

BIOLOGICAL TREATMENT OF WASTE WATER USING AQUATIC PLANTS AND ORGANISMS

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Abstract

The increased awareness and valuing of wetlands over the past 50 years has in a large part been due to people experiencing and connecting with these areas. The dynamics of east Kolkata wetlands has drawn our attention towards the purification process that treats many million liters of water in east Kolkata. The process is naturally occurring and has no man-made arrangements. You would be stunned to know that no chemicals are involved in this treatment process and only aquatic plants and organisms (fishes) treat the contaminated water. The east Kolkata wetlands is situated at 88° 20' E -88° 35' E and 20° 25' N - 20° 35' N. Climate here is around sub-tropical and an annual rainfall of 200 cm. The maximum temperature here rises up to 39°C. In today's world the scarcity of water has shown a major problem to the whole world. Fresh water is available in very less quantity and quality. Even though water is polluted at a very large scale and no one understands the consequences of what will happen to our coming generation. As per the rules every industry emitting waste water has to install a waste water treatment plant in its industrial premises and reuse that water wherever they can, but the sad part is that no one follows these rules.

Key words -*Biological Treatment, Waste water, aquatic plants, aquatic organism.*

1. INTRODUCTION

Water is essential for life. Water is made up of hydrogen ions (H⁺) linked to hydroxyl ions (OH⁻) to form H₂O. The molecular formula for water is H₂O. Your body uses water in all its cells, organs, and tissues to help regulate its temperature and maintain other bodily functions. Because your body loses water through breathing, sweating, and digestion, it's important to rehydrate by drinking fluids and eating foods that contain water. The distribution of water on Earth's surface is extremely uneven. Only 3% of water on the surface is fresh, the remaining 97% resides in ocean. Of fresh water, 69% resides in glacier, 30% underground, and less than 1% is located in lakes, rivers, and swamps. As per standards laid down by the CPHEEO (Central Public Health Environment & Engineering Organization), the fresh water consumption per day per person should be between 135 to 150 liters per day. In spite of such a worrying percentage large amount of waste water is produced which is very harmful for coming generation. There would have been no worries if an adequate treatment process was available. Waste water treatment is big issue nowadays, due to high cost of equipment and chemicals. As well as sometime it can't be reduced the pollutant like heavy metal or contain nitrogen up to the required limit. Due to untreated water it affects the social (health) and nature (soil, flora and fauna) life. Especially when soil is polluted it affects the all system. It is due to spreading of untreated runoff and leachates. In land spreading on free draining soils, the main nutrient removal process is filtration, soil adsorption, microbial decomposition and plant uptake. [1]

Watercourses receive pollution from many different sources, which vary both in strength and volume. The composition of wastewater is a reflection of the life styles and technologies practiced in the producing society (Gray, 1989). It is a complex mixture of natural organic and inorganic materials as well as man-made compounds. Three quarters of organic carbon in sewage are present as carbohydrates, fats,

proteins, amino acids, and volatile acids. The inorganic constituents include large concentrations of sodium, calcium, potassium, magnesium, chlorine, sulphur, phosphate, bicarbonate, ammonium salts and heavy metals (Tebbutt, 1983; Horan, 1990; Lim et al., 2010). Different sources of pollutants include "Discharge of either raw or treated sewage from towns and villages; discharge from manufacturing or industrial plants; run-off from agricultural land; and leachates from solid waste disposal sites" these sites of pollution have problems so that a solution is sought (Horan, 1990). Scarcity of water, the need for energy and food are forcing us to explore the feasibility of wastewater recycling and resource recovery (De la Nou'e and De Pauw, 1988). [2]

1.1. Need of wastewater treatment:

We consider wastewater treatment as a water use because it is so interconnected with the other uses of water. Much of the water used by homes, industries, and businesses must be treated before it is released back to the environment. If the term "wastewater treatment" is confusing to you, you might think of it as "sewage treatment." Nature has an amazing ability to cope with small amounts of water wastes and pollution, but it would be overwhelmed if we didn't treat the billions of gallons of wastewater and sewage produced every day before releasing it back to the environment. Treatment plants reduce pollutants in wastewater to a level nature can handle.

