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Phyto-Filtration: A New Approach of Waste Water Treatment

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Abstract:* As the industries are growing day by day the load on effluent treatment and disposal is also increasing. Now the condition is getting worst so new treatment and reuse techniques are needed to be discovered. One of the oldest techniques is sand filtration technique which are natural filters used for huge wastewater purification. Simultaneously another method of removal of toxic substances from soil and water was developed which is known as phyto-remediation. Phytoremediation technique has a large gap of application and research is only in its infancy. The purpose of the paper is to bring these two techniques together and make a design which can be used in small scale like house hold as well as for a whole colony to preserve, treat and reuse wastewater. In this project the various characteristics of waste water will be evaluated as well the water coming out of the phyto-filter will also be analyzed so that a comparative study can be done. The physio-chemical analysis of different parameters such as pH were there was average reduction of 18 % which was found in sample 1, 2 and 4; whereas the maximum reduction of 24% was in sample 3. Color has help to assess the qualitative characteristic for the general condition of wastewater. After the filtration process the appearance of the water was changed to transparent which gives a more as aesthetic look. There was no major drop in temperature of water before and after filtration on sample. There was a major variation in turbidity value of water before and after filtration and before filtration with** average 86% reductions. ***The value of total solid has significantly changed after filtration the initial value was 640,590,610 and 680 and the final value after filtration was 310,270,280.320 mg/l. The value of total dissolved solid has significantly changed after filtration the initial value was 420,390,400 and 450 and the final value after filtration was 210,180,170,200 mg/l. The value of settable solid has significantly changed after filtration the initial value was 6,5, 5.5 and 6 and the final value after filtration was 0.3,0.2,0.2,0.3 mg/l. BOD determines the strength or polluting power of sewage the value of BOD has significantly changed after filtration with 60% reduction in BOD***COD determines the strength or polluting power of sewage the value of COD has significantly changed after filtration with 75% reduction. The fluoride test is the measurement of the quantity of fluoride in one liter of sample. All the samples observed had high concentration of fluoride which slight changed after filtration. The analysis of the performance shows a gradual decrease in different parameters use for characteristic analysis of waste water. This shows the phyto-filtration is a proper approach of water treatment. This project will help to understand a new approach of an environmental friendly filtration technique.***

Index Terms: **Phytoremediation, Phyto filtration, TS-Total Solids, Biochemical Oxygen Demand and EC-Electrical Conductance.**

I. INTRODUCTION

A.NEED OF THE STUDY

India is the seventh-largest country by area and stands second in respect of population in the world. India is developing country industrialization and agriculture advancement is necessary [1]. India's environment is becoming delicate and environmental pollution is one of the undesirable side effects of industrialization, urbanization, population growth and insensible attitude towards the environment. In India, due to lack of sewage treatment plants, generally unprocessed sewage effluents are released either on agricultural land for irrigation or disposed of in the vicinity water bodies [2]. The purposes of pollution control activities should be to protect the assimilative capacity of surface waters, to protect fish; plants and wildlife; to preserve as well restore the aesthetic and recreational value of surface waters, to protect humans from adverse water quality conditions and to find better reuse, treatment and disposal techniques [5,6]. As industries are growing day by day the load on effluent treatment and disposal is also increasing. Now there is need of new treatment and reuse techniques which can be easily installed, need least space as well as cheap. Rajasthan has been always in the scarcity of water due to its climatic as wells topological condition that is most of it is desert. Adding to further is the presence of fluoride in waste also increased the problems related to water thus we need a treatment which just not only purifies the waste water but also remove fluoride by keeping environment safe. This project deals water treatment without use of chemicals and encouraging people to plant tree simultaneously make an eco-friendly green environment. One of the oldest techniques used was sand filtration technique which were natural filters used for huge wastewater purification [3]. Simultaneously another method of removal of toxic substances from soil and water was developed which is known as phyto-remediation. Phytoremediation technique has a large gap of application and research is only in its infancy. The purpose of the paper is to bring these two techniques together and make a design which can be used in small scale like house hold as well as for a whole colony to preserve, treat and reuse wastewater. Tulsi known as Holy Basil and one of the popular ancient plants which can be found in any house of India it serve the purpose.

