TREATMENT AND REUSE OF WASTE WATER IN COEA CAMPUS

A.V. Deshmukh[1] and P.A. Hangargekar[2]
P.G. Student and Associate Professor,
S.T.B.C.E, Tuljapur (M.S.), India

Abstract— Water is one of the world's most valuable resources, yet it is under constant threat due to climate change and resulting drought, explosive population growth, and waste. One of the most promising efforts to stem the global water crisis is industrial and municipal water reclamation and reuse. The Water Reuse Association defines reused, recycled, or reclaimed water as "water that is used more than one time before it passes back into the natural water cycle." Thus, water recycling is the reuse of treated wastewater for beneficial purposes such as agricultural and landscape irrigation, toilet flushing, or replenishing a groundwater basin (referred to as groundwater recharge). Thus, treatment and reuse was taken as the research for given COE Ambajogai Campus using various technique. Ambajogai is situated in Marathwada region, having less rainfall every year so there is water scarcity. In this campus there are three hostels having capacity of 425 for boys and 400 for girls. When studied the given area, it has been founded that large amount of wastewater is generated through the bathing and washing the cloths. Around 40,000lit water is used daily for baths and washing the clothes. Total area of campus is around 22 acres and having garden and trees over large area. Campus needs large amount of water for the gardening purpose. So To reduce the load over fresh water and to reduce the demand of fresh water, treatment is required for wastewater and then it is utilized for gardening. After studying it is found that wastewater from bathroom is used for gardening, after giving the treatment by using sand filter, used with activated charcoal.

Keywords: Wastewater, reuse, Treatment, sand filter, activated charcoal.

I. INTRODUCTION

Maharashtra occupies the western and central part of the country and has a long coastline stretching nearly 720 kilometres along the Arabian Sea. The Sahyadri mountain ranges provide a physical backbone to the State on the west, while the Satpuda hills along the north and Bhamragad-Chiroli-Gaikhuri ranges on the east serve as its natural borders. The State is surrounded by Gujarat to the North West, Madhya Pradesh to the northland Chhattisgarh to the east, Andhra Pradesh to the south Eastland Karnataka to the south and Goa to the south west. The state has a geographical area of 3, 07,713 sq. km and is bounded by North latitude 15°40' and 22°00' and East 73'and 80°30'.
Mahatma Basaveshwar Education Society College of Engineering, Ambajogai campus is one of the leading colleges in Marathwada Region providing technical education for both undergraduate and post graduate students. Today it has around 1500 students and around 230 faculties. The total area of college campus is 22 acres. Wastewater generated in large quantity in this campus so keeping in consideration research is continued.

Grey water is all wastewater that is discharged from a house, excluding black water (toilet water). This includes water from showers, bathtubs, sinks, kitchen, dishwashers, laundry tubs, and washing machines. It commonly contains soap, shampoo, and toothpaste, food scraps, cooking oils, detergents and hair. Grey water makes up the largest proportion of the total wastewater flow from households in terms of volume. Typically, 50-80% of the household wastewater is grey water. If a composting toilet is also used, then 100% of the household wastewater is grey water.

The main purpose of grey water recycling is to substitute the precious drinking water in applications which do not require drinking water quality. Non-potable reuse applications include industrial, irrigation, toilet flushing and laundry washing dependent on the technologies utilized in the treatment process. With grey water recycling, it is possible to reduce the amounts of fresh water consumption as well as wastewater production, in addition to reducing the water bills. If grey water is regarded as an additional water source, an increased supply for irrigation water can be ensured which will in turn lead to an increase in agricultural productivity. Unlike rainwater harvesting; grey water recycling is not dependent on season or variability of rainfall and as such is a continuous and a reliable water resource.

Objective- The main objective of study was to reduce demand of potable water and generate the new source from reuse for irrigation purpose.

II. STUDY AREA:

Mahatma Basaveshwar Education Society's College of Engineering, Ambajogai is one of the leading colleges in Marathwada Region providing technical education for both undergraduate and post graduate students. Today it has around 1500 students and around 230 faculties. The total area of college campus is 22 acres. The distance of college from main city is at a distance of 2 km. college requires huge amount of potable water for different purpose because in campus two boys hostels of capacity 425 and two girls hostels of capacity 400.in campus no of trees and greenery is available so for maintaining the greenery and garden college required large quantity of water. Ambajogai is situated in Marathwada region, having less rainfall every year so there is water scarcity. Generally during the summer session water scarcity is severe. So to fulfil the demand of water we work on treatment and reuse of waste water through bathrooms of hostels.