Wastewater is used water. It includes substances such as human waste, food scraps, oils, soaps and chemicals. In homes, this includes water from sinks, showers, bathtubs, toilets, washing machines and dishwashers. Businesses and industries also contribute their share of used water that must be cleaned. Wastewater also includes storm runoff. Although some people assume that the rain that runs down the street during a storm is fairly clean, it isn't. Harmful substances that wash off roads, parking lots, and rooftops can harm our rivers and lakes:

- It's a matter of caring for our environment and for our own health. There are a lot of good reasons why keeping our water clean is an important priority
- Clean water is critical to plants and animals that live in water. This is important to the fishing industry, sport fishing enthusiasts, and future generations.
- Our rivers and ocean waters team with life that depends on shoreline, beaches and marshes. They are critical habitats for hundreds of species of fish and other aquatic life. Migratory water birds use the areas for resting and feeding.
- Water is a great playground for us all. The scenic and recreational values of our waters are reasons many people choose to live where they do. Visitors are drawn to water activities such as swimming, fishing, boating and picnicking.
- If it is not properly cleaned, water can carry disease. Since we live, work and play so close to water, harmful bacteria have to be removed to make water safe.

1.2. Effects of wastewater pollutants:

If wastewater is not properly treated, then the environment and human health can be negatively impacted. These impacts can include harm to fish and wildlife populations, oxygen depletion, beach closures and other restrictions on recreational water use, restrictions on fish and shellfish harvesting and contamination of drinking water. Environment Canada provides some examples of pollutants that can be found in wastewater and the potentially harmful effects these substances can have on ecosystems and human health:

- Decaying organic matter and debris can use up the dissolved oxygen in a lake so fish and another aquatic biota cannot survive.
- Excessive nutrients, such as phosphorus and nitrogen (including ammonia), can cause eutrophication, or over-fertilization of receiving waters, which can be toxic to aquatic organisms, promote excessive plant growth, reduce available oxygen, harm spawning grounds, alter habitat and lead to a decline in certain species.
- Bacteria, viruses and disease-causing pathogens can pollute beaches and contaminate shellfish populations, leading to restrictions on human recreation, drinking water consumption and shellfish consumption.

1.3. What makes water a wastewater:

- Wastewater can contain physical, chemical and biological pollutants. Households may produce

wastewater from flush toilets, sinks, dishwashers, washing machines, bath tubs, and showers. Wastewater that is discharged to the environment without suitable treatment causes water pollution.

- All the impurities added in a usable water makes it wastewater.
- Depending on the type of waste added to water, wastewater is classified in number of categories, like if metals and hazardous things are found in water. It is called industrial wastewater and if household wastes like fruit peels, human excreta etc, are found then it is called domestic wastewater.
- You would be stunned to know that each and every factory or industry are meant to install a wastewater treatment plant in their premises to treat sewage produced by them and reuse it.
- But the problem recites in carelessness because no one follows the rules. If every industry installs a treatment plant and don't dispose waste in water bodies then the problem of water doesn't seems so big.

1.4. Types of wastewater:

Wastewater comes in three main types namely Black water, Grey water and yellow water.

□ **Black water:**

This is wastewater that originates from toilet fixtures, dishwashers and food preparation sinks. It is made up of all the things that you can imagine going down the toilets, bath and sink drains. They include poop, urine, toilet papers and wipes; body cleaning liquids, anal cleansing water and so on. They are known to be highly contaminated with dissolved chemicals, particulate matter and is very pathogenic.

□ **Greywater:**

This is wastewater that originates from non-toilet and food fixtures such as bathroom sinks, laundry machines, spas, bathtubs and so on. Technically it is sewage that does not contain poop or urine. Graywater is treated very differently from blackwater and is usually suitable for reuse.

□ **Yellow water:**

This is basically urine collected with specific channels and not contaminated with either black water or grey water.

1.5. Sources of wastewater:

□ **Domestic sewage:**

This includes all wastewater generated by home dwellings, public restrooms, hotels, restaurants, motels, resorts, schools, places of worship, sport stadiums, hospitals and other health centres, apartments and the like. They all produce high volume of wastewater.

