{--}$) and hydroxides ($OH^-$) and the maximum alkalinity in the range of 11 to 14 will be due to hydroxides ($OH^-$). Highly alkaline waters affect the boilers by forming scales on the inner surface. The alkalinity of water has little public health significance. Highly alkaline waters are usually unpalatable because of bitter taste and the consumers tend to seek other supplies. As per BIS: 10500-2012 the desirable limit for alkalinity is less then 200 mg/L, beyond this the water becomes bitter in taste affecting its taste or palatability. Excess alkalinity in water is harmful to irrigation, which leads to soil damage, and reduce crop yield due to reduced fertility. For RCC works alkalinity should be less then 250 mg/L. But when water (especially drinking water) becomes too alkaline, treatments, such as reverse osmosis, distillation and deionization, are used to remove excessive amounts of minerals to reduce alkalinity.

**PROCEDURE:**

1. Take a 50 ml of sample in a clean conical flask. Add 01 drop of sodium thiosulfate ($Na_2S_2O_3.5H_2O$) of 0.1 N to remove residual chlorine if present.
2. Add 2 to 3 drops of **phenolphthalein** indicator, if sample turns to **pink** color presume that the pH of water is more then 8.2 and it contains phenolphthalein alkalinity, titrate with sulfuric acid ($H_2SO_4$) of 0.02 N till pink color changes to **colorless**. Note down the ml of titrant used as $V_1$ ml.
3. If sample does not turn to pink color, (then pH of the sample must be less then 8.2) add 2 to 3 drops of **methyl orange** indicator, sample turns to **yellow** color. Continue the titration till color changes fro8m **yellow** to **orange** and note down total titrant used as $V_2$ ml.
4. Run a blank (distilled water) also with the same procedure as above & find out its alkalinity in mg/L.

### 4.3 DETERMINATION OF ACIDITY(By Titrimetric method)

**AIM:** To determine the Acidity (base capacity) of the given water sample.

**APPARATUS:** Titration apparatus.

**REAGENTS:**

a) Standard sodium hydroxide (NaOH) of 0.02 N – Titrant.
b) Phenolphthalein – Indicator.
c) Methyl Orange – Indicator.
d) Sodium thiosulfate ($Na_2S_2O_3.5H_2O$) of 0.1 N.

**THEORY:** Acidity in water is mainly due to the mineral acids and carbon dioxide. It is the measure of the ability of water to neutralize the bases $HCO_3^-$, $CO_3^{--}$ and $OH^-$. Carbon dioxide ($CO_2$) acidity is due to presence of free $CO_2$ in ground and surface waters. Mineral acidity is due to the presence of HCl, $H_2SO_4$, $HNO_3$ acids and strong organic acids like acetic acid and fumic acid mainly discharged from industries. It is expressed in terms of $CaCO_3$ equivalent of the hydroxyl ions neutralized. Acid waters are of concern because of their corrosive nature and the expense involved in removing or controlling the corrosion producing substances. On the pH scale of 0 to 14, there will be maximum acidity from 0 (zero) to 4.2 due to mineral acids such as HCl, $H_2SO_4$, $HNO_3$, 4.2 to 8.2

the acidity is due to carbon dioxide and from 8.2 to 14 there will be no acidity. Major industries discharging acidic effluents are electroplating industries, fertilizer industry, distilleries, mining industries etc. There is no limit for acidity in drinking water as per BIS: 10500-2012, since it has no adverse effect on consumers. Only the taste becomes sour if the pH is less then 04. Acidity in water can be removed by neutralization with lime (CaO) or sodium hydroxide (NaOH). The permissible limit of total acidity, as $CaCO_3$ in water used for RCC works should be less then 50 mg/L because of its corrosive nature.

**PROCEDURE:**

1. Take 50 ml of water sample in a clean conical flask. Add 01 drop of Sodium thiosulfate of 0.1 N to remove residual chlorine if any. {The presence of chlorine in water makes methyl orange end point difficult to identify}.
2. Add 02 drops of **methyl orange** indicator, if sample turns to **pink** color, titrate against NaOH (0.02 N) till color changes from **pink** to **yellow**. Note down the volume of titrant added as $V_1$ ml.

**NOTE:** If **yellow** coloris directly observed instead of **pink** after the addition of methyl orange indicator then $V_1$ has to be recorded as **ZERO** ml& it is an indication of **NIL mineral acidity.**

3. Take a fresh sample of 50 ml in a clean conical flask and add 02 drops of **phenolphthalein** indicator to get **temporary pink** color and titrate till the **temporary pink** turns to **permanent pink**. Note down the volume of titrant added as $V_2$ ml.
4. Similarly do the above steps for distilled water (blank).

### 4.4 DETERMINATION OF HARDNESS(By EDTA Titrimetric method)

**AIM:** To determine the Total, Calcium & Magnesium Hardness of given water sample.

**APPARATUS:** Titration apparatus.

**REAGENTS:**

a) Buffer solution.
b) EDTA – Ethylene Diamine Tetra Acetic acid of 0.01 **M** – Titrant.

c) Eriochrome Black T - Indicator.
d) Murexide – Indicator.
e) Sodium hydroxide (NaOH) of 01 N.

**THEORY:** Hardness in water is that characteristic which prevents the formation of sufficient foam or leather, when such hard waters are mixed with soap. The hardness is usually caused by the presence of calcium and magnesium salts present in the water, which form scum by reaction with soap to prevent the formation of leather or foam. If topsoil is thick and lime stone formations are present then it causes hard water. If topsoil is thin and granite rock formations are present then it causes soft water. Usually surface water is softer then ground water. Cat ions are responsible for more consumption of soap and an ion are responsible for formation of scales in boilers.