For this purpose we select one hostel of student capacity 200. From this hostels bathroom outlet we measure the discharge and then further decision is made on the basis of collected data. Total discharge for this hostel is around 8000 liters to 9000 liters per day. This amount of water is also considerable so keeping this point in consideration research work is continued.

III. MATERIALS AND METHODOLOGY:

Data required:

1. Quantity of waste water generated through selected area.

2. Total no of student in hostel.
3. Information of System of waste water disposal and there network.
4. Characteristics of waste water.
5. Indian Standards of irrigation water

Methodology: Detailed research plan carried out during the study was as per the follows. This shows the step by step procedure carried out during the research work shown in figure 1

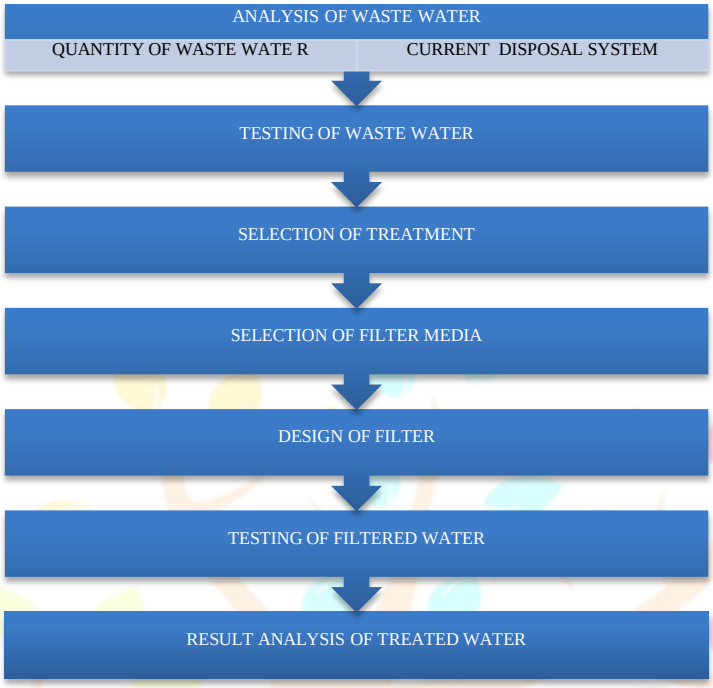

Fig. 1 flow chart of steps in research work

Analysis of waste water from bathrooms.

1) Quantity of waste water- It can be calculated by

- Direct discharge measurement.

For direct discharge measurement of waste water we use a tank which situated near to the outlets. Firstly outlet is connected by PVC pipe and this pipe is poured in to the tank. We measured the dimensions of tank for calculation of the volume. Then from 6 am to 8 pm water is collected in this tank and at the end of day taking the depth of water and calculates the quantity of water. From this way measured the quantity of waste water and we found that total waste water generated is 8000 liters to 9000 liters per day.

- By using the standard requirement of human for bath and washing the cloths.

In this method we use the standard value of water consumption for bath and washing the clothes. Generally 40 liters per head per day is used. From this consideration, Total waste water generated = 40 * 200 = 8000 liters per day.

By comparing the both quantities it is observed that collected waste water quantity is nearly same as the measured discharge.

2) Current disposal system-

For this filed survey is required. It is seen that during the survey separate pipe system is used for the collection and disposal of waste water through bathrooms. So it is Convenient to collect the waste water in one place from all the outlets of bathrooms. During the site visit it is seen that separate pipes are used for bathroom waste Collection and WC waste collection.

Testing of waste from bathrooms.

After calculation of quantity we required to find charactristics of waste water for selection of treatment. So with respect to the reuse of waste water some parameters are Important like BOD, COD, Phenols, Boron, Chloride, Nitrate, Hardness due to Ca and Mg, DO, Suspended solids, P^H, TDS, EC. These parameter are measured with help of different instruments and different methods.

Following are the instruments are used for testing the sample,

1) BOD- It is measured with the help of incubator.

With the help of BOD incubator we can measure the initial BOD and 5 days BOD of the sample. BOD test is important for waste water; this test gives the Biological Oxygen Demand of sample so from this value we can decide the treatment option.

2) COD- it is measured with help of photo spectrometer.