□ **Non-sewage:**

These include water from floods (storm water), runoff (rainwater running through cracks in ground and into gutters), water from swimming pools, water from car garages and cleaning centres. They also include laundromats, beauty salons, commercial kitchens, energy generation plants and so on.

Wastewater is also generated from agricultural facilities. Water used for cleaning in animal farms, washing harvested produce and cleaning farm equipment.

1.6 Aquatic plants and organisms:

The term aquatic plant is used much like the term aquatic macrophyte plants visible to the unaided eye. Therefore, this will include flowering plants, conifers, mosses, ferns and fern allies, charophytes, macroalgae of all descriptions, and any other plant found in standing or moving water. We will discuss plants that are completely submersed, rooted in the sediment with leaves floating on the surface, plants rooted in standing water with leaves emerging from the water, and plants that are free-floating in the water with leaves either submersed, or partly or fully emergent.

Aquatic plants grow partially or completely in water. As with other plants, they require light and carbon dioxide (or other inorganic carbon source) for photosynthesis, oxygen for respiration, water, and nutrients such as nitrogen, phosphorus and others. Plants that grow with emergent or floating leaves form some of the most productive communities in the world, because they are rarely limited by water availability. With leaves exposed to the air, they have a ready source of light, carbon dioxide and oxygen. The depth limitation of aquatic plants is controlled by light penetration through the water column. While plants may grow only 3m deep in productive, eutrophic waters, in oligotrophic waters they may grow to depths of 10 m or more.

➤ **Uses and benefits of aquatic plants:**

□ **Ecosystem benefits:**

Aquatic plants provide many ecological benefits and are essential in promoting the diversity and function of aquatic systems (Carpenter and Lodge, 1986). Aquatic habitats, both freshwater and marine, are some of the most productive areas worldwide.

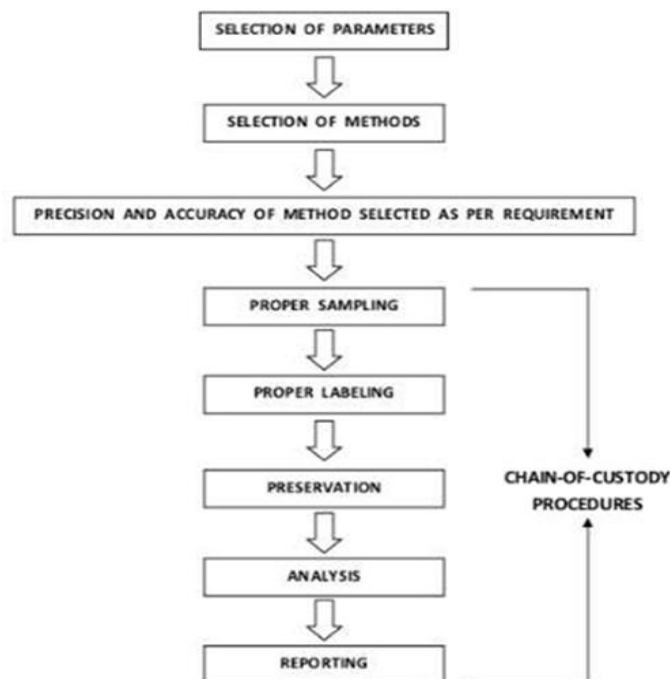
□ **Uses of aquatic plants:**

Aquatic plants, both marine and freshwater, are used extensively worldwide as livestock fodder, fertilizer, compost, mulch and bioremediation. These uses have received considerable attention prior to this report and therefore little additional information will be presented here. In a review by Little (1979) on the utilization of aquatic plants, it was reported that many aquatic plants contain as much or more crude protein, crude fat and mineral matter as many conventional forage crops on a dry weight basis. Although, fibre values were usually lower in aquatic plants than for forages. Aquatic plants tended to have increased tannin content, which may decrease the digestibility of protein. It was concluded that using aquatic plants as fodder would help pay for harvesting, which is the best way to remove nutrients from lakes suffering from artificial enrichment. Harvesting should be done when protein content of the plants is highest for their maximum usefulness as fodder. Further, Hasan and Chakrabarti (2009) offer a global review of the uses of aquatic plants as feed in aquaculture production. The authors concluded that under current conditions algae may not be a viable choice as a feed for aquaculture production, though a cost-benefit analysis would be needed before drawing any definite conclusions for its use as fish feed. Pursuant to this, the authors suggested that the use of algae as an additive to fish feed may be limited to the commercial production of high-value fish.