B.OBJECTIVES

The objectives of this project are as follows:

- To collect wastewater sewage samples using sampling techniques.
- To perform physical and chemical analyses on the samples and estimate contaminant loadings before and after filtration.
- To design a prototype of phyto-filter.

C. HISTORY OF WASTEWATER

As the human race modernized in the way of living waste production increased simultaneously. Thus science of wastewater management came in existence whose one of the most ancient example was found in Mohenjo-Daro near the

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river Indus (presently part of Pakistan) at about 1500 BC. Waste management within the town was not proper till middle of the 19th century when water supply system were installed, water toilets and the construction of open and closed wastewater was done In 1868, on the occasion of a meeting of the Royal Institution of Great Britain, Frank land proposed ten analyses of water to characterize the river water quality [5]. He studied the routine of filtration of untreated London sewage in laboratory columns packed with media ranging from coarse gravel to peaty soil and maintained the performance for 4 month [5, 6].Dr. Alexander Mueller's demonstration was first who discovered and patented the biological process of purification [5] Latter experiment of Franklin was improved by Hiram F. Mills, a distinguished hydrologist, and Professors Sedgwick and Drown from the Massachusetts Institute of Technology. [7, 8] Under the direction of Allen Hazen, and publication in 1890 provided a monumental analysis of the associated microbial activity Trickling filters were first introduced to the U. S. in 1901 at Madison, Wisconsin. (7) By 1910. Inspired by the experiments of Lawrence, Gilbert John Fowler and his students discovered a new idea in the field of suspended growth treatment [8]

D. WASTEWATER CHARACTERIZATION

Wastewaters contain water more than 95% with solids as settle able particles, dispersed as colloids, which are materials that do not settle readily, or solids in a dissolved state as well as organic particles such as feces, hairs, food, paper fibbers, etc. and the soluble organic material such as urea, fruit sugars, etc The wastewater mixture will contain large numbers of microscopic organisms, mostly bacteria that are capable of consuming the organic component (fats, proteins and carbohydrates) of the mixture and bringing about rapid changes in the wastewater[1].

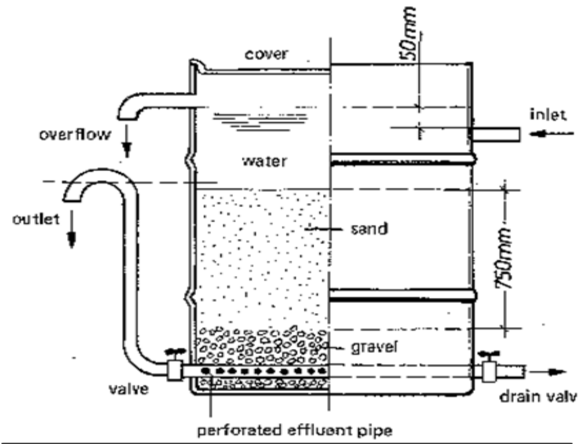

Fig. 1 Construction of Sand filter

E. SLOW SAND FILTER

In 1804, first experiment slow sand filter was designed by John Gibbs for his bleachery in Paisley, Scotland. Later in 1852 this filtration process was used for public water supply in London. Slow sand filtration is a simple and reliable process. The process percolates untreated water slowly through a bed of porous sand, with the influent water introduced over the surface of the filter, and then drained from the bottom. Slow sand filtration reduces bacteria, cloudiness, and organic levels—thus reducing the need for disinfection some of the advantages of SSF are Sludge handling problems are minimal; Systems can make use of locally available materials and labor, they can be used for poor and isolated areas. Slow sand filters do have certain limitations like it is slow, it require a large land area for installation, needs manual labor for cleaning, quickly clog of filters, less effective at removing microorganisms from cold water .

F. PHYTO-REMEDIATION

Phytoremediation is a technology that uses plants to clean up contaminated sites. Phytostabilization which is technique in which removal of contaminant in soil is done through absorption and accumulation by roots, adsorption onto roots, or precipitation within the root.