With help of photo spectrometer we can measure the chemical oxygen demand of the sample. Photo spectrometer is the advance instrument for measurement of different parameter related to the water. On this instrument more than hundreds of parameter can be measured and computerized results are generated.

3) P^H, TDS, EC- These are measured with the help of P^H meter, TDS meter, EC meter.

P^H is measured in two way i.e. by P^H Paper and by using the P^H meter. In this research work it is measured by digital P^H meter. P^H test is useful to know the water is acidic or alkaline. If the value of P^H is less than 7 it is acidic and value is more than 7 then it is alkaline.

Also TDC and EC is measured by using the TDS meter, EC meter. With the help of TDS meter we know the amount of total dissolved solids and by EC meter we know the amount of salt content or ability of passing the current of sample.

4) Phenols,Boron,Chloride.Nitrate,Hardness due to Ca and Mg,DO,Suspended solids.

For measurement of these parameter we use the photo spectrometer. In bathroom water there is possibility of phenols so to know the amount of this we conduct the test. Phenols are harmful to the trees. Boron is harmful to the agricultural crops and trees so by using the photo spectrometer the amount of boron is measured. Also chloride and nitrate is measured during the testing.

Dissolved oxygen is required for plant growth and for some microorganism's growth so it is also measured in testing. Suspended solids are measured if they are in large amount there is possibility of blocking the pores of surface. Hardness also measured by using the photo spectrometer. Hard water is not useful for the irrigation purpose.

Selection of treatment.

After analyzing the waste water next step is for selection of type of treatment. Generally for treatment of waste water following methods are used,

1) Trickling filter
2) Anaerobic Digestion
3) Lagoons and Wetlands
4) Rotating biological contactor (RBC)

But these methods are used for large quantity treatment and cost of project also high. The land required for these methods is large and also there is problem of odour and sludge disposal. So keeping these points in consideration we prefer the sand filter for treatment of waste water.

After analyzing the waste water we found that slow sand filter is capable to remove the impurities but it requires additional layer of activated charcoal at the top surface. So with this consideration slow sand filter along with activated charcoal is finalized for treatment.

Selection of filter media.

With respect to characteristics of waste water the filter media is finalized. In filter three layers are provided of activated charcoal, sand and aggregate respectively.

1) Activated charcoal-

Activated carbon, also called activated charcoal, is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption or chemical reactions. *Activated* is sometimes substituted with *active*. Due to its high degree of micro porosity, just one gram of activated carbon has a surface area in excess of 3,000 m^2 (32,000 sq ft), as determined by gas adsorption. An activation level sufficient for useful application may be attained solely from high surface area; however, further chemical treatment often enhances adsorption properties. Activated charcoal traps impurities in water including solvents, pesticides, industrial waste and other chemicals. This is why it's used in water filtration systems throughout the world. One of the most common activated charcoal uses is to remove toxin and chemicals in the event of ingestion. Most organic compounds, pesticides, mercury, fertilizer and bleach bind to activated charcoal's surface, allowing for quicker elimination. The of particle plays important role in filtration process so here powder form activated charcoal is preferred and size is less than 75 micron.

2) Sand –

Sand bed work by providing the particulate solids with many opportunities to be captured on the surface of a sand grain. As fluid flows through the porous sand along a tortuous route, the particulates come close to sand grains. They can be captured by one of several mechanisms, direct collision, London force attraction, Surface charge attraction, Diffusion. In addition, particulate solids can be prevented from being captured by surface charge repulsion. if the surface charge of the sand is of the same sign (positive or negative) as that of the particulate solid. Furthermore, it is possible to dislodge captured particulates although they may be re-captured at a greater depth within the bed. Finally, a sand grain that is already contaminated with particulate solids may become more attractive or repel addition particulate solids. This can occur if by adhering to the sand grain the particulate loses surface charge and becomes attractive to additional particulates or the opposite and surface charge is retained repelling further particulates from the sand grain. The sand of size 1mm to 1.36 mm is used for this filter.

3) Aggregate –

Filter gravel is used as a support media to filter sand and coal in water filters. For maximum efficiency, filter gravel must possess the necessary attributes of hardness and be rounded rather than angular. River Sands Filter Gravel is a hard, predominantly quartz aggregate. The filter gravel, like filter sand, contains hard durable particles with a slow breakdown rate. This helps to prolong filter media life. The gravel is screened into three standard sizes which effectively supports the filter media. The of aggregate is used in this filter is 10 mm to 12.5 mm.