Table no 4.4.1: calcium and magnesium present in the water

| MAJOR CAT IONS | MAJOR AN IONS |
|---|---|
| Calcium $Ca^{++}$ | Bicarbonates $HCO_3^-$ |
| Magnesium $Mg^{++}$ | Carbonates $CO_3^{--}$ |
| Strontium $Sr^{++}$ | Sulfate $SO_4^-$ |
| Iron $Fe^{++}$ | Chlorides $Cl^-$ |
| Manganese $Mn^{++}$ | Hydroxides $OH^-$ |
| Aluminum $Al^{+++}$ | Nitrates NO3- |

For regular public supplies hardness of water should be between 75 to 115 mg/L or ppm. Hard waters are undesirable because they consume more soap, forms scales on boilers and incrustation of pipes, it also makes food tasteless. Water samples are commonly classified in terms of the degree of hardness as follows:

**Table no 4.4.2: Degree of hardness**

| Degree of hardness | mg/L as $CaCO_3$ |
|---|---|
| Soft | 0-50 |
| Moderately soft | 50-100 |
| Slightly hard | 100-150 |

| | |
|---|---|
| Moderately hard | 150-200 |
| Hard | 200-300 |
| Very hard | Above 300 |

- Temporary hardness or carbonate hardness is mainly due to carbonates and bicarbonates in combination with calcium and magnesium. It can be removed by boiling of water (to some extent) and by addition of lime (to full extent).
- Permanent hardness or non-carbonate hardness is due to sulfates, chlorides and nitrates of calcium and magnesium. This hardness can be effectively removed by (1) Soda-lime process (2) Base exchange or Zeolite process and (3) Demineralization process. Using these 3 softening methods temporary as well as permanent hardness can be removed. As per BIS: 10500-2012 for drinking water the limits are as given in table below

**Table no 4.4.3: BIS10500- 2012 for drinking water**

| **Typeof hardness as $CaCO_3$** | **Desirable limit** | **Permissible limit** |
|---|---|---|
| Total hardness | ≤ 300 mg/L | ≤ 600 mg/L |
| Calcium hardness | ≤ 75 mg/L | ≤ 200 mg/L |
| Magnesium hardness | ≤ 30 mg/L | ≤ 100 mg/L |

Hard waters as satisfactory as soft waters in human consumption. Calcium is a major useful element in development of human bones. Hard waters are beneficial to human cardiovascular system because calcium promotes removal of cadmium that can adversely affect cardiovascular system. Hard waters are required by breweries, distilleries and

bakeries where as soft waters are required by textile, paper, dying, canning, laundries and ice industries.

**PROCEDURE FOR TOTAL HARDNESS:**

1. Take 50 ml of water sample in a clean conical flask.
2. Add 02 drops of buffer solution to maintain pH.
3. Add 2 to 3 drops of **Eriochrome Black T** indicator to get **wine red** color.
4. Titrate against EDTA solution (titrant) of 0.01 M till color changes from **wine red** to **blue**.
5. Note down the volume of titrant added as A ml.
6. Similarly run a blank (distilled water) and note down the volume of titrant added as B ml.

**PROCEDURE FOR CALCIUM HARDNESS:**

1. Take 50 ml of sample in a clean conical flask.
2. Add 2 to 3 drops of NaOH to raise pH ≥12 and add a pinch of **murexide** (ammonium purporate) indicator to get **pink** color.
3. Titrate with EDTA (0.01M) titrant till color changes from **pink** to **purple**.
4. Note down the volume of titrant added as $A_1$ ml.
5. Run a blank (distilled water) as per above procedure and note down the volume of titrant added as $B_1$ ml.

**4.5 DETERMINATION OF TURBIDITY (By Nephelometry)**

**AIM:** To determine the Turbidity in the given water sample.

**APPARATUS:** Nephelometer, glass cuvette etc.

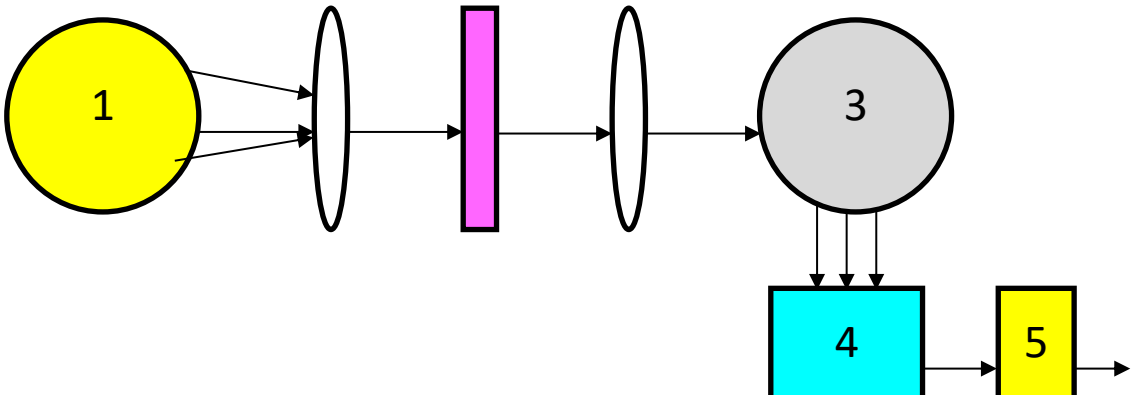
**REAGENT:** 100 NTU standard solution (Stock solution).

**THEORY:** Turbidity is caused in natural surface waters by finely divided suspended particles of clay, slit, sand or by organic materials, and by microscopic organisms. The standard unit for turbidity is mixing of 01 mg of finely divided silica ($SiO_2$)also called Fuller's earth in one liter of distilled water. Turbidity can be measured by secchi disc, turbidity rod, Jackson turbidimeter, Baylis turbidimeter and nephelometer. Jackson turbidimeter works on the principle of light absorption and nephelometer is based on

intensity of light scattering. Now-a-days nephelometer is commonly used and the unit is Nephelometric Turbidity Unit (NTU). Turbidity is considered to be a very important factor in drinking water due to aesthetic and psychological reasons, besides being a sign of pollution in some particular cases. The permissible limit of turbidity for drinking water should not be more than 05 NTU (as per BIS: 10500–2012). Turbid waters become warmer as suspended particles absorb heat from sunlight, causing oxygen levels to fall. (Warm water holds less oxygen than cooler water.) Photosynthesis decreases with lesser light, resulting in even lower oxygen levels. Suspended solids in turbid water can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. Settled particles smother eggs of fish and aquatic insects. In drinking water, the higher the turbidity level, the higher the risk that people may develop gastrointestinal diseases.

