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Laboratory Scale Study for Reuse of Greywater

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Abstract: *Greywater is the wastewater that is generated in houses and commercial buildings through the use of water for laundry, dishes and bathroom. This project's aim is to treat and reuse greywater for gardening, toilet flushing and street washing. The treatment system consists of natural process involving equalization cum sedimentation, filter bed consisting of sand, aggregates and marbles and collection tank. Physico-chemical parameters viz. turbidity, pH, COD, DO, total dissolved solids, conductivity, hardness and alkalinity were analyzed. By this system results have shown that filtration increases DO concentration and other parameters decrease in greywater so as to make it usable. It is an effective method of treatment of greywater as compared to the conventional method so it can be implemented on small scale at houses, schools/colleges, commercial buildings, etc. Quantification of greywater generated from bathing, washing cloths and from basin was also done. Greywater reuse has the advantage that it is a possible technique where water consumption on daily basis can be reduced. Also to evaluate the awareness in people about greywater and health risk associated with it.*
Keywords: *Filtration, Greywater, Reuse, Sources, Treatment*

I. Introduction

Water is becoming a typical source in the world and most essential for our society. Water can be classified as fresh water, salt water, greywater and black water. The greywater are discharged from household and other buildings. Main sources of greywater are from bathrooms, wash basins and sinks.

Increasing interest in the reuse of greywater in many parts of the world, including both industrial and developing countries may reduce the usage of potable water by up to 50%. Water reuse typically involves treatment and disinfection of the source water prior to reuse for application such as toilet flushing and irrigation. Infertile and semi-fertile areas municipal water consumption typically increases by 40-60% in summer months due to landscape irrigation. Reuse of greywater also reduces sewage generation. It also saves money and increasing the effective water supply in regions where irrigation is needed and scarcity of water is more. The reuse of greywater involving sufficient treatment i.e., filtration, sedimentation, adsorption and disinfection process to prevent bacteria proliferation, minimize health risk and avoid unpleasant odor.

It is estimated that treated wastewater will contribute to 20% of the water budget in the kingdom by the year 2020. Currently, 60% of the population is served by sewerage networks. The total greywater fraction has been estimated to account for about 75% of all wastewater of the combined residential sewage. Treatment and disinfection of greywater are important to provide water that is safe and aesthetically suitable for reuse. [7]

Greywater contains many of the same contaminants as sewage water, and while generally present in lower concentrations than in sewage water, they can be well above international drinking, bathing, and irrigation water standards. Greywater can contain pathogens derived from fecal contamination, food handling, and opportunistic pathogens such as those found on the skin.

The main objectives of this research work are (i) to do physico-chemical characterization of the raw greywater and treated greywater; (ii) to do the quantification and reduction in usage of water; (iii) to assess acceptability and awareness of greywater reuse; (iv) to investigate and evaluate the health risk due to the reuse if any.

The work is focused on the reuse of greywater for the different purposes like toilet flushing, street washing and gardening. The health risk due to the reuse of greywater will be evaluated and the awareness of reuse of greywater will be assessed.

II. Methodology

The greywater is collected from the outlet of the residential building consist of 8 flats having 32 people including three children. The residential building is located in Hingna Road Octorai Naka, Nagpur. This building has been selected because in this apartment the greywater piping system is different as compared to other areas. The greywater which is generated from bathrooms sinks and excluding kitchen wastewater was used. In kitchen wastewater containing oil and grease which increases organic loading that's why for this project the use of only bathrooms and sinks wastewater was taken.

2.1 Grey water treatment setup

The experimental set up was in laboratory of Environmental Engineering in G. H. Raisoni College of Engineering. Fig (2-b) shows the schematic diagram of the treatment process comprises of equalization cum sedimentation unit, filtration unit and storage unit. The equalization cum sedimentation unit regulates between raw greywater inflows and outflows to the treatment system, and equalizes the quality and temperature of the raw greywater. This unit has a volume of 60ltrs and receives raw greywater directly from the outlet of the bathrooms. In this unit the particles are allowed to settle under gravity with the addition of coagulants. This equalization cum sedimentation unit also serves as a sampling point to test for the level of contamination of the greywater. The filtration unit is a 20-liter water tank filled with marbel and gravel acting as drain with size range of 2–16 mm to a height of 100mm from the bottom of the unit. Fig (2-a) shows the particle size distribution of a sand filter media with d_{10}=0.29, d_{30} = 0.38, d_{60}=0.52 and uniformity coefficient, Cu=1.79 was laid on top of the gravel to a height of 300mm. The sand screens off particles larger than its pore size while the marbles and gravel acts as a drainage system to let off filtered greywater. The storage unit mainly receives filtered water from the filtration unit. In this storage unit there is an addition of chlorine is done for the removal of odor from the treated greywater.

