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# Treatment of Borewell Water and Sullage Water using Various Activated Carbons

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## Abstract

*Water plays a vital role in shaping land and normalizing climatic characteristics. Their qualities are illustrated in accordance to physical, chemical and biological characteristics. Humans suffer many water borne diseases due to the use of contaminated water which has led to improvement in water quality. This project purpose is to purify domestic water that will meet the needs of the rural and urban areas for drinking, cleaning and flushing purposes. Purification of water is done by using activated carbon that is produced in one step activation from dry materials and sulphuric acid as activator. In this work, the activated carbon is prepared from locally available stems such as tamarind, thorn, Indian beech and yellow flame in order to increase the quality of water. The samples are from tap water and sullage water which is treated with various activated carbons. The purified tap water can be used cooking, bathing and even for drinking purposes; and the treated sullage water is used for cooking, bathing, flushing and cleaning purposes.*

**Keywords:** *Activated Carbon, Biological Characteristics, Chemical, Physical, Sewage, Sullage*

## 1.0 Introduction

Water is an apparent, tasteless, odourless substance and is the main component of stream, lakes, and oceans. It is the basic need for most of the living organisms. The substance is made up of chemical substances that exist in gaseous, liquid, and solid states, such as oxygen and hydrogen. It can dissolve a wide variety of compounds, and one of its many uses is as a solvent for living things. In this project, the topic goes on quality of water. Because of less quality, several water borne diseases are caused. To reduce the effects, quality of water must increase. Quality of water is characterized by its physical, chemical, and microbiological properties which possess wide variability. Hence, the quality of usable water is instituted in aspect to specific water quality considerations that may affect the use of potable water.

The module explores the properties of pure water and the dissolved/suspended components in "natural" water systems[1]. It also explore how natural or man-made compounds, in water, changes water properties in aspect of benefit & sick. We have numerous simple measurements that are used to evaluate water quality around us in lakes, rivers or wetlands[2]. In this project, water quality is increased by purification method using activated carbon (that is referred commonly by the name "activated charcoal"), which is a variant of carbon, possessing low-volume pores, small in size and increases surface area for adsorption[3]. The chemical reaction is because of its high degree of micro porosity, in excess of

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3,000m$^2$ (32,000sq.ft) as determined by gas adsorption[4]. Now that activated carbon is prepared by using locally available raw materials[5]. Only high surface area can produce an activation level high enough for meaningful use. Adsorption properties are frequently enhanced by further chemical adsorption. Activated carbon is typically made from charcoal and occasionally used to make "bio char"[6]. Activated carbons posses large adsorption capacity, which are used in liquids and gas purification processes. A variety of activated carbon can be obtained by controlling its process of *carbonization* and activation[7]. These are chiefly used in powdered and granular forms; sometimes in textile form by controlled *carbonization* and by activating with textile fibers. Activated carbons are effective adsorbent due to its extreme porosity providing hefty surface area that contaminants will get absorbed. Grainy activated carbon will be irregular in shape with particle sizes ranging from 0.2mm to 5mm[8] and powdered activated carbon have sizes less than 0.18mm. These are primarily used in liquid phase applications for flue gas treatment[9]. Preparation of activated carbon can be done from locally available materials such as tamarind stem and thorn stem, Indian beech stem, and yellow flame stem etc[10]. The principal objective of domestic water treatment is to purify the water using activated carbon so as to not to cause any disease a risk to the public's health or harm to the environment[11]. The purification of water in a healthy manner and is an essentially required now-a-days. The activated carbon prepared with locally available material will also reduce the cost water includes household waste liquid from kitchen i.e., sullage water, textile industry water and top water. The purified tap water is for drinking purpose sullage and dyeing water is for flushing purposes[12]. The main objective of the study is Physical, chemical and biological characterization of water samples from the tap water, sullage water (bathroom and kitchen) and textile waste water. This study concentrated on the performance of activated carbon. The waste materials which are locally available are used to prepare activated carbon. It has a small, low volume pores that may have high adsorption capacity.