**PROCEDURE:**

1. Calibrate the instrument by using distilled water for Zero NTU and 100 NTU standard solution.
2. Take the water sample in a glass cuvette and keep the cuvette in the nephelometer and observe the constant display of the reading on the screen. Lesser value of NTU for less turbid waters and higher value of NTU for more turbid waters will be displayed on the digital screen of the instrument.
3. If the readout goes beyond 100 NTU or if ‘1’ is observed on the display, dilute the sample with distilled water for suitable proportion and then note down the value of turbidity in NTU (Nephelometric Turbidity Unit).



Scattered light

by 90

2

6

**Fig No 4.5 working principle of Nephelometer**

1. Light source- Tungsten bulb.
2. Lens system.
3. Sample solution.
4. Photoelectric detector.
5. Processing electronics.
6. Digital readout.


**Fig No 4.6 collection of water sample and testing wat**

## RESULTS

**Table No 5.1 As per BIS permissible limit for drinking water**

| **AS PER BIS 10500-2012** | | | | |
|---|---|---|---|---|
| **PH** | **Alkalinity** | **Acidity** | **Turbidity** | **Hardness** |
| 6.5-8.5 | 200 mg/L | No limit | 5 NTU | 300mg/L |

**Table No 5.2 Initial water sample test results**

| **INITIAL WATER SAMPLE TEST RESULTS** | | | | |
|---|---|---|---|---|
| **pH** | **Alkalinity** | **Acidity** | **Turbidity** | **Hardness** |
| 7.4 | 12 mg/L | 1.34 mg/L | 17.8 NTU | 13.34 mg/L |

**Table No 5.3 Collecting Tank Test Results**

| COLLECTING TANK TEST RESULTS | | | | | |
|---|---|---|---|---|---|
| **HRT** | **pH** | **Alkalinity** | **Acidity** | **Turbidity** | **Hardness** |
| **0.5** | 8.2 | 7.7 | 8.1 | 4.2 | 1.3 |
| **1** | 8.96 | 7.4 | 7.8 | 3.9 | 0.8 |
| **1.5** | 8.09 | 7.2 | 7.8 | 3.9 | 0.8 |
| **2** | 7.91 | 4.4 | 6.5 | 4 | 0.73 |
| **2.5** | 7.85 | 2.5 | 6.1 | 4.1 | 0.64 |
| **3** | 7.64 | 0.6 | 5.8 | 4.2 | 0.68 |
| **3.5** | 7.01 | 1.02 | 5.3 | 4.1 | 0.51 |
| **4** | 7.65 | 2.01 | 4.5 | 4 | 0.43 |
| **4.5** | 7.69 | 3.2 | 3.9 | 4.2 | 0.39 |
| **5** | 8.63 | 3.9 | 3.3 | 4.1 | 0.31 |
| **5.5** | 8.42 | 4.0 | 3.1 | 4.2 | 0.28 |
| **6** | 8.32 | 4.6 | 3 | 4.3 | 0.2 |

**Table No 5.4 First Reactor Test Results**

| FIRST REACTOR TEST RESULTS | | | | | |
|---|---|---|---|---|---|
| **HRT** | **pH** | **Alkalinity** | **Acidity** | **Turbidity** | **Hardness** |
| **0.5** | 8.45 | 1.7 | 20.4 | 4.4 | 1.38 |
| **1** | 8.43 | 1.9 | 20.9 | 4.2 | 1.35 |
| **1.5** | 8.35 | 2 | 21.8 | 4 | 1.34 |
| **2** | 8.37 | 3.3 | 16 | 4.2 | 1.54 |
| **2.5** | 8.36 | 4.7 | 11 | 4.1 | 1.67 |
| **3** | 8.35 | 5.2 | 7 | 4.1 | 2 |
| **3.5** | 8.33 | 3.1 | 6 | 4 | 1.7 |
| **4** | 8.23 | 6.7 | 5.3 | 4.2 | 1.4 |

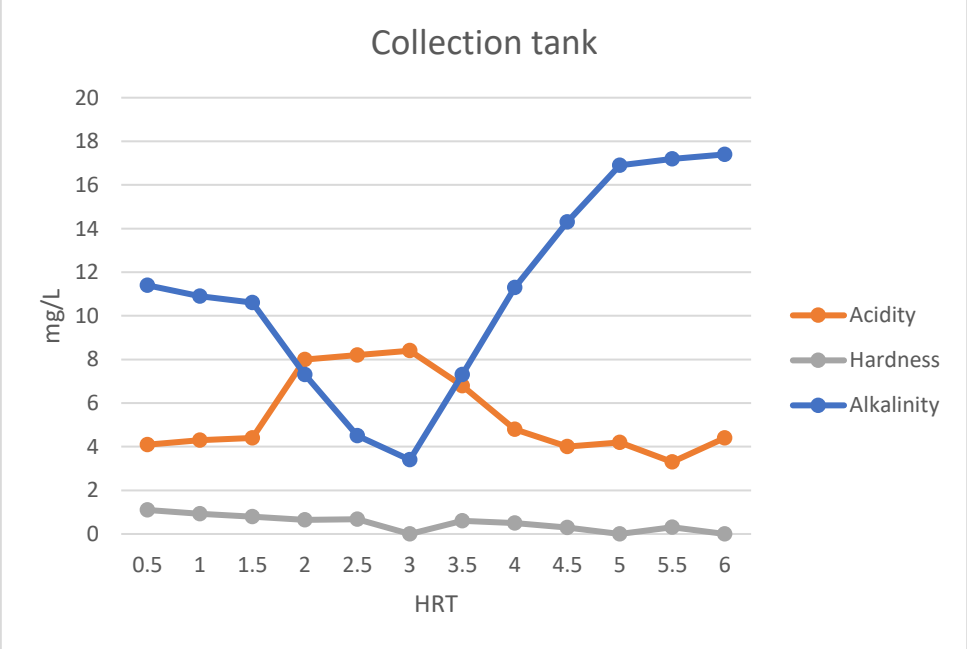
| | | | | | |
|---|---|---|---|---|---|
| **4.5** | 8.27 | 7.9 | 4.5 | 4.1 | 1.1 |
| **5** | 8.3 | 9.6 | 4 | 4.1 | 0.9 |
| **5.5** | 8.25 | 10.0 | 4.4 | 3.9 | 0.5 |
| **6** | 8.30 | 11.2 | 3 | 4.1 | 0 |