Design of filter.

For design the filter there are two parts in it, first is tank and second is filter media. In this experimental study first a model is prepared and filter media is installed in it. Then waste water is poured in it for filtration. Basically this model contents three different units, 1) collection tank or sedimentation tank 2) filter media tank and 3) storage tank. In this manner a model is prepared in lab and material is filled in filter tank. Following are the images of model with different units.

Before the design of filter unit we check the performance of this method by using the model.

Model is prepared in lab and filter media is placed in it. Firstly at the bottom of the filter wooden blocks are placed like lateral drains in filter unit for collection of water and to provide support to the upper material. Then at the bottom aggregate is placed of 7 cm thick and size of aggregate varies from 10 mm to 12.5 mm. then sand is placed of 4 cm thick and of size varies from 1.36 mm to 1 mm. then activated charcoal is placed of 3 cm thick and having size 75 micron to 90 micron.

After placing of filter media sample is filled in first tank that is in collection tank and 4 hours detention period is given to sample then water is released in constant rate in to the filtration tank.

Tests are performed on the filtered water and results are excellent, during the performance it is observed that the results are directly proportional to the particle size of filter media. It means that finer the size of activated charcoal and sand more the amount of removal of impurities from the waste water.

When we perform the experiment two times we change the particle size and continued the project.

Design of filter tank.

After checking the performance of model actual design of filter unit is started. We know there three parts in this plant 1) Collection or sedimentation tank 2) filtration tank 3) storage tank. For design purpose we required data that is collected at initial level like,

1) Total quantity of waste water = 9000 liters per day

As per standards for slow sand filter loading rate is consider that is 0.3 $m^3/hr/m^2$ With this loading and considering the surface area 6 m^2, time required for filtration is 5 hours. So with this data other dimensions are calculated.

Three tanks in this plant for each tank dimensions are calculated.

Length of tank = 3 m and width of tank = 2 m

With respect to capacity we required minimum volume of tank is 9 m^3. So on safe side we consider the capacity of tank is 15 m^3. Then the depth of tank required is 2.5 m. this depth is for first tank means for collection tank and for filter tank is 2 m from the outlet of first tank and 0.5 m for storage tank.

Three tanks are arranged in stepped manner for higher rate of filtration and to reduce head loss at the filter tank. In first tank we increase the capacity of because in case of maintenance water can be stored during the maintenance period.

Now next important part is thickness of the filter media and it is decided as per the standard guidelines for slow sand filter. Generally total thickness of filter bed is varies from 1.8 m to 1.5 m. keeping this value in consideration and characteristics of waste water we provide the total thickness of filter bed is 1.5 m. in which thickness of each filter media is as follows,

1) Thickness of activated charcoal = 30 cm
2) Thickness of sand = 60 cm
3) Thickness of aggregate = 60 cm

So total thickness of filter bed = 1.5 m

Testing of filtered water.

When water is passed through the filter bed in model water get filtered and this water is again tested in lab for checking the characteristics of filtered water. Also to decide the modification in treatment testing is required for filtered water. All parameters are tested again like BOD, COD, DO, EC, TDS, Suspended solids, Boron, Hardness due to Ca and Mg, Phenols, P^H, Chloride, Nitrate.

All these parameter tested on same instruments and by same methods. Following are the images of performing the test in lab.

Performance of filter.

For checking the filtration capacity we conduct the permeability test over the filter media under constant head method. Permeability is 0.0153 cm/sec and the cleaning period is required generally 30 to 40 days. After every 30 days top surface of filter is removed and another layer of same quantity of activated charcoal is laid. Top layer which remove is cleaned by fresh water and this can be utilized again for filter. After 6 to 8 months total filter media is removed and clean the filter tank and again filled the new material.

At the entry of collection tank screen is provided for removal of larger particles and some paper or other material. After 12 hours check the screen and remove the material at the screen. In this manner routing and periodic maintenance is done then there is no problem of operation of filter. Also there is no Impact over the efficiency of filter and it gives maximum results for long period. If head loss is more in that situation cleaning of filter is required

IV. RESULT AND DISCUSSION

This chapter deals with the results obtained during the research work. This study was depends upon the water requirement and water availability in the selected area. Results obtained during the research work are presented by the graphs and tables and analysis was done on the basis of these results. This study was very important to solve the water related problem of that Campus. COEA Campus is situated in the draught affected area. After every 4 to 5 years draught was observed in that region. The main problem has been observed in summer season i.e. from February to June in every year.