## 2.0 Literature Study

*Jjagwe et al.,* studied on the synthesis and application of granular activated carbon from biomass waste material[1]. Literatures on production of activated carbons from biomass were searched, and their composition, properties were studies. It was concluded that the use of GACs for water treatment has exhibited a great potential sometimes performing better than the commercial carbons depending on the target contaminant and has increased the demand for granular activated carbon.

Alves A. T. *et al.,* studied the potential of treatment of water for human consumption and various techniques for its development[2]. Activated carbons from vegetable wastes and its benefits and techniques were studied and treated in the water. It was concluded that for human consumption, the biological treatment of water reduces the instability that is mainly characterized by the occurrence of organic matter in low concentrations. It also leads to cutback of bacterial growth, the formation of bio films and corrosion in the distribution network and lessen the need for disinfectant, thereby curtailing the toxic by-product formation.

Dvorak *et al.,* some drinking water may be disinfected with chlorine or chloramines. During disinfection the reaction of chlorine with organic matter can produce compounds such as Trihalomethanes (THMs) as by products. It was determined that the risk of some malignancies may rise as a result of these disinfection byproducts. The EPA requires that treated water in public systems contain no more than 80 parts per billion (ppb) of THMs. Chlorine, chloramines, and some disinfection byproducts can be effectively removed by air conditioning filtration[13].

*Rajeswari A. et al.*, carried over an experiment to purge tap water and well water of impurities. They used a variant of activated carbon which posses a tremendous adsorption capacity that is commonly used in home water filtering system. The experiment was carried out by using two Granular Activated Carbons (GAC-A and GAC-B) to investigate how it performs with filters. The prototype of the ultraviolet radiation system, which uses no harmful chemicals to clean water, was created using air conditioners. These two activated carbons are also subjected to surface area and porosity analyses, and Scanning Electron Microscopy (SEM) is utilised to produce enlarged images of GAC-A and GAC-B in order to compare their surface morphologies.

# 3.0 Materials and Methods

The materials that are used in this study are as follows:

## 3.1 Activated Carbon

As already mentioned, activated carbons with small and low-volume pores are used in this project. These increase the surface area that is required for adsorption and for chemical reactions.

### *3.1.1 Use of Activated Carbon in Water Treatment*

Activated carbon is found to be an effective solid adsorbent. It is a highly porous material and provides large surface area to which contaminants may absorb. They are used to remove organic volatile compounds and are also used as bacteria inhibitor in drinking water filters. Granular Activated Carbon (GAC) and Powdered Activated Carbon (PAC) are the two primarily used type of activated carbon in water treatment applications.

### *3.1.2 Adsorption*

Adsorption of activated carbon takes place as its porosity offers enormous large surface. It occurs in pores that are to some extent larger than the molecules being adsorbed, which makes it an important parameter to match the molecule that are brought to adsorb with activated carbon's pore size. Vander Waals forces and other bonds accumulates into a solid surface which traps within the carbon's internal pore structure.

### *3.1.3 Types of Activated Carbon*

According to shape, they can be categorized as

**Granular Activated Carbon**

Irregularly shaped particles ranging from 0.2mm to 5mm; the type of which is used both in liquid and gas phase (Figure 1).

**Powdered Activated Carbon**

Minced carbon, referred as powdered activated carbon possessing a size less than 0.18mm[11] are used as they are commonly used in for flue gas treatment (Figure 2).

**Figure 1.** Granular activated carbon.

**Figure 2.** Powdered activated carbon.

**Extruded Activated Carbon**

Diameters ranging from 0.8mm to 5mm are used in extruded and cylindrical shaped activated carbons. The main purpose to use them is due to their low pressure drop, low dust content and high mechanical strength that makes its suitability in gas phase applications (Figure 3).

**Figure 2.** Extruded activated carbon.

Various activated carbons that are available in the markets are listed below:

1. Coconut shell
2.Orange peel
3. Tamarind seeds
4. Egg shell
5. Petroleum Coke etc.

## 3.2 Various Water used to Treat with Activated Carbon

### *3.2.1 Tap Water (Figure 4)*

**Figure 4.** Tap water.

### *3.2.2 Sullage Water (Figure 5)*

**Figure 5.** Sullage water.

The materials used for the preparation of activated carbon include:

1. Tamarind stem (Figure 6)
2. Thorn stem (Figure 7)

**Figure 6.** Tamarind tree.

**Figure 7.** Thorn tree.

# 4.0 Experimental Program

## 4.1 Analysis of Water Samples

### *4.1.1 Physical Characteristics of Water*

Various water physical characteristics like odour, temperature, taste and colour etc. are determined. They are done by senses of smell, touch, taste and sight respectively.