**Table No 5.5 Second Reactor Test Results**

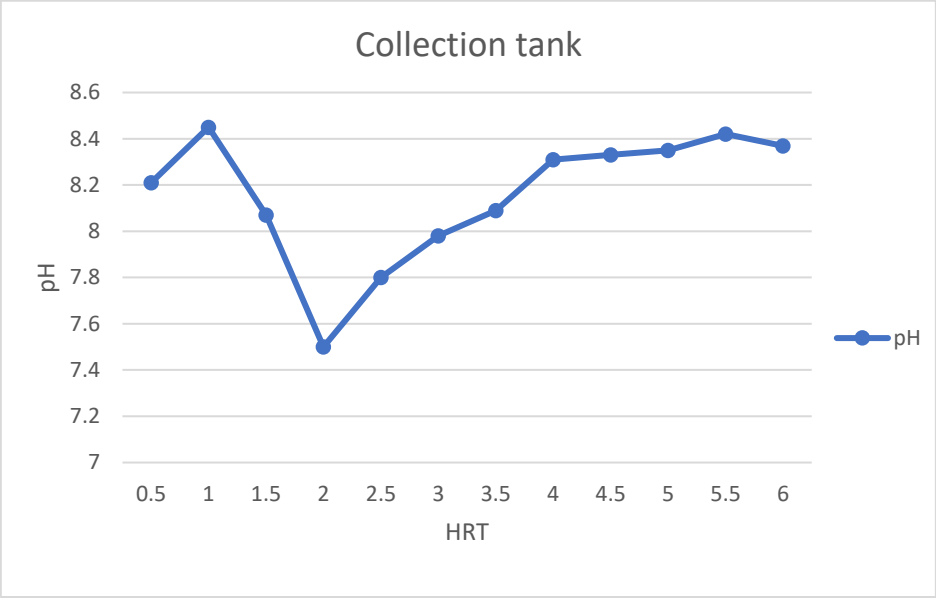
| SECOND REACTOR TEST RESULTS | | | | | |
|---|---|---|---|---|---|
| **HRT** | **pH** | **Alkalinity** | **Acidity** | **Turbidity** | **Hardness** |
| **0.5** | 8.29 | 7.5 | 18.2 | 3.7 | 1.3 |
| **1** | 8.31 | 7.8 | 18.7 | 3.8 | 1.1 |
| **1.5** | 8.33 | 8 | 19.8 | 3.9 | 0 |
| **2** | 8.34 | 8.1 | 11.1 | 4 | 2.3 |
| **2.5** | 8.36 | 8.4 | 12.5 | 4.4 | 3.6 |
| **3** | 8.38 | 8.6 | 9 | 4.4 | 4 |
| **3.5** | 8.39 | 7.9 | 4.7 | 4.5 | 3.2 |
| **4** | 8.37 | 7.5 | 3.9 | 4.3 | 1.9 |
| **4.5** | 8.39 | 7.3 | 2.7 | 4.5 | 1.2 |
| **5** | 8.34 | 7.1 | 2.9 | 4.3 | 0.9 |
| **5.5** | 8.25 | 7.3 | 2.5 | 4.0 | 0.8 |
| **6** | 8.32 | 8 | 3 | 4.2 | 0.6 |

**Table No 5.6Third Reactor Test Results**

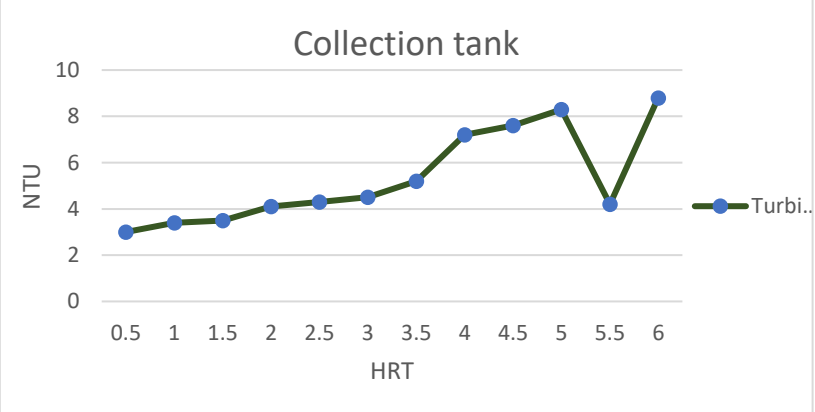
| THIRD REACTOR TEST RESULTS | | | | | |
|---|---|---|---|---|---|
| **HRT** | **pH** | **Alkalinity** | **Acidity** | **Turbidity** | **Hardness** |
| 0.5 | 8.21 | 11.4 | 4.1 | 3 | 1.1 |
| 1 | 8.45 | 10.9 | 4.3 | 3.4 | 0.92 |
| 1.5 | 8.07 | 10.6 | 4.4 | 3.5 | 0.8 |
| 2 | 7.5 | 7.3 | 8 | 4.1 | 0.65 |
| 2.5 | 7.8 | 4.5 | 8.2 | 4.3 | 0.67 |
| 3 | 7.98 | 3.4 | 8.4 | 4.5 | 0 |
| 3.5 | 8.09 | 7.3 | 6.8 | 5.2 | 0.6 |
| 4 | 8.31 | 11.3 | 4.8 | 7.2 | 0.5 |
| 4.5 | 8.33 | 14.3 | 4 | 7.6 | 0.3 |
| 5 | 8.35 | 16.9 | 4.2 | 8.3 | 0 |
| 5.5 | 8.34 | 17.0 | 4.35 | 8.5 | 0.2 |
| 6 | 8.37 | 17.4 | 4.4 | 8.8 | 0 |