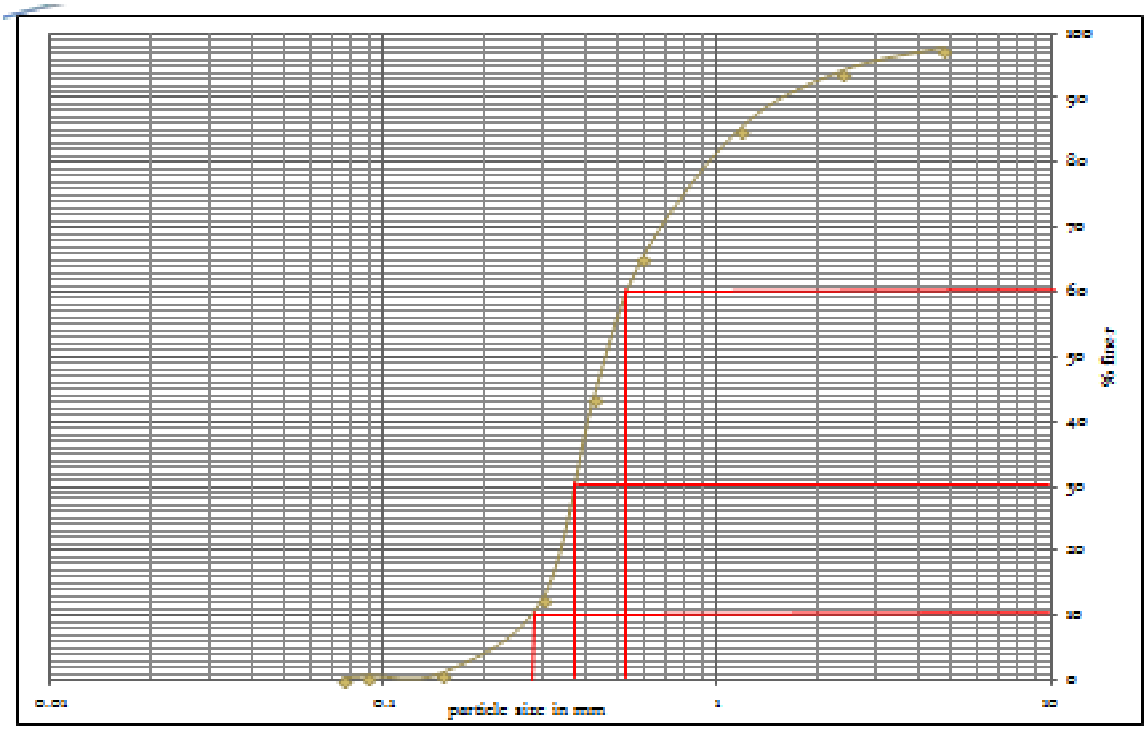

Figure (2-a): Particle size distribution curve

2.2 Sampling and testing

For regular 30 days, greywater sample was collected from the outlet of the apartment's pipeline and the characteristics of that raw greywater was tested for the further design of set-up i.e., its different treatment units for filtration so that it can be checked that the treated greywater by the different filtration unit can be considered for further reuse option or not. The tests conducted on the samples are chemical oxygen demand (COD), total dissolved solids (TDS), dissolved oxygen (DO), pH, turbidity, hardness, alkalinity, conductivity.