### *4.1.2 Chemical Characteristics of Water*

Total solids, Total suspended solids, Total dissolved solids, Chloride contents, Nitrogen contents, Total hardness, Dissolved gases, Dissolved Oxygen (DO), pH.

## 5.0 Result and Discussion

### 5.1 Tap Water

**Table 1.** Tamarind stem (Tap water)

| Characteristics | BIS Specifications | Tamarind stem | |
|---|---|---|---|
| | | Before Treatment | After Treatment |
| **Physical Characteristics** | | | |
| Colour | 5 | 5 | 4 |
| Odour | Not Objectionable | Agreeable | Agreeable |
| Turbidity (in NTU) | 10 | 10 | 5.2 |
| **Chemical Characteristics** | | | |
| pH | 6.5-8.5 | 8.2 | 7.92 |
| Total dissolved solids, TDS (in mg/L) | 300-1500 | 450 | 374 |
| Calcium, Ca (in mg/L) | 75 | 65 | 59 |
| Chlorine, Cl (in mg/L) | 250 | 267 | 255 |
| Magnesium, Mg (in mg/L) | 30 | 25 | 20 |
| Sulphate,S (in mg/L) | 150 | 212 | 200 |
| Hardness (in mg/L) | 300 | 350 | 302 |
| Iron, Fe (in mg/L) | 0.3 | 0.7 | 0.5 |
| Nitrate, $NO_3$ (in mg/L) | 45 | 43 | 40 |
| Phenolic Compounds (in mg/L) | 0.001 | 0.001 | 0.001 |
| Copper, Arsenic, (Cu, As) (in mg/L) | 0.05 | 0.04 | 0.01 |
| Lead, Pb (in mg/L) | 0.1 | 0.1 | 0.1 |
| Cyanides, CN (in mg/L) | 0.05 | 0.03 | 0.01 |
| Cadmium, Scandium(Cd, Sc) (in mg/L) | 0.01 | 0.001 | 0.001 |
| Anionic detergents (in mg/L) | 0.2 | 0.2 | 0.2 |
| Residual Chlorine (in mg/L) | 0.2 | 0.2 | 0.2 |

## 5.2 Tap Water

**Table 2.** Thorn stem (Tap water)

| Characteristics | BIS Specifications | Thorn stem | |
|---|---|---|---|
| | | Before Treatment | After Treatment |
| **Physical Characteristics** | | | |
| Colour | 5 | 5 | 5 |
| Odour | Not Objectionable | Agreeable | Agreeable |
| Turbidity (NTU) | 10 | 10 | 8.5 |
| **Chemical Characteristics** | | | |
| pH | 6.5-8.5 | 8.2 | 7.88 |
| Total dissolved solids, TDS (in mg/L) | 300-1500 | 450 | 367 |
| Calcium, Ca (in mg/L) | 75 | 65 | 60 |
| Chlorine, Cl (in mg/L) | 250 | 267 | 260 |
| Magnesium, Mg (in mg/L) | 30 | 25 | 21 |
| Sulphate, S (in mg/L) | 150 | 212 | 210 |
| Hardness (in mg/L) | 300 | 350 | 300 |
| Iron, Fe (in mg/L) | 0.3 | 0.7 | 0.6 |
| Nitrate, $NO_3$ (in mg/L) | 45 | 43 | 42 |
| Phenolic compounds (in mg/L) | 0.001 | 0.001 | 0.001 |
| Copper, Arsenic, Cu, As (in mg/L) | 0.05 | 0.04 | 0.03 |
| Lead, Pb (in mg/L) | 0.1 | 0.1 | 0.1 |
| Cyanides, CN (in mg/L) | 0.05 | 0.03 | 0.03 |
| Cadmium, scandium, Cd, Sc (in mg/L) | 0.01 | 0.001 | 0.001 |
| Anionic detergents (in mg/L) | 0.2 | 0.2 | 0.15 |
| Residual Chlorine (in mg/L) | 0.2 | 0.2 | 0.2 |