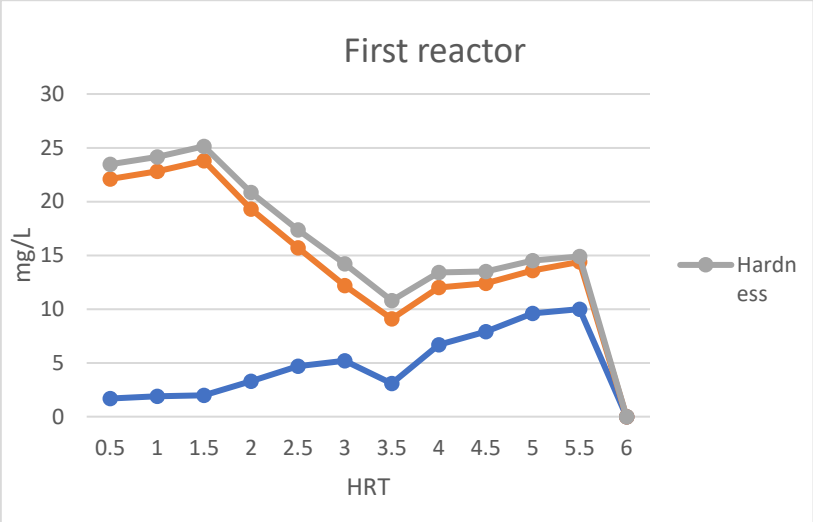

**Graph No 5.1 Collecting Tank**



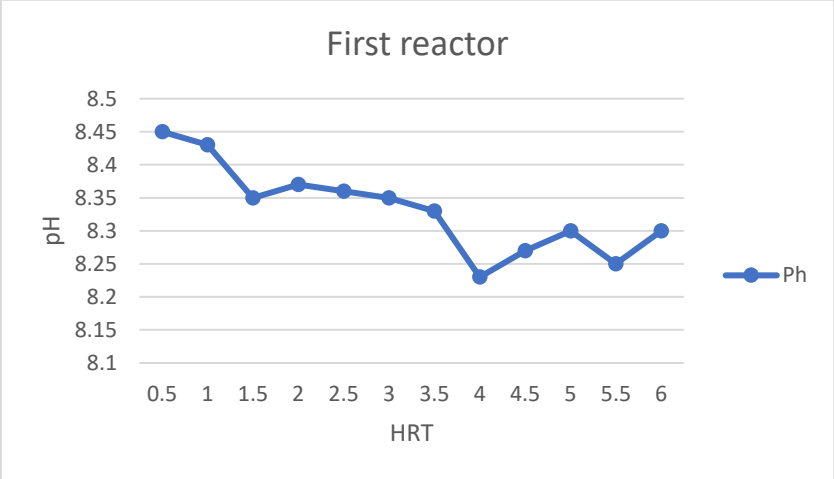

**Graph No 5.2 Collecting Tank**



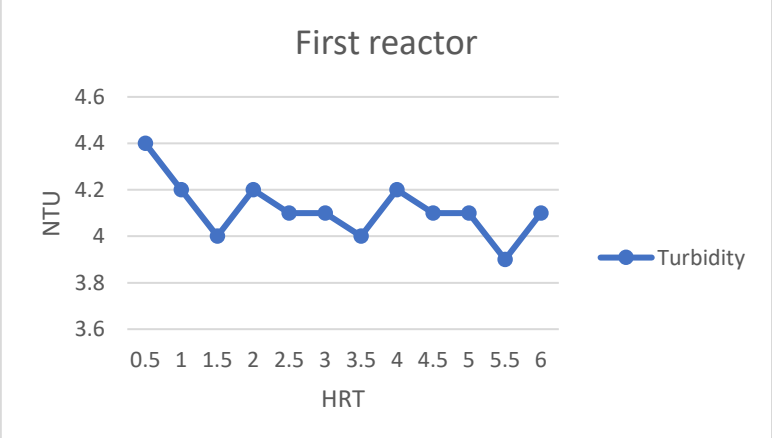

**Graph No 5.3 Collecting Tank**



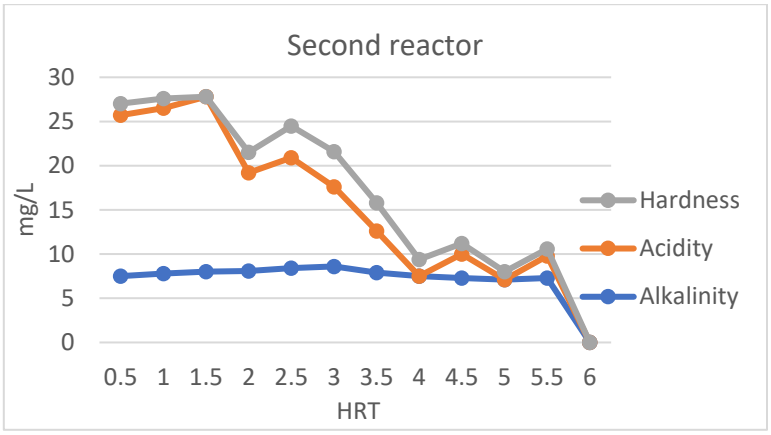

**Graph No 5.4 First Reactor**



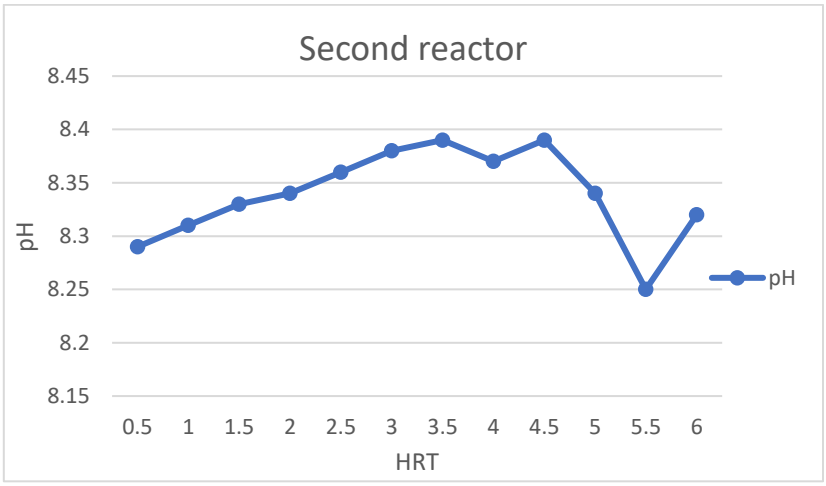

**Graph No 5.5 First Reactor**



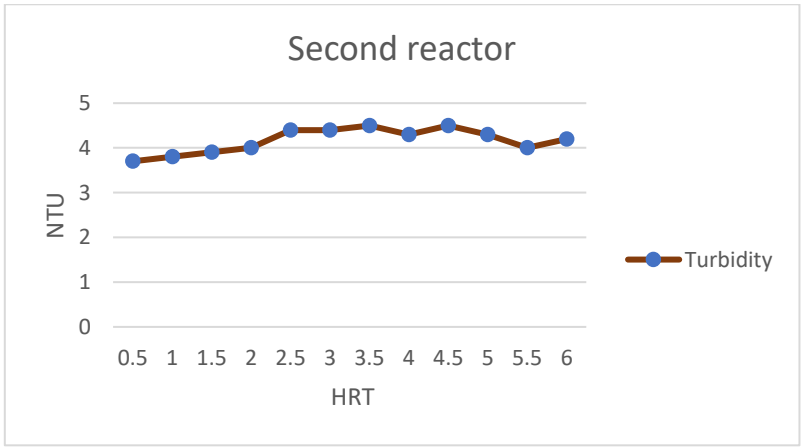

**Graph No 5.6 First Reactor**



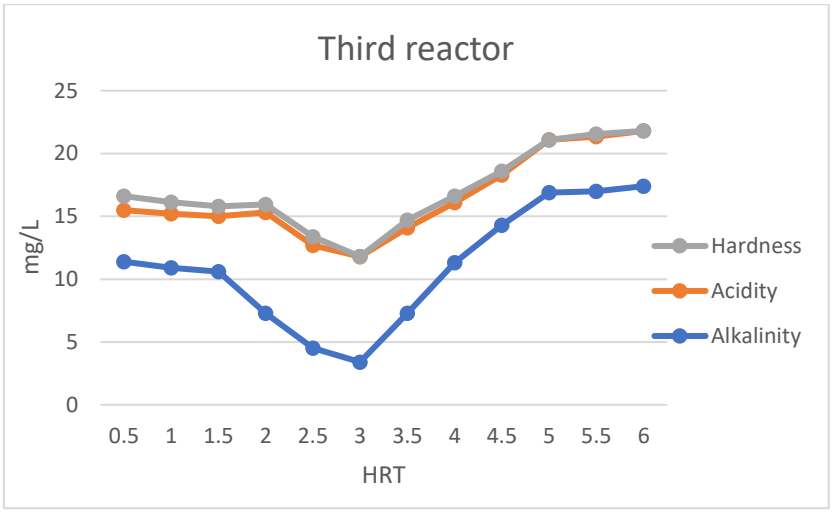

**Graph No 5.7 Second Reactor**



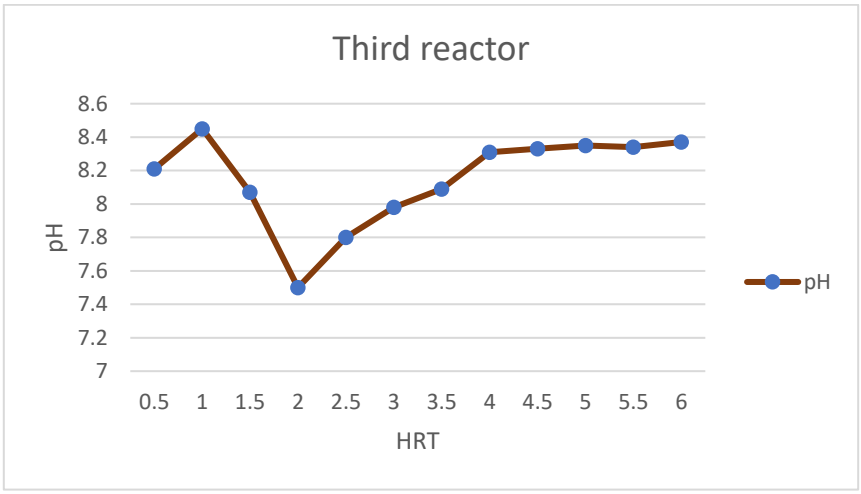