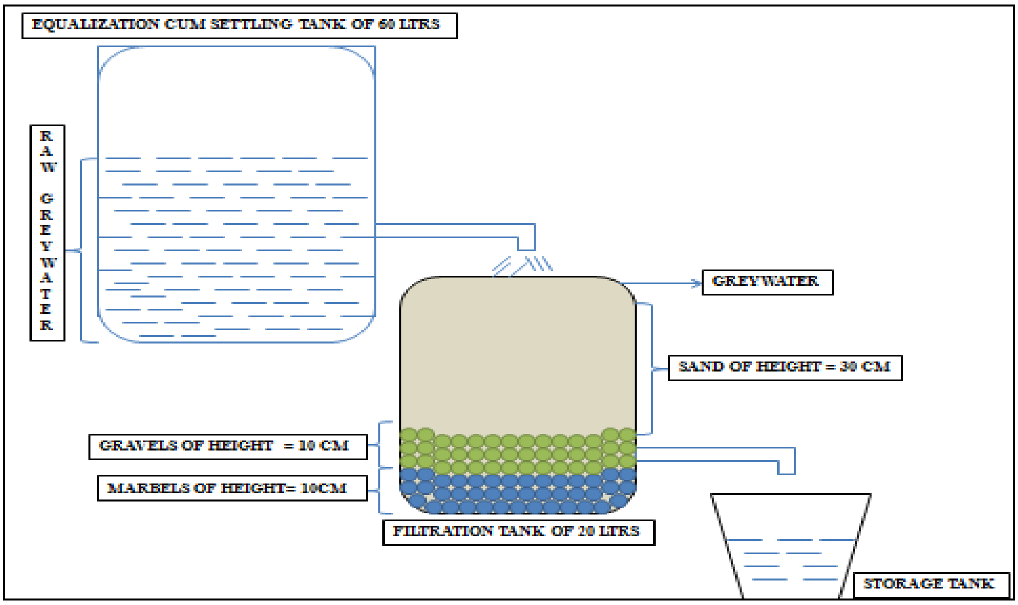

Figure (2-b): Schematic diagram of experimental setup.

2.3 Analytical method used in laboratory

All the samples of greywater which were being collected as per sampling program were analyzed at the college laboratory of G.H. Raisoni College of Engineering, Nagpur. The important parameter like pH, turbidity, conductivity, alkalinity, hardness, DO, total dissolved solids, COD of the influent and effluent of the greywater were analyzed.

2.3.1 Test for pH

pH is measured by using digital pH meter PM 100.

2.3.2 Tested for Turbidity

Turbidity is measured by using Nephelometric Turbidity Meter.

2.3.3 Tested for Conductivity

Conductivity is measured by using conductivity meter VSI-04.

2.3.4 Tested for Alkalinity

Alkalinity is measured by using APHA (American Paint Horse Association) standards.

2.3.5 Tested for Hardness

Hardness is measured by APHA (American Paint Horse Association) standards.

2.3.6 Test for Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is measured by using COD digester 2015 M(S)

2.3.7 Total Dissolved Solid (TSS)

The method is to measure the amount of solids present in greywater sample in dissolved form by using wattman filter paper.

2.3.8 Tested for Dissolved Oxygen (DO)

Dissolved oxygen is measured by using APHA (American Paint Horse Association) standard.

III. Results and discussion

Fig-3.1 shows that the pH of the influent and effluent greywater from the treatment system was relatively steady with an average of 8.2 with deviation of ± 0.5 for the raw grey water, an average of 8.06 for after sedimentation with deviation of ± 0.58 and an average of 7.98 for after filtration with deviation of ± 0.54 respectively.

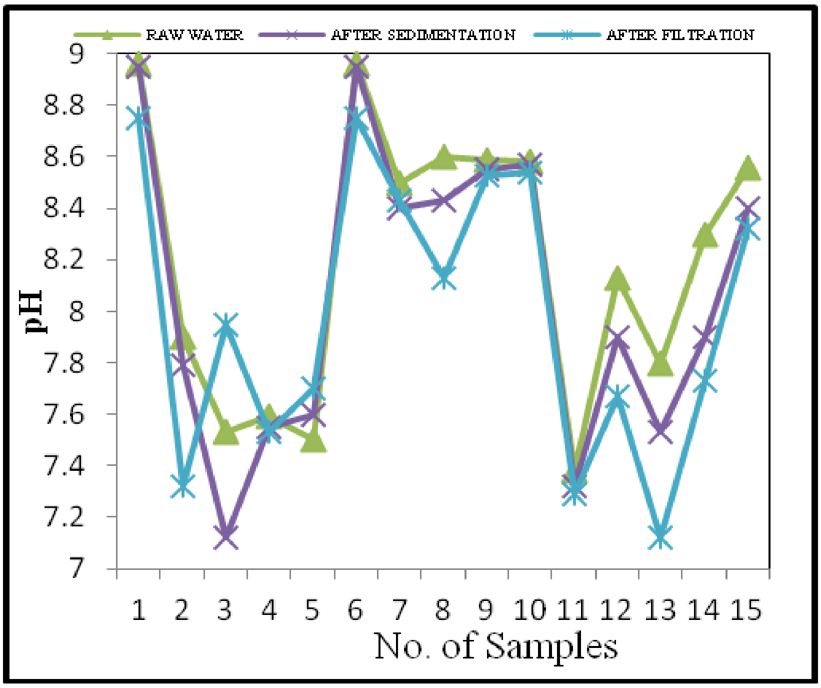

Figure-3.1:

Fig-3.2 shows that the turbidity of the influent and effluent greywater from the treatment system was relatively decreases with an average of 33.85 with deviation of ± 14.54 for the raw grey water, an average of 3.95 for after sedimentation with deviation of ± 1.43 and an average of 1.95 for after filtration with deviation of ± 0.99 respectively.

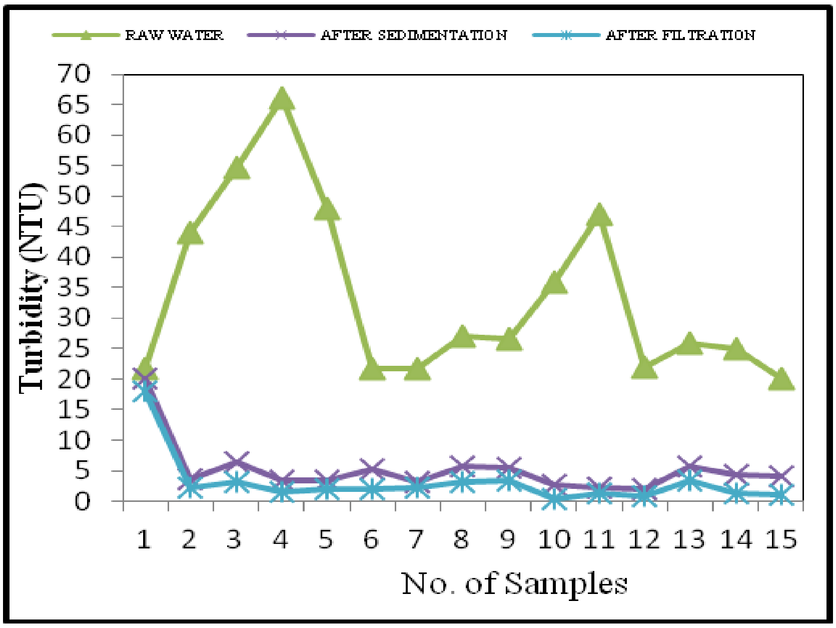

Figure-3.2:

Fig-3.3 shows that the conductivity of the influent and effluent greywater from the treatment system was relatively decreases with an average of 4.5 with deviation of ± 0.15 for the raw grey water, an average of 4.36 for after sedimentation with deviation of ± 0.15 and an average of 4.28 for after filtration with deviation of ± 0.16 respectively.

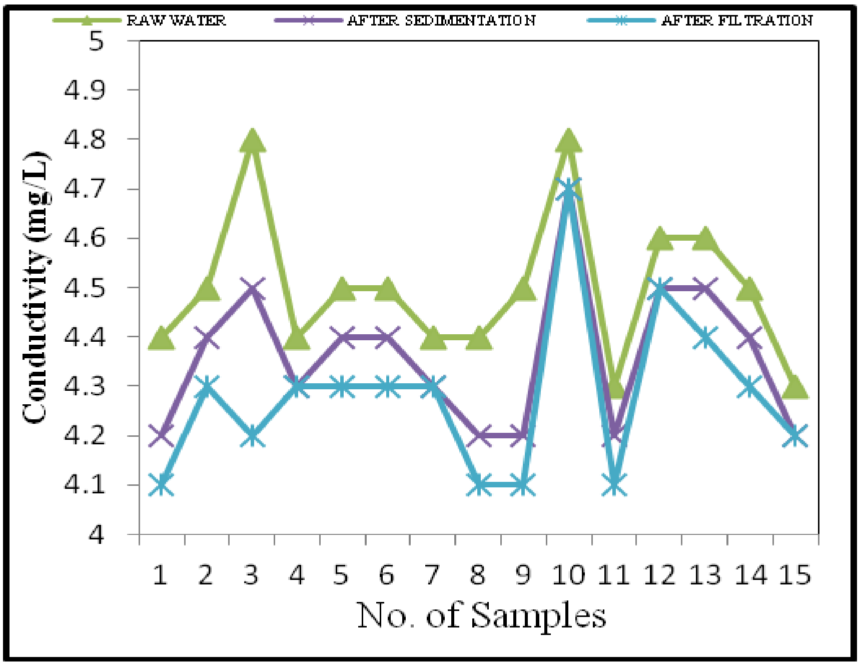

Figure-3.3:

Fig-3.4 shows that the alkalinity of the influent and effluent greywater from the treatment system was relatively decreases with an average of 492.4 with deviation of ± 69.40 for the raw grey water, an average of 380 for after sedimentation with deviation of ± 54.74 and an average of 297.8 for after filtration with deviation of ± 77.11 respectively.

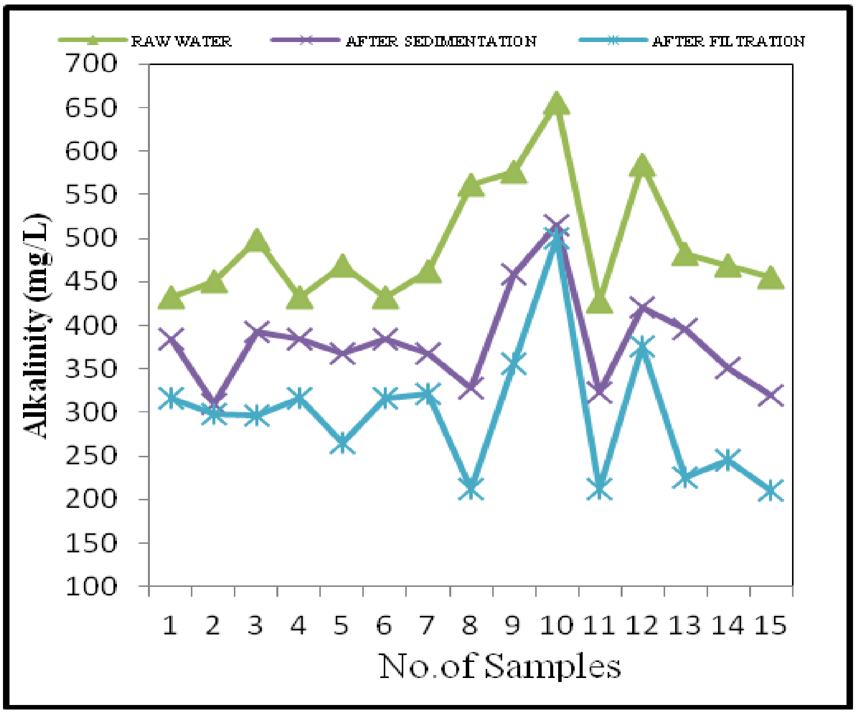

Figure-3.4:

Fig-3.5 shows that the hardness of the influent and effluent greywater from the treatment system was relatively decreases with an average of 485.6 with deviation of ± 68.90 for the raw grey water, an average of 378.4 for after sedimentation with deviation of ± 70.71 and an average of 318.4 for after filtration with deviation of ± 73.02 respectively.