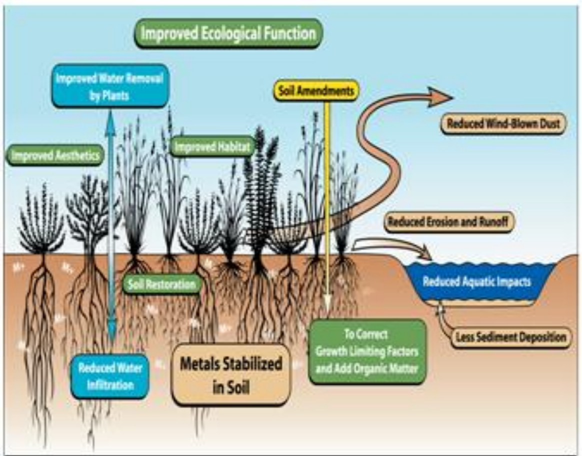

Fig. 2 Benefits of phytostabilization. Source: Pierzynski et al., 2001, Copyright KSU

This technology reduces the mobility, and therefore the risk, of inorganic contaminants without removing them from their location as well as do not generate contaminated secondary waste that needs treatment. This technology enhances the soil fertility. But there are some disadvantages like a) The contaminants are left in place, so the site need stabilization for sometime b) Elevated, toxic effects may prevent plants from growing. c) If soil additives are used, they may need to be periodically reapplied to maintain the effectiveness of the immobilization etc.

G.PLANT USED: TULSI (Ocimum Sanctum)

Tulsi also known as holy basil, Tulsi is a potent herb that has been used in India for thousands of years to treat colds, coughs, and flu. There is three variety of tulsi Rama Tulsi (Ocimum Sanctum), KrishnaTulsi (Ocimum Sanctum), VanaTulsi (Ocimum gratissium), According to Ayurveda, tulsi promotes purity and lightness in the body, cleansing the respiratory tract of toxins and relieving digestive gas and bloatingetc [10]. Tulsi leaves offer a rich source of essential oil, containing eugenol, nerol, camphor, and a variety of

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terpenes and flavonoids. The oil is a strong antiseptic against many kinds of disease-causing organisms, including bacteria, fungi, and parasites [10].While basil is found on every continent, tulsi is indigenous to the Indian subcontinent. It is a bushy shrub that grows to about 18 inches in height. Its leaves are oval and serrated, with colors ranging from light green to dark purple, depending on the variety. The plant has delicate lavender-colored flowers, and its fruit consists of tiny rust-colored nuts. Tulsi possess anti- pollutant, anti–oxidants and air purifying properties making it an ideal. Essential oil of Tulsi have antibacterial, antifungal and antiviral properties it in habits the growth of e-coli, b-anthraces, Tuberculosis (11).

Fig No.3.OcimumSanctum

II. METHODOLOGIES

A.PHYSICAL AND CHEMICAL CHARACTERIZATION

The objective of sampling is to collect sample so that it can be collected in its relative concentration of all significant components will be the same as in the material being sampled. Record of sample should be done as sample identification number, location, date and hour, water temperature, weather, water level. Various parameter of wastewater was tested before and after filtration like, colour, pH, Conductivity, Turbidity, TDS, TS, TSS, Settle able Solids, BOD, COD and Fluoride.

B.CONSTRUCTIONAND INSTALLATION OF FILTER

The following chart is an overview of the stages that are required to construction and installation