**Graph No 5.8 Second Reactor**



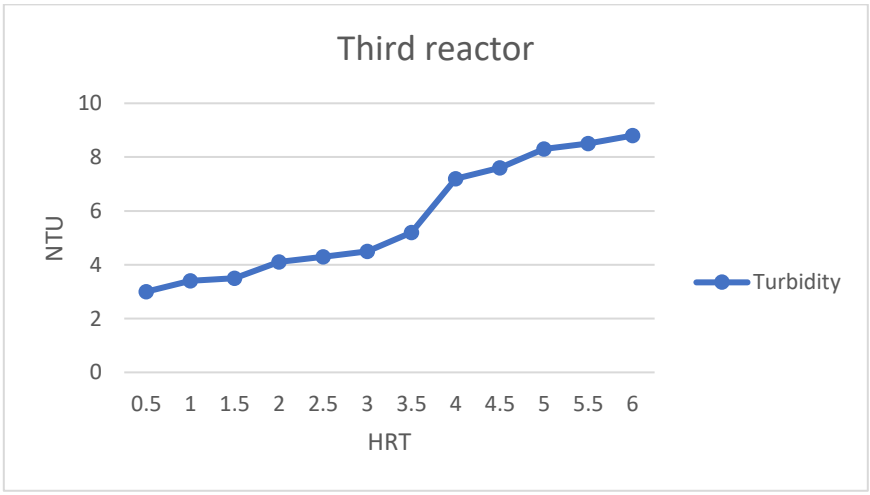

**Graph No 5.9 Second Reactor**




**Graph No 5.10 Third Reactor**




**Graph No 5.11 Third Reactor**



**Graph No 5.12 Third Reactor**

## DISCUSSION

The entire setup was set for different HRT'S. The different HRT'S are 0.5hr, 1.0hr, 1.5hr, 2.0hr, 2.5,hr, 3.0hr, 3.5hr, 4.0hr, 4.5hr, 5.0hr, 5.5hr, 6.0hr. After every first reactor, second reactor, third reactor, and fourth reactor we have collected treated water sample and tested for different parameters. The different reactor water sample parameter for different HRT'S are discussed below.