## 5.3 Sullage Water

**Table 3.** Tamarind stem (Sullage water)

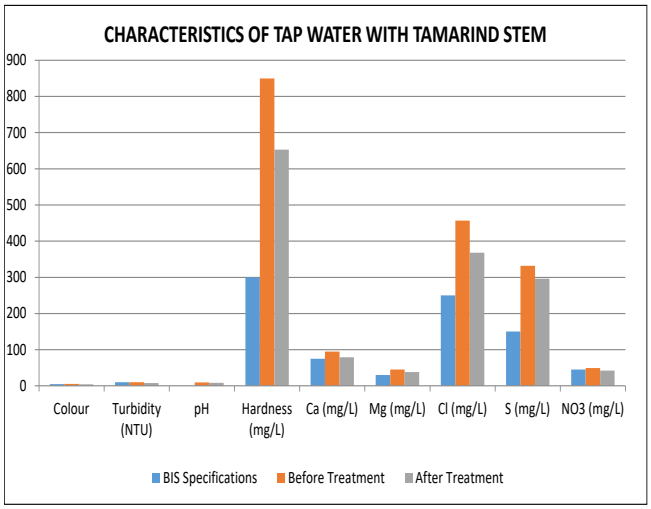
| Characteristics | BIS Specifications | Tamarind stem | |
|---|---|---|---|
| | | Before Treatment | After Treatment |
| Physical Characteristics | | | |
| Colour | 5 | 5.5 | 4.5 |
| Odour | Not Objectionable | Agreeable | Agreeable |
| Turbidity (NTU) | 10 | 10 | 7.8 |
| **Chemical Characteristics** | | | |
| pH | 6.5-8.5 | 9.7 | 8.53 |
| Total dissolved solids, TDS (in mg/L) | 300-1500 | 650 | 555 |
| Calcium, Ca (in mg/L) | 75 | 95 | 79 |
| Chlorine, Cl (in mg/L) | 250 | 457 | 368 |
| Magnesium, Mg (in mg/L) | 30 | 45 | 38 |
| Sulphate, S (in mg/L) | 150 | 332 | 296 |
| Hardness (in mg/L) | 300 | 850 | 653 |
| Iron, Fe (in mg/L) | 0.3 | 0.8 | 0.7 |
| Nitrate, $NO_3$ (in mg/L) | 45 | 49 | 42 |
| Phenolic compounds (in mg/L) | 0.001 | 0.001 | 0.001 |
| Copper, Arsenic, Cu, As (in mg/L) | 0.05 | 0.07 | 0.01 |
| Lead, Pb (in mg/L) | 0.1 | 0.1 | 0.1 |
| Cyanides, CN (in mg/L) | 0.05 | 0.03 | 0.02 |
| Cadmium, scandium, Cd, Sc (in mg/L) | 0.01 | 0.001 | 0.001 |
| Anionic detergents (in mg/L) | 0.2 | 0.2 | 0.2 |
| Residual Chlorine (in mg/L) | 0.2 | 0.7 | 0.5 |