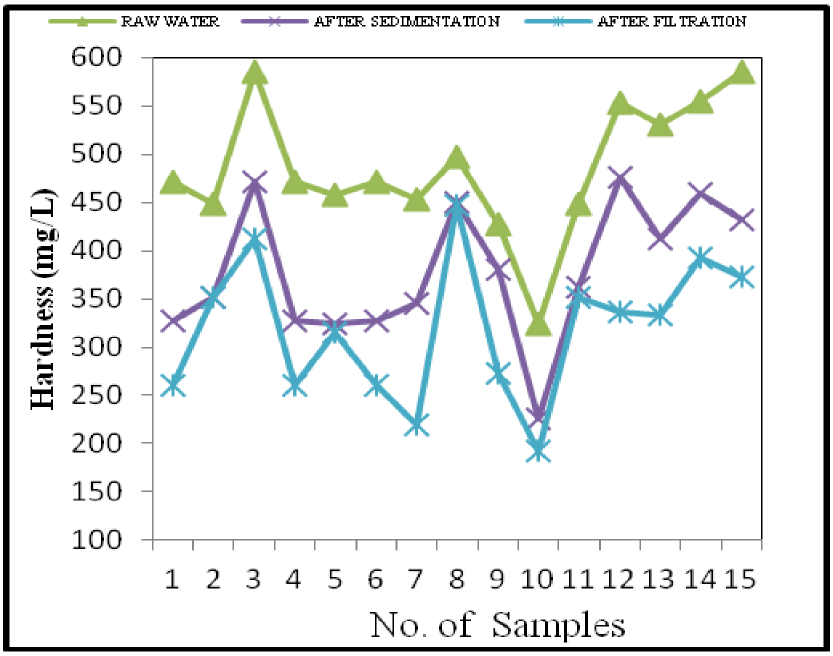

Figure-3.5:

Fig-3.6 shows that the dissolved oxygen of the influent and effluent greywater from the treatment system was relatively increases with an average of 2.54 with deviation of ± 0.74 for the raw grey water, an average of 3.38 for after sedimentation with deviation of ± 0.67 and an average of 6.58 for after filtration with deviation of ± 0.55 respectively.

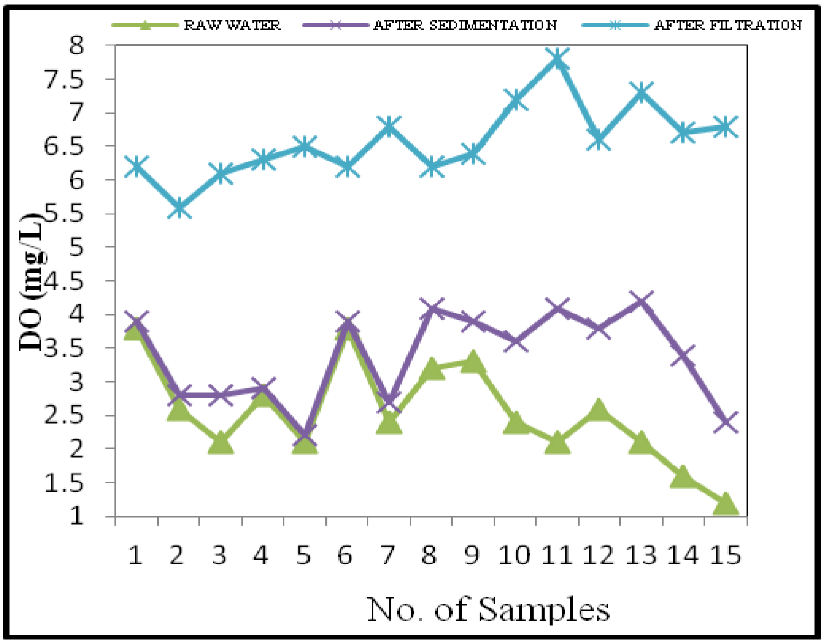

Figure-3.6:

Fig-3.7 shows that the total dissolved solids of the influent and effluent greywater from the treatment system was relatively decreases with an average of 2.68 with deviation of ± 0.10 for the raw grey water, an average of 2.54 for after sedimentation with deviation of ± 0.13 and an average of 2.46 for after filtration with deviation of ± 0.14 respectively.