2. Methodology:

3. **2.1.** This chapter basically comprises of the methods and processes involved in completion of this project.

Following are the processes involved in the successful completion of this project:



2.2. Selection of parameters:

The parameters of water quality are selected entirely according to the need for a specific use of water. Some of the common parameters followed for checking the water sample are as follows:

- Temperature*
- Turbidity*
- pH*
- Hardness*
- Alkalinity*
- Bio-chemical oxygen demand*
- Chemical oxygen demand*
- Dissolved oxygen*
- Chlorides*

These parameters have been analyzed with the help of equipment available in our college environmental lab.

- pH*
- Alkalinity*
- B.O.D.*
- C.O.D.*
- Dissolved oxygen*
- Total dissolved solids*
- Total suspended solids*
- Chloride content*

2.3. Selection of method:

The method of water quality analysis is selected according to the requirement. The factors playing key role for the selection of methods are:

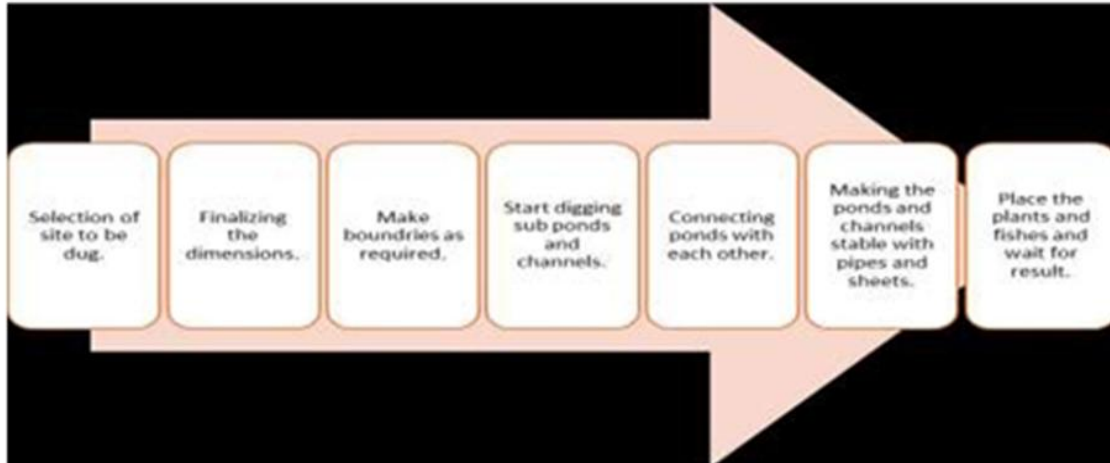
- Volume and number of samples to be analyzed.* *Cost of analysis.*
- Precision required.*
- Promptness of the analysis as required.*
- Availability of proper lab equipment.*
- Proper experimental procedure known.*

2.4. Selection of site for prototype:

It is a very important step in completion of this project. A ground that can be easily dugged and easily workable. It should also not absorb much water and can sustain adequate load.

Luckily our college garden ground was somewhat matching the requirements posed by our project.

After the site selection we were to decide the layout of the treatment plant that we were going to build.