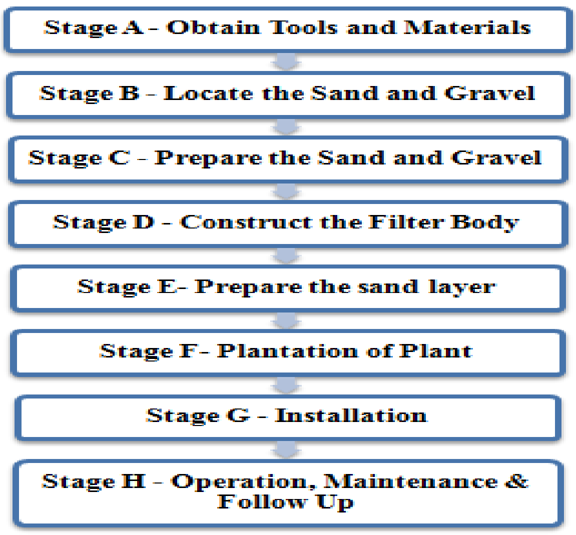

Fig No.4.Flow Chart of Filter Construction

Design Parameter Value

Fig. No.7 Construction of Filter Body

Fig. No. 5 Fine and Coarse filter media

Fig. No. 6 Fine and Coarse filter media

III. RESULT AND DISCUSSION

A. COLOUR

Color has help to assess the qualitative characteristic for the general condition of wastewater. Wastewater which was pale white in color was less than 6 h old collected from site 1 sample, while a light-to-medium grey color was characteristic of wastewaters that have undergone some degree of decomposition since it was stored for some time. The color of site 4 sample was dark grey or black, showing the wastewater was typically septic. The blackening of wastewater was may be due to the formation of various sulphides, particularly, ferrous sulphide. After the filtration

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process the appearance of the water was changed to transparent which gives a more as aesthetic look.

Experiment	Sample 1	Sample 2	Sample 3	Sample 4
pH				
Before	8.1	8.3	8.5	8
After	7.1	7.2	6.5	6.7
Temperature				
Before	24	24	25	25
After	24	23.5	24	24.5
Turbidity				
Before	590	600	570	550
After	70	100	80	60
Electrical conductance				
Before	149	153	144	137
After	57	67	61	58
Total solid				
Before	640	590	610	680
After	310	270	280	320
Total dissolve solid				
Before	420	390	400	450
After	210	180	170	200
Suspended solid				
Before	220	200	210	230
After	110	100	100	110
Settalable solid				
Before	6	5	5.5	6
After	0.3	0.2	0.2	0.3
COD				
Before	650	670	695	660
After	300	320	340	290
BOD				
Before	430	450	455	440
After	170	180	190	180
Fluoride				
Before	27	30	25	20
After	25	27	21	17

Table No. 1 Result variation of different parameters

B. TEMPERATURE

The measurement of temperature is important because most wastewater treatment schemes include biological processes that are temperature dependent. There was no much variation in temperature was found. There was no major drop in temperature of water before and after filtration on sample. The minute variation of temperature has been shown in fig. No.8

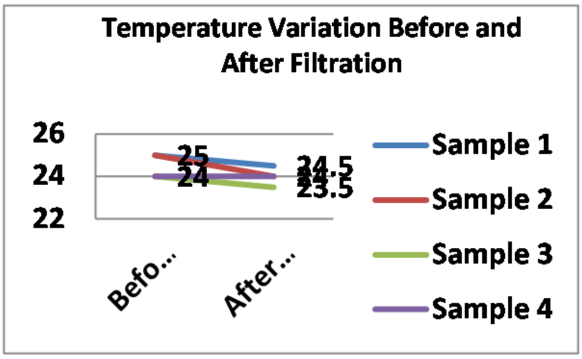

Fig. No.8 Temp. Variation before and after

C. PH-VALUE

Most of the chemical and biochemical reactions are influenced by the pH; it is of great practical importance. The adverse effects of most of the acids appear below pH 5 and of alkalis above pH 9.5. There is average reduction of 18 % which was found in sample 1, 2 and 4; whereas the maximum reduction of 24% was shown in sample 3.

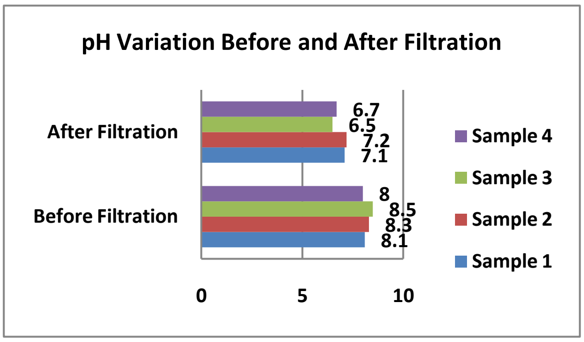

Fig. No. 9 pH Solid before and after filtration

D. ELECTRICAL CONDUCTANCE (AT 25°C)

Conductivity is a fast and inexpensive way to calculate the ionic strength of wastewater. Wastewater contains ionized salts. A significance variation was found before and after filtration. There was average 59 % reduction in EC after filtration as shown in fig. no. 10.