### After First Reactor:

- For 0.5 hr HRT pH value is 8.45,Alkalinity value is 1.7mg/L, Acidity value is 20.4mg/L,Turbidity value is 4.4 NTU and Hardness value is 1.38mg/L
- For 1.0 hr HRT pH value is 8.43,Alkalinity value is 1.9mg/L, Acidity value is 20.9mg/L,Turbidity value is 4.2 NTU and Hardness value is 1.35mg/L
- For 1.5 hr HRT pH value is 8.35,Alkalinity value is 2.0mg/L, Acidity value is 21.8mg/L,Turbidity value is 4.0 NTU and Hardness value is 1.34mg/L
- For 2.0 hr HRT pH value is 8.37,Alkalinity value is 3.3mg/L, Acidity value is 16mg/L,Turbidity value is 4.2 NTU and Hardness value is 1.54mg/L
- For 2.5 hr HRT pH value is 8.36,Alkalinity value is 4.7mg/L, Acidity value is 11mg/L,Turbidity value is 4.1 NTU and Hardness value is 1.67mg/L
- For 3.0 hr HRT pH value is 8.35,Alkalinity value is 5.2mg/L, Acidity value is 7mg/L,Turbidity value is 4.1 NTU and Hardness value is 2mg/L
- For 3.5 hr HRT pH value is 8.33,Alkalinity value is 3.1mg/L, Acidity value is 6mg/L,Turbidity value is 4NTU and Hardness value is 1.7mg/L
- For 4.0 hr HRT pH value is 8.23,Alkalinity value is 6.7mg/L, Acidity value is 5.3mg/L,Turbidity value is 4.2 NTU and Hardness value is 1.4mg/L
- For 4.5 hr HRT pH value is 8.27,Alkalinity value is 7.9mg/L, Acidity value is 4.5mg/L,Turbidity value is 4.1 NTU and Hardness value is 1.1mg/L
- For 5.0 hr HRT pH value is 8.3, Alkalinity value is 9.6mg/L, Acidity value is 4.0mg/L,Turbidity value is 4.1 NTU and Hardness value is 0.9mg/L

- For 5.5 hr HRT pH value is 8.42,Alkalinity value is 4.0mg/L, Acidity value is 3.1mg/L,Turbidity value is 4.2 NTU and Hardness value is 0.28 mg/L
- For 6.0 hr HRT pH value is 8.30, Alkalinity value is 11.2mg/L, Acidity value is 3.0mg/L,Turbidity value is 4.1 NTU and Hardness value is 0 mg/L

**After Second Reactor:**

- For 0.5 hr HRT pH value is 8.29,Alkalinity value is 7.5mg/L, Acidity value is 18.2mg/L,Turbidity value is 3.7 NTU and Hardness value is 1.3mg/L
- For 1.0 hr HRT pH value is 8.31,Alkalinity value is 7.8mg/L, Acidity value is 18.7mg/L,Turbidity value is 3.8 NTU and Hardness value is 1.1mg/L
- For 1.5 hr HRT pH value is 8.33,Alkalinity value is 8.0mg/L, Acidity value is 19.8mg/L,Turbidity value is 3.9 NTU and Hardness value is 0mg/L
- For 2.0 hr HRT pH value is 8.34,Alkalinity value is 8.1mg/L, Acidity value is 11.1mg/L,Turbidity value is 4.0 NTU and Hardness value is 2.3mg/L
- For 2.5 hr HRT pH value is 8.36, Alkalinity value is 8.4mg/L, Acidity value is 12.5mg/L,Turbidity value is 4.4 NTU and Hardness value is 3.6mg/L
- For 3.0 hr HRT pH value is 8.38, Alkalinity value is 8.6mg/L, Acidity value is 9.0mg/L,Turbidity value is 4.4 NTU and Hardness value is 4.0mg/L
- For 3.5 hr HRT pH value is 8.39, Alkalinity value is 7.9mg/L, Acidity value is 4.7mg/L,Turbidity value is 4.5 NTU and Hardness value is 3.2mg/L
- For 4.0 hr HRT pH value is 8.37, Alkalinity value is 7.5mg/L, Acidity value is 3.9mg/L,Turbidity value is 4.3NTU and Hardness value is 1.9mg/L
- For 4.5 hr HRT pH value is 8.39, Alkalinity value is 7.3mg/L, Acidity value is 2.7mg/L,Turbidity value is 4.5 NTU and Hardness value is 1.2mg/L
- For 5.0 hr HRT pH value is 8.34, Alkalinity value is 7.1mg/L, Acidity value is 2.9mg/L,Turbidity value is 4.3NTU and Hardness value is 0.9mg/L
- For 5.5 hr HRT pH value is 8.25,Alkalinity value is 7.3mg/L, Acidity value is 2.5mg/L,Turbidity value is 4.0NTU and Hardness value is 0.8 mg/L
- For 6.0 hr HRT pH value is 8.32, Alkalinity value is 8.0mg/L, Acidity value is 3.0mg/L,Turbidity value is 4.2NTU and Hardness value is 0.6mg/L