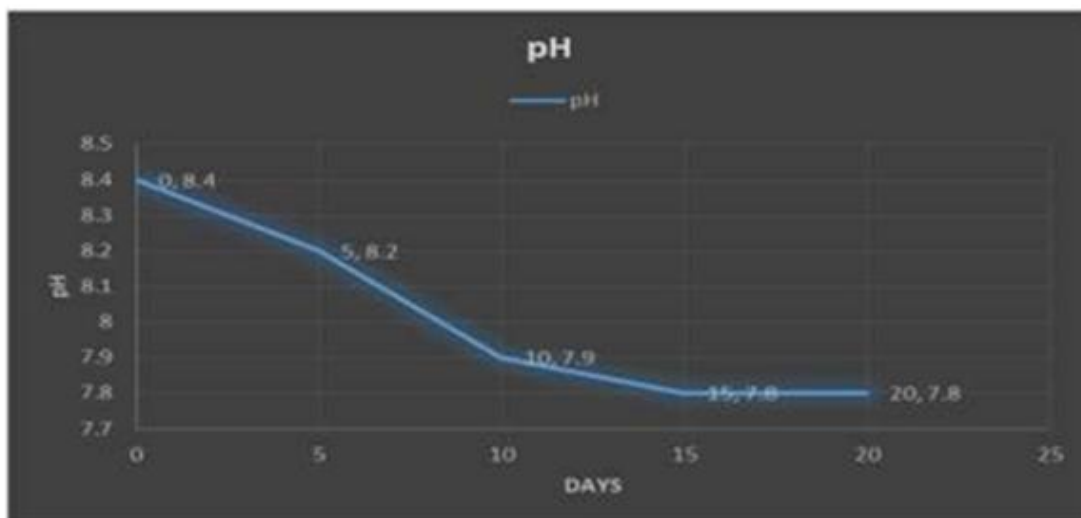
This is the prototype that we have constructed for explaining the treatment process of our project. As you can see there are number of ponds with unique specifications. The ponds on the right side have a dimension of 3.5' * 4.0' the pond in the middle has a dimension of 3.5' * 2.5' and the ponds on the left has a dimension of 4.5' * 5.0' each. There is a channel on the at most right which will be used to inflow water in all channels. Each pond is connected thorough P.V.C. pipes which are installed at different elevation. All the ponds will be covered with high strength polythene to avoid seepage of water in soil. After this the waste water will be induced in the channel which will be treated further. A variety of fishes and plants will be there to indicate the presence of impurity and to treat water simultaneously.

3. Result and Discussion

3.1 pH:

Table.1 pH variations with time

Days	pH
0	8.4
5	8.2
10	7.9
15	7.8
20	7.8



Graph 1: pH Variations

3.2 Alkalinity:

Table.2. Alkalinity variations with time

Days	Alkalinity	Permissible limit
0	258	200
5	250	200
10	248	200
15	244	200
20	239	200

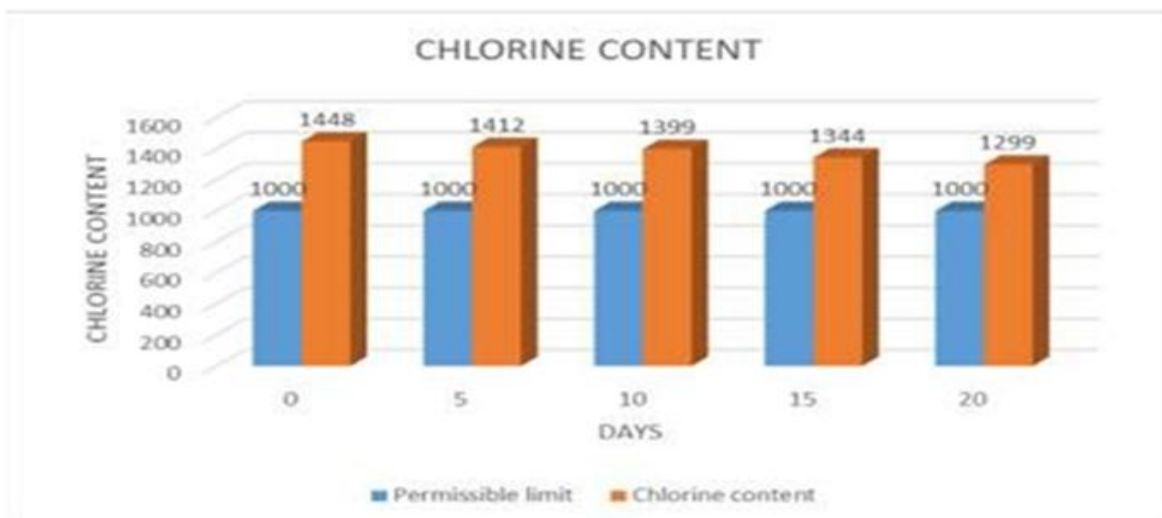


Graph 2: Alkalinity Variations

3.3 Chloride content:

Table.3 Chloride content variations with time

Days	Chloride content	Permissible limit
0	1448	1000
5	1412	1000
10	1399	1000
15	1344	1000
20	1299	1000