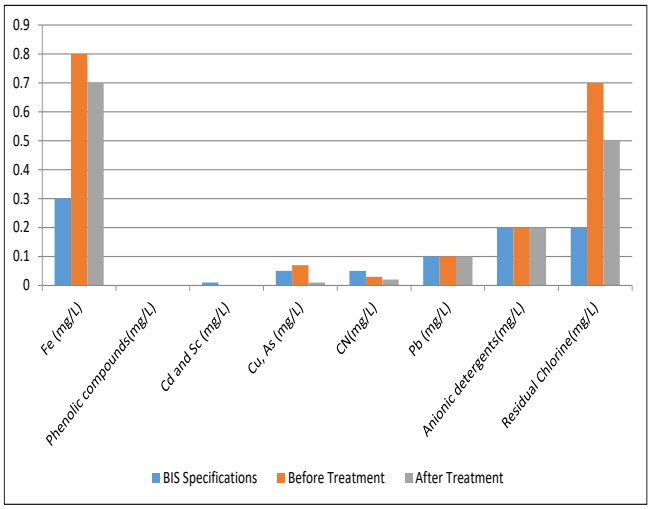
## 5.4 Sullage Water

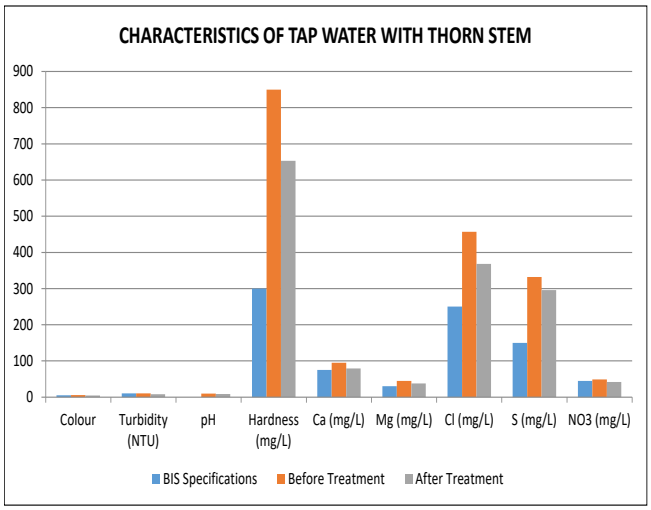
**Table 4.** Thorn stem (Sullage water)

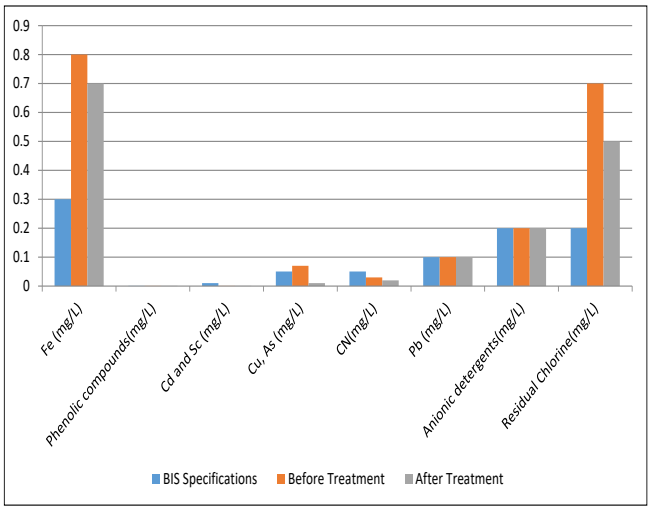
| Characteristics | BIS Specifications | Thorn stem | |
|---|---|---|---|
| | | Before Treatment | After Treatment |
| Physical Characteristics | | | |
| Colour | 5 | 5.5 | 4.3 |
| Odour | Not Objectionable | Agreeable | Agreeable |
| Turbidity (NTU) | 10 | 10 | 8.4 |
| **Chemical Characteristics** | | | |
| pH | 6.5-8.5 | 9.7 | 8.34 |
| Total dissolved solids, TDS (in mg/L) | 300-1500 | 650 | 457 |
| Calcium, Ca (in mg/L) | 75 | 95 | 82 |
| Chlorine, Cl (in mg/L) | 250 | 457 | 333 |
| Magnesium, Mg (in mg/L) | 30 | 45 | 34 |
| Sulphate, S (in mg/L) | 150 | 332 | 301 |
| Hardness (in mg/L) | 300 | 850 | 703 |
| Iron, Fe (in mg/L) | 0.3 | 0.8 | 0.65 |
| Nitrate, $NO_3$ (in mg/L) | 45 | 49 | 39 |
| Phenolic compounds (in mg/L) | 0.001 | 0.001 | 0.001 |
| Copper, Arsenic, Cu, As (in mg/L) | 0.05 | 0.07 | 0.05 |
| Lead, Pb (in mg/L) | 0.1 | 0.1 | 0.1 |
| Cyanides, CN (in mg/L) | 0.05 | 0.03 | 0.03 |
| Cadmium, scandium, Cd, Sc (in mg/L) | 0.01 | 0.001 | 0.001 |
| Anionic detergents (in mg/L) | 0.2 | 0.2 | 0.13 |
| Residual Chlorine (in mg/L) | 0.2 | 0.7 | 0.6 |