E. TURBIDITY

Turbidity is imparted by colloidal material which provides adsorption sites for chemical and increases the load on filters.

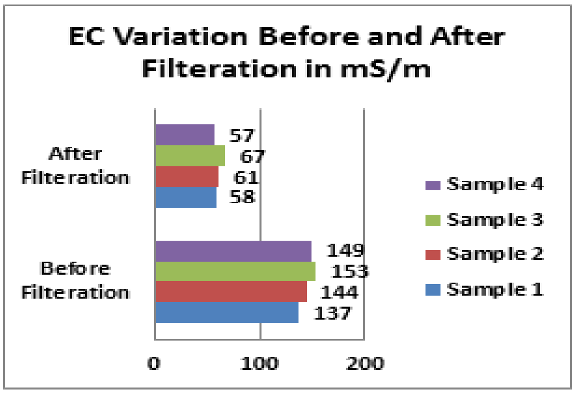

Fig. No.10 EC before and after filtration

Turbidity is an essential parameter for measuring the proper working as well as decides the time of cleaning of filter. The result of turbidity reduction was very good, there was average 86% reduction. Sample 1 and 4 showed 89% reduction as in fig no. 11.

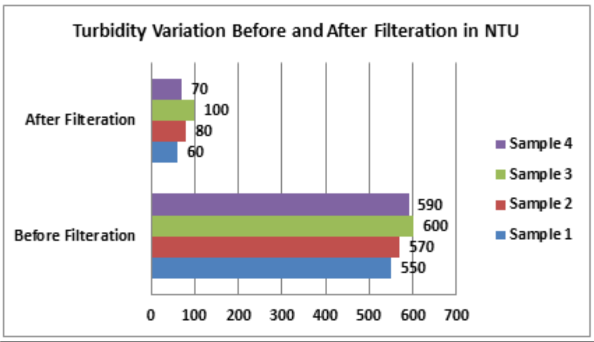

Fig. No.11 Turbidity before and after filtration

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F. TOTAL SOLIDS

Total solid can be easily seen in wastewater which itself creates anesthetic condition. The value of total solid has significantly changed after filtration. The initial value was decreased by 52.5% which shows the filtrate is working properly. The different sample filtrate value shows smooth and uniform filtration process as given fig. no. 12.

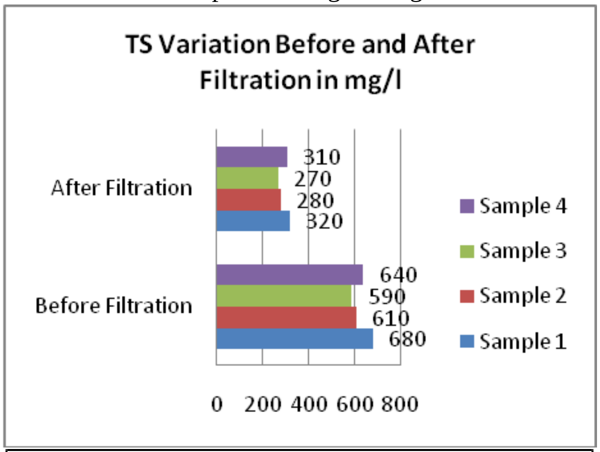

Fig. No.12 TS before and after filtration

G. TOTAL DISSOLVED SOLIDS (TDS)

Total dissolve solid in wastewater itself creates anesthetic condition. As in fig. no. 13 the sample showed average total dissolved solid reduction of 54.5%. After filtration reduction in sample 1, 2, 3, and 4 was 54%, 55%, 57% and 53% respectively.