After the data collection from the selected area different tests are required to find the percentage of impurities in waste water. So for this sample is collected from the waste water source that is from the outlets of bathrooms of hostels and different test are conducted with help of different methods and instruments. Results are tabulated as below,

Sr. No	Parameters	Readings
1	P^H	8.1
2	TDS	0.90 PPT
3	EC	1.2 ms
4	Hardness Ca	0.71 Mg/lit
5	Hardness Mg	0.34 Mg/lit
6	BOD	18 Mg/lit
7	COD	286 Mg/lit
8	Boron	1.7 Mg/lit
9	Chloride	1.7 Mg/lit
10	Phenols	0.034 Mg/lit
11	Suspended Solids	80 Mg/lit
12	Nitrate	7.5 Mg/lit
13	Sulphides	61 Mg/lit
14	DO	1.3 Mg/lit

Table no.1 Test results of waste water before Filtration

Following chart (fig. 2) shows that the parameters of waste water before filtration. Chart was plotted on the basis of data tabulated in the table no. 1

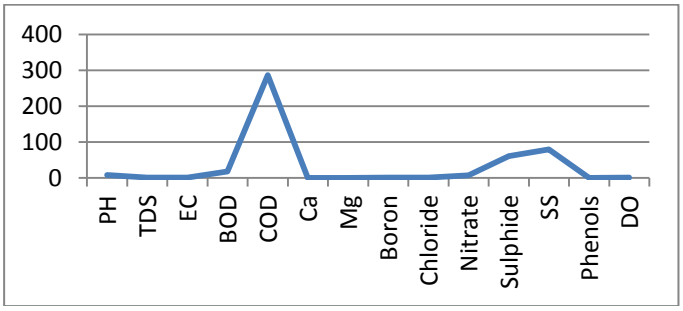

Fig.2 chart showing the parameters before filtration

After the testing of raw water same water is passed through the filter media as per the standard procedure of filtration like provision of detention period then passing through the filter bed.

For filtration a filter is used having three layers of filter media, first layer of activated charcoal having particle size passing from 2.36 mm and retain on 1 mm, second layer of sand passing through 4.75mm and retain on 1.36 mm, third layer of aggregate is passing through 12.5mm and retain on 10 mm sieve. After filtration filtered water is tested for analysis purpose. Results are tabulated as below,

Sr. No	Parameters	Readings
1	P^H	8.1
2	TDS	0.90 PPT
3	EC	1.2 ms
4	Hardness Ca	0.51 Mg/lit
5	Hardness Mg	0.29Mg/lit
6	BOD	14 Mg/lit
7	COD	200 Mg/lit
8	Boron	1.3 Mg/lit
9	Chloride	1.5 Mg/lit
10	Phenols	0.030 Mg/lit
11	Suspended Solids	30 Mg/lit
12	Nitrate	6.7 Mg/lit
13	Sulphides	45 Mg/lit
14	DO	1.1 Mg/lit

Table no.2 Test results of waste water after Filtration

Following chart (fig.3) shows that the parameters of waste water after filtration. Chart was plotted on the basis of data tabulated in the table no. 2

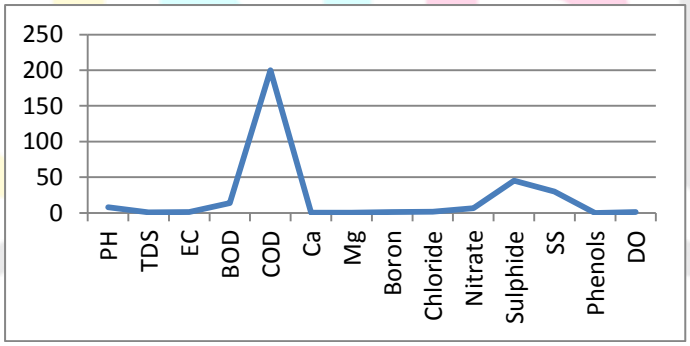

Fig.3 chart showing the parameters after filtration

From first arrangement of filter media Results are not satisfactory so to improve results the arrangement is kept same for filter but the particle size of filter media is changed i.e. activated charcoal of size less than 75 micron, sand of size 1mm and aggregate of size 10 mm passing. Then water is passed through this bed and test is conducted on this filtered water and Results are tabulated as below,