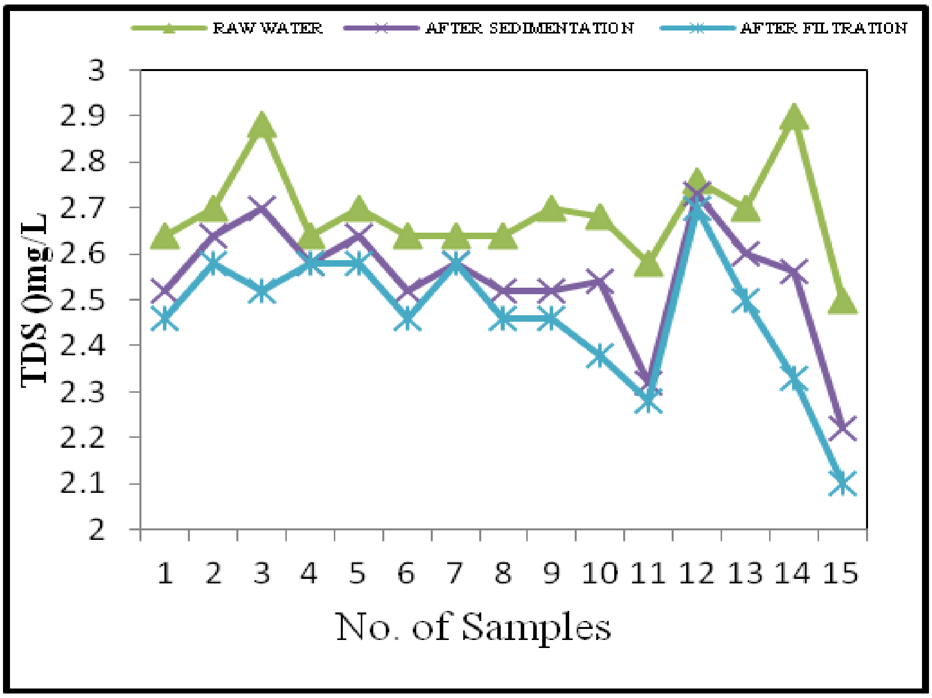

Figure-3.7:

Fig-3.8 shows that the chemical oxygen demand of the influent and effluent greywater from the treatment system was relatively decreases with an average of 30.80 with deviation of ± 4.74 for the raw grey water, an average of 15.40 for after sedimentation with deviation of ± 2.37 and an average of 7.71 for after filtration with deviation of ± 1.19 respectively.

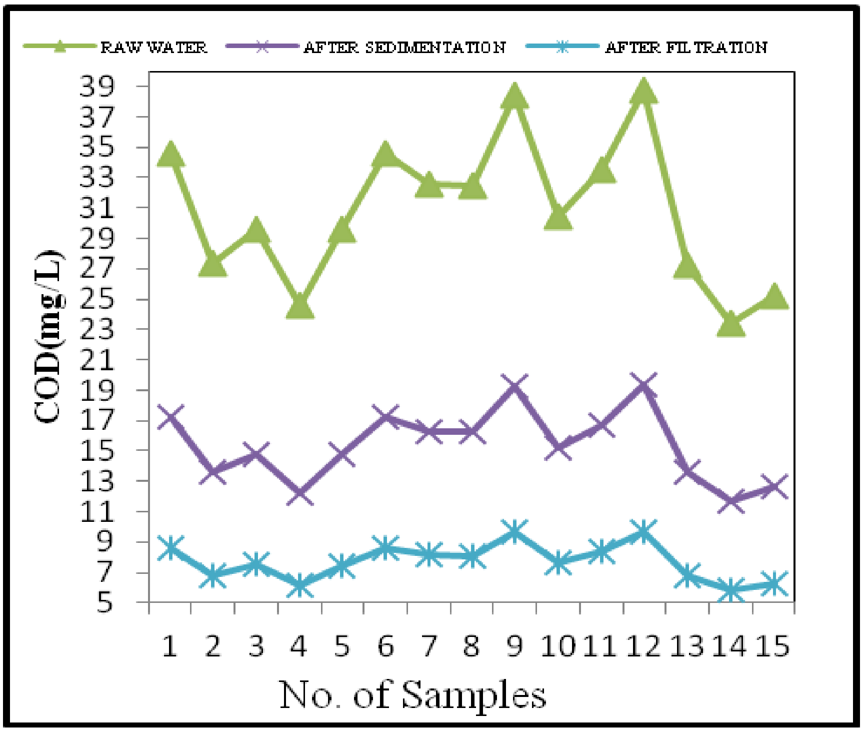

Figure-3.8:

IV. Conclusion

The overall performance of result was producing an appreciably improved quality of greywater. The total efficiency of COD removal is about 50.05%. The values of all parameters are within the limits recommended for land irrigation. The average percentage reductions in all parameter are 60-70%. The percentage of DO increases. Day by day people are mentally prepared for the reuse of greywater. The treated greywater does not use directly into the irrigation field in which the foods are eaten raw and uncooked. It may cause health risk. With the using of coagulants the rate of choking of filter bed is less. The treatment system is cost effective and easily operated manually. This treatment system can also be used in small scale basis like houses, hotels, office etc. With the using of chlorine, it removes foul odor from the treated greywater and it can be preserve for more than 24 hr, but if treated greywater can use within 24 hours it is much better according to the health risk. Greywater can be reuse for the toilet flushing, gardening and street washing.

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