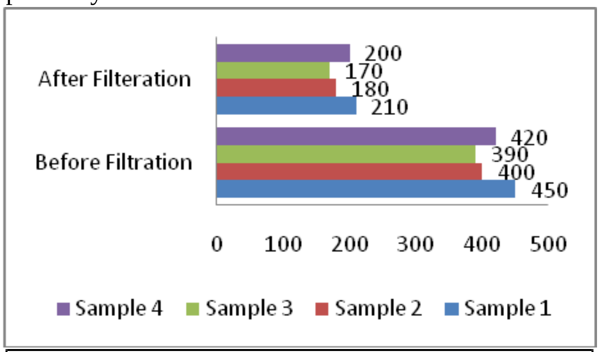

Fig. No.13 TDS before and after filtration

H. TOTAL SUSPENDED SOLIDS (TSS)

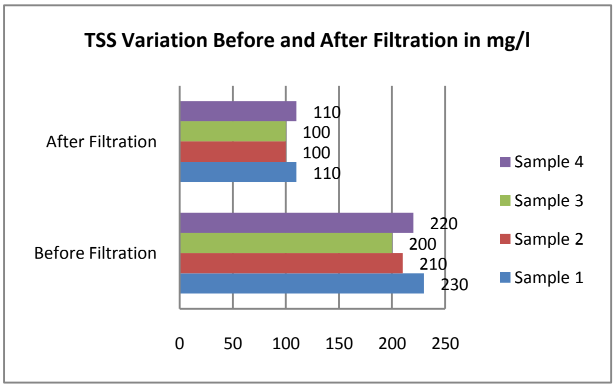

Fig. No.14 TSS before and after filtration

The total solids in a wastewater consist of the insoluble or suspended solids and the soluble compounds dissolved in water. In this fig. no.14 before the filtration the TSS of sample 1, 2, 3 and 4 was 230, 210, 200, and 220 which was reduced approximately 50%.

I. SETTLEABLE SOLIDS

The Settalable solids test is the measurement of the volume of solids in one liter of sample that will settle to the bottom of an Imhoff cone during a specific time period. The test indicates the volume of solids removed by settling in sedimentation tanks, clarifiers or ponds. The Settalable solids test indicated that there is a need of primary treatment. The quality of water was improved by 95% which is significant variation as shown in fig. no. 15

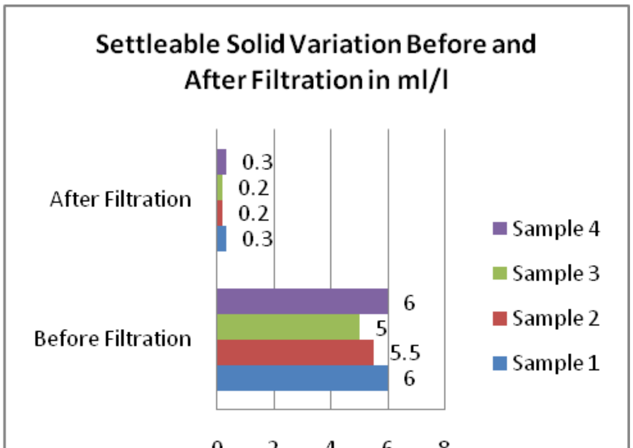

Fig. No. 15 Settalable Solid before and after filtration

J. BIOCHEMICAL OXYGEN DEMAND

BOD has been used as a measure of the amount of organic materials in an aquatic solution which support the growth of microorganisms .BOD determines the strength or polluting power of sewage, effluents and other polluted waters and provides data on the pollution load in natural waters. Higher values of BOD indicate a higher consumption of oxygen and a higher pollution load. After filtration there was 60% reduction in BOD.

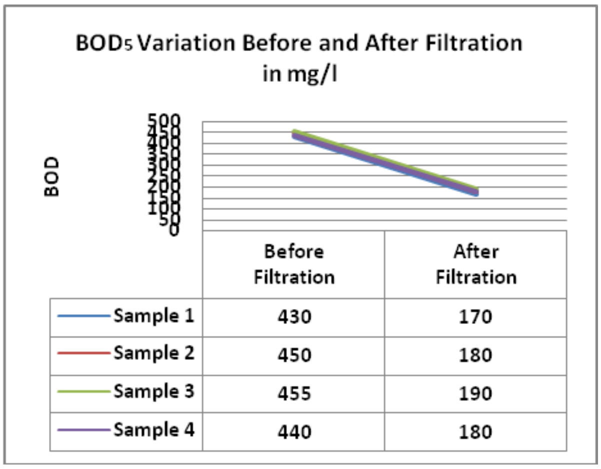

Fig. No.16 BOD5 before and after filtration

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K.CHEMICAL OXYGEN DEMAND

COD determines the amount of oxygen required for chemical oxidation of organic matter using a strong chemical oxidant, such as potassium dichromate under reflux conditions.