Sr. No	Parameters	Readings
1	P^H	8.0
2	TDS	0.90 PPT
3	EC	1.1 ms
4	Hardness Ca	0.06 Mg/lit
5	Hardness Mg	0.03 Mg/lit

6	BOD	11 Mg/lit
7	COD	40 Mg/lit
8	Boron	0.2 Mg/lit
9	Chloride	0.1 Mg/lit
10	Phenols	0.001 Mg/lit
11	Suspended Solids	12 Mg/lit
12	Nitrate	0.3 Mg/lit
13	Sulphides	8 Mg/lit
14	DO	1.1 Mg/lit

Table no.3 Test results of waste water after Filtration

In above table the results are based on the filter media size i.e. the size of filter media varies the result of test also varies. During the experimental study it is observed that for finer particles efficiency of filter is high and for larger size particles efficiency of filter is less. From above table no.3 it is clearly observed that if particle size of the filter media is changed then it directly affects the results. From table no.2 and table no.3 it is shown that lesser the particle size greater the capacity of removal of impurities and higher the particle size lesser the capacity of removal of impurities.

Following chart (fig. 4) shows that the parameters of waste water after filtration. Chart was plotted on the basis of data tabulated in the table no. 3

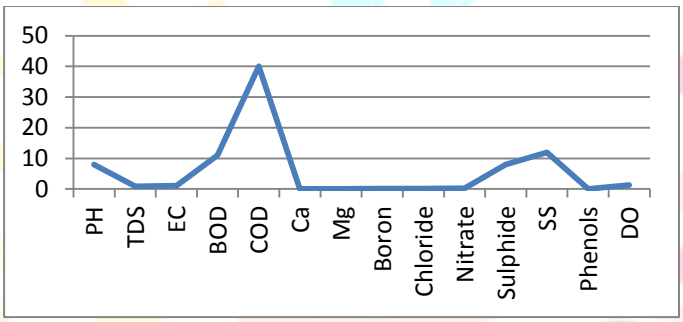

Fig.4 chart showing the parameters after filtration

Following chart (fig. 5) shows that the parameters of waste water after filtration. Chart was plotted on the basis of data tabulated in the table no. 1 and table no.4

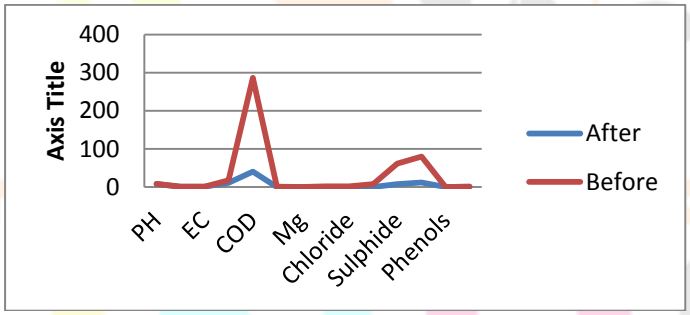

Fig.5 chart showing the parameters after and before filtration

In above fig 5 it is clearly seen that impurities are satisfactorily reduced up to standard requirement of irrigation water. So this water is used for the irrigation purpose.

V. CONCLUSION

On the basis of experimental result it can be concluded that filtration treatment by using Activated Charcoal is one of the best method for removal of pollutants from waste water from bath and washing the cloths and we can reshape the effluent characteristics so it could be used as irrigation water to reduce the pressure of application of normal water irrigation. The filtration treatment method of waste water could be profitably practiced for removing the pollutants and thus avoiding the ground water contamination and its environmental impacts. Activated Charcoal can be used for this purpose successfully. This experimental study also found that this filter is more effective for removal of COD, BOD, Boron, chloride, hardness due to Ca and Mg, suspended solids and phenols.

With the use of this multi layer filter successfully removal of the impurities from the waste water as follows:

1) COD - 85 to 90 % Removed.
2) BOD - 60 to 70 % Removed.
3) Hardness due to Ca & Mg- 90 to 95 % Removed.
4) Boron - 85 to 95 % Removed.
5) Phenols- 90 to 95 % Removed.
6) Suspended solids- 85 to 90 % Removed.
7) Sulphides and Nitrate- 85 to 90 % Removed.
8) Chloride- 95 to 99 % Removed.

Due to this study it is conclude that a new source is generated for purpose of irrigation and it reduce the load over potable water demand. Due to this techquanic the demand of water for irrigation is fulfilled.

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