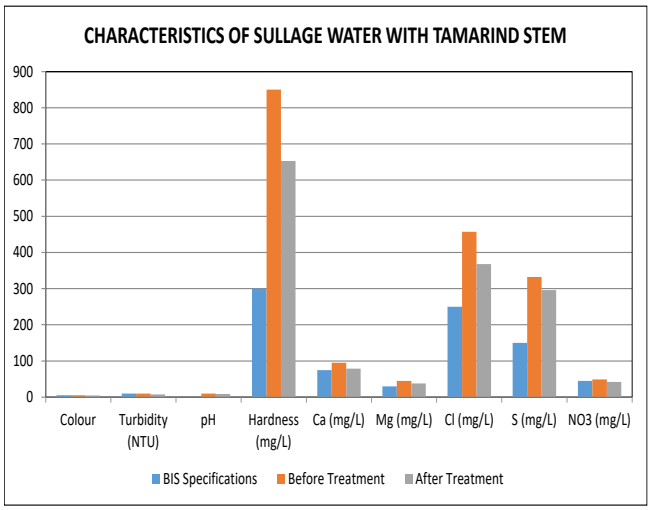
## 5.5 Graphs

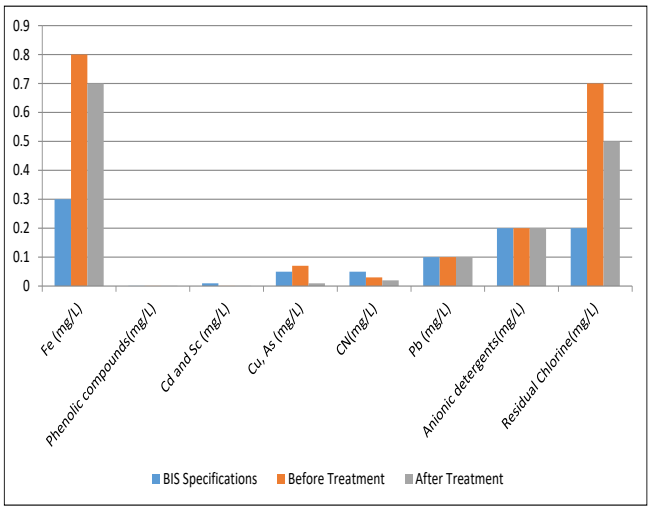

CHARACTERISTICS OF TAP WATER WITH TAMARIND STEM
900
800
700
600
500
400
300
200
100
0
Colour
Turbidity (NTU)
pH
Hardness (mg/L)
Ca (mg/L)
Mg (mg/L)
Cl (mg/L)
S (mg/L)
NO3 (mg/L)
BIS Specifications
Before Treatment
After Treatment

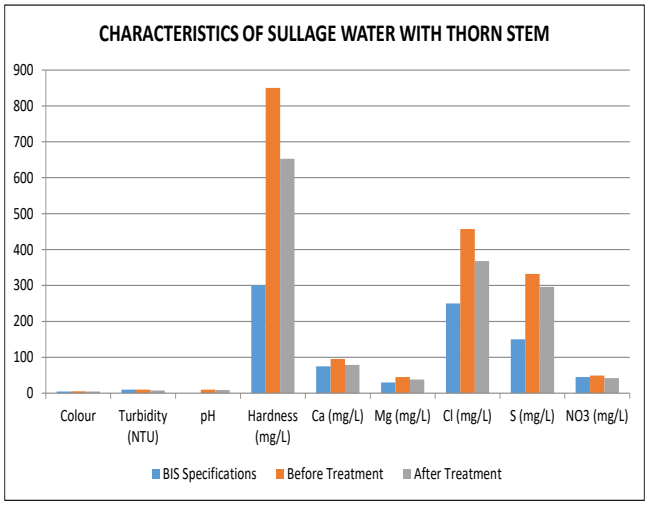

0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fe (mg/L)
Phenolic compounds(mg/L)
Cd and Sc (mg/L)
Cu, As (mg/L)
CN(mg/L)
Pb (mg/L)
Anionic detergents(mg/L)
Residual Chlorine(mg/L)
BIS Specifications
Before Treatment
After Treatment