**After Third Reactor:**

- For 0.5 hr HRT pH value is 8.21,Alkalinity value is 11.4mg/L, Acidity value is 4.1mg/L,Turbidity value is 3.0 NTU and Hardness value is 1.1mg/L
- For 1.0 hr HRT pH value is 8.45,Alkalinity value is 10.9mg/L, Acidity value is 4.3mg/L,Turbidity value is 3.4 NTU and Hardness value is 0.92mg/L
- For 1.5 hr HRT pH value is 8.07,Alkalinity value is 10.6mg/L, Acidity value is 4.4mg/L,Turbidity value is 3.5 NTU and Hardness value is 0.8mg/L
- For 2.0 hr HRT pH value is 7.5, Alkalinity value is 7.3mg/L, Acidity value is 8mg/L,Turbidity value is 4.1 NTU and Hardness value is 0.65mg/L
- For 2.5 hr HRT pH value is 7.8, Alkalinity value is 4.5mg/L, Acidity value is 8.2mg/L,Turbidity value is 4.3 NTU and Hardness value is 0.67mg/L
- For 3.0 hr HRT pH value is 7.98, Alkalinity value is 3.4mg/L, Acidity value is 8.4mg/L,Turbidity value is 4.5 NTU and Hardness value is 0mg/L
- For 3.5 hr HRT pH value is 8.09, Alkalinity value is 7.3mg/L, Acidity value is 6.8mg/L,Turbidity value is 5.2NTU and Hardness value is 0.6mg/L
- For 4.0 hr HRT pH value is 8.31, Alkalinity value is 11.3mg/L, Acidity value is 4.8mg/L,Turbidity value is 7.2NTU and Hardness value is0.5mg/L
- For 4.5 hr HRT pH value is 8.33, Alkalinity value is 14.3mg/L, Acidity value is 4.0mg/L,Turbidity value is 7.6NTU and Hardness value is 0.3mg/L
- For 5.0 hr HRT pH value is 8.35, Alkalinityvalue is 16.9mg/L, Acidity value is 4.2mg/L,Turbidity value is 8.3NTU and Hardness value is 0mg/L
- For 5.5 hr HRT pH value is 8.34,Alkalinity value is 17.0mg/L, Acidity value is 4.35mg/L,Turbidity value is 8.5NTU and Hardness value is 0.2 mg/L
- For 6.0 hr HRT pH value is 8.37, Alkalinity value is 17.4mg/L, Acidity value is 4.4mg/L,Turbidity value is 8.8NTU and Hardness value is 0 mg/L

**After Fourth Reactor(Collecting Tank):**

- For 0.5 hr HRT pH value is 8.2,Alkalinity value is 7.7mg/L, Acidity value is 8.1mg/L,Turbidity value is 4.2NTU and Hardness value is 1.3mg/L

- For 1.0 hr HRT pH value is 8.96,Alkalinity value is 7.4mg/L, Acidity value is 7.8mg/L,Turbidity value is 3.9NTU and Hardness value is 0.8mg/L
- For 1.5 hr HRT pH value is 8.09,Alkalinity value is 7.2mg/L, Acidity value is 7.8mg/L,Turbidity value is 3.9 NTU and Hardness value is 0.8mg/L
- For 2.0 hr HRT pH value is 7.91, Alkalinity value is 4.4mg/L, Acidity value is 6.5mg/L,Turbidity value is 4.0 NTU and Hardness value is 0.73mg/L
- For 2.5 hr HRT pH value is 7.85, Alkalinity value is 2.5mg/L, Acidity value is 6.1mg/L,Turbidity value is 4.1NTU and Hardness value is 0.64mg/L
- For 3.0 hr HRT pH value is 7.64, Alkalinity value is 0.6mg/L, Acidity value is 5.8mg/L,Turbidity value is 4.2 NTU and Hardness value is 0.68mg/L
- For 3.5 hr HRT pH value is 7.01, Alkalinity value is 1.02mg/L, Acidity value is 5.3mg/L,Turbidity value is 4.1NTU and Hardness value is 0.51mg/L
- For 4.0 hr HRT pH value is 7.65, Alkalinity value is 2.01mg/L, Acidity value is 4.5mg/L,Turbidity value is 4.0NTU and Hardness value is 0.43mg/L
- For 4.5 hr HRT pH value is 7.69, Alkalinity value is 3.2mg/L, Acidity value is 3.9mg/L,Turbidity value is 4.2NTU and Hardness value is 0.39mg/L
- For 5.0 hr HRT pH value is 8.63, Alkalinityvalue is 3.9mg/L, Acidity value is 3.3mg/L,Turbidity value is 4.1NTU and Hardness value is 0.31mg/L
- For 5.5 hr HRT pH value is 8.42,Alkalinity value is 4.0mg/L, Acidity value is 3.1mg/L,Turbidity value is 4.2NTU and Hardness value is 0.28mg/L
- For 6.0 hr HRT pH value is 8.32, Alkalinity value is 4.6mg/L, Acidity value is 3.0mg/L,Turbidity value is 4.3NTU and Hardness value is 0.2mg/L

## CONCLUSION

The total reactor was setup for different HRT'S. That is 0.5hr, 1.0hr, 1.5hr, 2.0hr, 2.5,hr, 3.0hr, 3.5hr, 4.0hr, 4.5hr, 5.0hr, 5.5hr, 6.0hr based on results and discussion at 3 hours HRT in the collecting tank observed that the least value at 3 hours is compared with initial test results

Hence we conclude that 3hr is the optimum HRT for entire setup. Individual Boxes(Reactor) acts like a treatment unit but the results were good when we compare the all reactor as one

- In the presence study, a model of reactor using natural materials is prepared to treat the raw water.
- For the given reactor the optimum HRT is form to be 3hours.
- The initial pH value of water sample was 7.8 and after treatment it got reduced to 7.64.
- The initial Alkalinity value was 12mg/L and after treatment it got reduced to 0.6 mg/L
- The initial Acidity value was 1.34 mg/L and after treatment it got increased to 5.8 mg/L.
- Before treating the water had Turbidity value of 17.8 NTU and after treatment the Turbidity value has reduced to 4.2 NTU.
- The initial Hardness value was 13.34 mg/L and after treatment it got reduced to 0.68 mg/L .
- All the above parameters are within the limits prescribed by Bureau of Indian Standards (BIS).
- Hence, this reactor is capable of treating raw water can be used for drinking purpose.
- This method is very effective and the treated water can be utilized for drinking purposes.

➢ Innovation in the project is that the turbidity sensor is used which detects the turbidity in the water it shows the values along with the comment like water is dirty, cloudy or clear and in this project we have used the natural ingredients which helps to purify the water.

**SCOPE OF THE PROJECT**

- Use of other natural materials rather than lemon peel, laterite soil, Coconut shell charcoal, River pebbles.
- Use of other tests other than pH, Alkalinity, Acidity, Hardness, Turbidity.

- Use of other water sample rather than the raw water.
- Use of other HRT'S other than the 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6 hrours.

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