Graph 3: Chloride Variations

3.4 Hardness:

Table.4 pH variations with time

Days	Hardness	Permissible limit
0	712	600
5	705	600
10	689	600
15	682	600
20	671	600

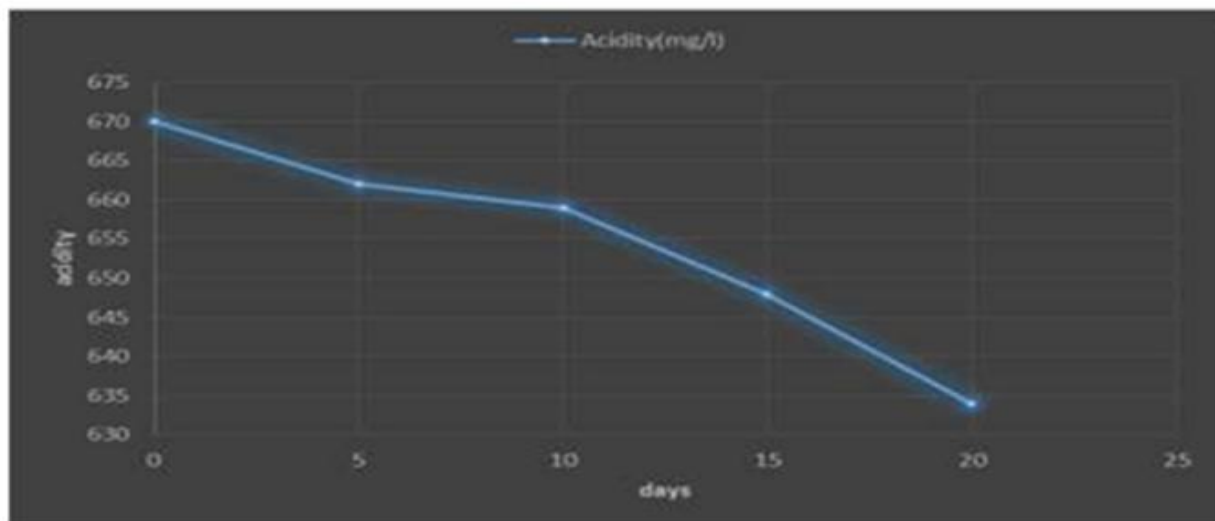


Graph 4: Hardness Variations

3.5 Acidity:

Table.5 Acidity variations with time

Days	Acidity
0	670
5	662
10	659
15	648
20	634

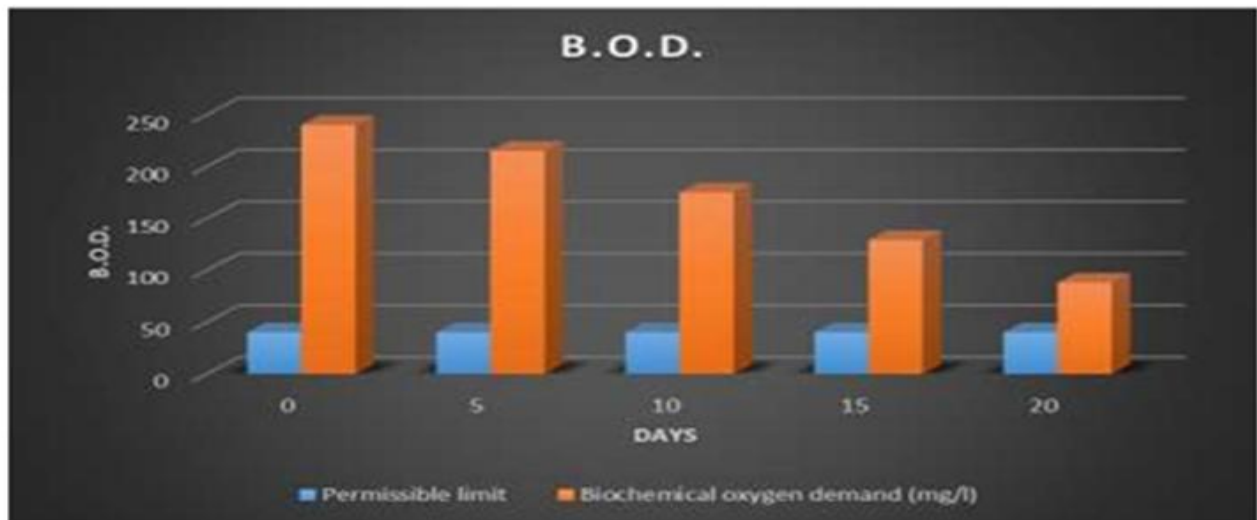


Graph 5: Acidity Variations

3.6 Bio-chemical demand (B.O.D.)

Table.6 BOD variations with time

Days	Permissible limit	B.O.D.
0	40	240
5	40	215
10	40	175
15	40	129
20	40	88



Graph 5: BOD Variations

4. CONCLUSIONS:

Conclusions are derived on the basis of following table.7.

Table 7: Summary of variations of waste water treatment with respect to time.

Parameters	0 day	5 th day	10 th day	15 th day	20 th day	Permissible value	Remark
1. pH	8.4	8.2	7.9	7.8	7.8	6.5-7.5	Moving towards acceptable value
2. Turbidity	-	-	-	-	-	-	-
3. Alkalinity	258	250	248	244	239	200	Towards purity
4. Chloride content	1448	1412	1399	1344	1299	1000	Towards acceptable value
5. Hardness	712	705	689	682	671	600	Good Removal of impurities
6. Acidity	670	662	659	648	634	-	moving towards neutrality
7. B.O.D.	240	215	175	129	88	40	Towards permissible value
8. C.O.D.	-	-	-	-	-	-	-

1. pH:

The permissible value of pH for drinking water in 6.5 - 8.5 and the waste water that we have treated through the biological treatment has given a value of 7.8 the is in the range of permissible value. So, the treatment plant is good for domestic sewage and can be used on large scale treatment process.

2. Turbidity:

The value of turbidity of waste water observed is 6 NTU and the permissible value should not be more than 5 NTU. After 20 days the value observed is 3.5 NTU. So, it is in the permissible range. For drinking water, the value of turbidity should be around 1 NTU.

3. Alkalinity:

The permissible limit of alkalinity is 200 mg/l and with the help of biological treatment we have observed a value of 239 mg/l of alkalinity after 20 days. This means that the treatment process is doing well in removing the impurities. With some more fixed standards and more precision we can attain a value below 200 mg/l. Also, this process can be applied to treat large scale domestic sewage efficiently.

4. Chloride content:

The permissible limit of chloride content in usable water is 1000 mg/l and with the help of the treatment process we have reached a value of 1299 mg/l after 20 days which is moving towards acceptable value. So, we can say that if with some more precision and equipment and some more research a value less than 1000 mg/l can be easily attained.

5. Hardness:

According to the norms the permissible limit of harness in a usable water is 600 mg/l, a value greater than this not acceptable for usable water. With the procedure that we were following for the treatment of domestic sewage we have lowered the value up to 671 mg/l. With a little more precision and good handling a value in the range of permissible limit can be easily attained.

6. Acidity:

After 20 days we have recorded the value of acidity to be 634. This value is moving towards neutrality. So, it can be concluded that the acidic behavior that is the sourness of water is being removed effectively.

7. Bio-chemical oxygen demand:

This is the most important parameter and should be performed very carefully. B.O.D. shows the amount of oxygen needed to decompose organic matter. Generally, the value of B.O.D. is taken at 20⁰C for 5 days. The permissible limit of B.O.D. is around 40 mg/l and with the help of treatment process we were able to get a value of 88 mg/l. This value is slightly high but if the process is performed more accurately and with precision surely, we can get a value in the range of permissible value.

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