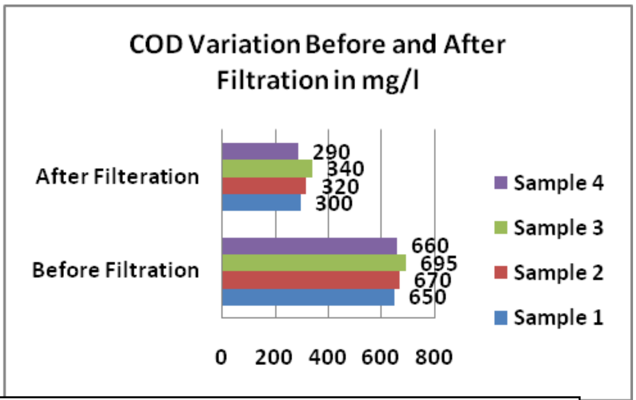

Fig. No. 17COD before and after filtration

L. FLUORIDE

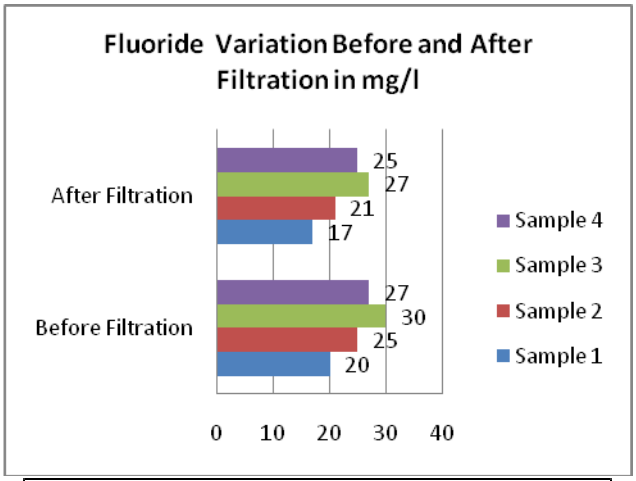

Fig. No.18 Fluoride before and after filtration

The fluoride test is the measurement of the quantity of fluoride in one liter of sample. The fluoride more than 1.2mg/l can cause chronic disease like fluorosis. All the 4 sample observed has high concentration of fluoride shown in fig no.18 therefore this water is not suitable for drinking purpose.

IV. CONCLUSION

The water treatment work has started with sample collection from sewage site in a closed lid bottle at four different times and went for the physio-chemical analysis of the samples. Calculated data of the parameter of the sample reveals that there was a significant decrease in the physio-chemical characteristic of the sample as the parameters such as pH, TS, TDS, SS, TSS, EC, BOD, COD, fluoride drop out to a major extent which shows that this water can be reused.

This project will help to understand a new approach of an environmental friendly filtration technique which can be used commonly in the household. Overall performance of the filter was satisfactory since the wastewater was sewage water thus the quality of the water after filtration improved considerably. This water now can be used for other purposes like disposed to the sewer which will improve the quality of municipal water and decrease the load on treatment; this purified water can be re-circulated as grey water so that it can be used for flushing etc and for gardening.

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Suraj Kumar Bhagat achieved SFRF-2013 from Indian Institute of Technology (IIT), Delhi; He published three research papers in International Journal, Five in conference proceedings as well as presents his research work in many National and International conferences. I am also the author of book “Rural water supply and sanitation” with Priya Tech Publication Pvt. Ltd. He attained many National workshop, has the life membership of Biotech Helpline Foundation(Scientific Societies), Rajasthan He is working at Department of Civil Engineering, Sri Balaji College of Engineering and Technology, Jaipur; He obtained his B.E. from Vinayaka Mission University, Tamilnadu and his M. Tech dissertation is under review in Environmental Engineering from Rajasthan Technical University, Rajasthan. Driven by his strong interest in the potential for water supply and sanitation, especially in Rajasthan, INDIA; he has been gathering information in this book. He has included his knowledge and investigation in this book.

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