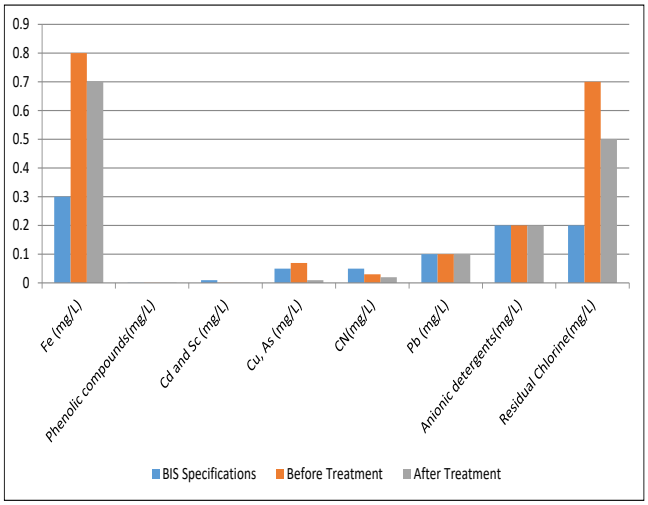

CHARACTERISTICS OF TAP WATER WITH THORN STEM
900
800
700
600
500
400
300
200
100
0
Colour
Turbidity (NTU)
pH
Hardness (mg/L)
Ca (mg/L)
Mg (mg/L)
Cl (mg/L)
S (mg/L)
NO3 (mg/L)
BIS Specifications
Before Treatment
After Treatment


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fe (mg/L)
Phenolic compounds(mg/L)
Cd and Sc (mg/L)
Cu, As (mg/L)
CN(mg/L)
Pb (mg/L)
Anionic detergents(mg/L)
Residual Chlorine(mg/L)
BIS Specifications
Before Treatment
After Treatment


CHARACTERISTICS OF SULLAGE WATER WITH TAMARIND STEM
900
800
700
600
500
400
300
200
100
0
Colour
Turbidity (NTU)
pH
Hardness (mg/L)
Ca (mg/L)
Mg (mg/L)
Cl (mg/L)
S (mg/L)
NO3 (mg/L)
BIS Specifications
Before Treatment
After Treatment


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fe (mg/L)
Phenolic compounds(mg/L)
Cd and Sc (mg/L)
Cu, As (mg/L)
CN(mg/L)
Pb (mg/L)
Anionic detergents(mg/L)
Residual Chlorine(mg/L)
BIS Specifications
Before Treatment
After Treatment




### *5.5.1 Tap Water*

While treating the tap water, the activated carbon from the two stems gives satisfactory results as the physical characteristics of the stems are within permissible limits and the chemical characteristics such as pH, chloride and nitrate gives effective results. Now, the treated tap water can be used for various purposes like drinking, cooking, bathing etc.

### *5.5.2 Sullage Water*

In case of sullage water treatment, the physical characteristics are got within permissible limits but in chemical characteristics, except magnesium other parameters are removed from water. The removal of heavy metals like scandium, arsenic is nearly good when compared with that of tap water standards. Hence, it concluded that this treated water is not useful for drinking purpose but used for flushing and cleaning purposes.

## 6.0 Conclusion

The quality of treated tap water is found to be within the permissible limit as per BIS standard when treated with the activated carbons made from thorns and tamarind. Hence the treated tap water can be effectively used for various purposes like drinking, cooking, bathing etc.

The quality of treated sullage water is found to contain some amount of magnesium and cannot be recommended for drinking purposes. However, they can be used for domestic purposes like bathing, flushing and cleaning purposes.

Improvement in quality of sullage water can be achieved by advanced treatment or other activated carbons.

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