"GREY WATER TREATMENT AND RECYCLING FOR USE IN HOUSEHOLD APPLICATIONS"

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Abstract: ~

Grey water can be defined as any domestic wastewater produced, excluding sewage. The main difference between grey water and sewage (or black water) is the organic loading. Sewage has a much larger organic loading compared to grey water. Some people also categorize kitchen wastewater as black water because it has quite a high organic loading relative to other sources of wastewater such as bath water.
People are now waking up to the benefits of grey water re-use, and the term "Wastewater" is in many respects a misnomer. Maybe a more appropriate term for this water would be "Used Water".

In water scarce environments, waste water reuse and reclamation are often considered as viable option for increased water resources availability. For example many Mediterranean countries are investing in waste water reclamation, and reuse due to high evaporation and evapotranspiration, low rainfall and increased demand for water for irrigation and tourism (Angelakis *et al.*, 2001). Equally, in water scarce developing countries, grey water reuse in schools, hospitals and government institutions is proving to be an essential alternate water resource to fresh ground, surface or rain water supplies, (Godfrey *et al.*, 2006).

Reuse of water particularly grey water is important in the context of availability of rain water and over-extraction of ground water for meeting water demand during annual cycle. An analysis of rainwater and groundwater availability and water demand in Ashram schools of Madhya Pradesh highlights the importance of grey water treatment alkalinity (1225 mg $CaCO_3$/lit) pH (9.8), turbidity (11.7 NTU), TDS (6.67g/lit), TSS (3.52g/lit), and BOD_5 (130mg/lit) have been monitored to study the reusability of this grey water. The results for treated water are good enough to be directly pumped to the overhead tank for supply to be used. Thus grey water treatment systems can play a very important role in future water management and prospective sustainable living. The details of the study can be easily interpreted from the plots below. The experimental data were analyzed by the Langmuir and Freundlich isotherms of adsorption.

and reuse. In Madhya Pradesh and in several other states, groundwater is a major source and temporarily supplemented by surface/rainwater during the monsoon. The grey water reuse will substantially reduce groundwater abstraction since majority of water demand for toilet flushing and gardening in Ashram school can be met from treated grey water. Saving water to save the planet earth and to ensure a safe future for mankind is the ultimate necessity of the hour. Besides other needs, the demand for water (UNESCO) has increased enormously with agricultural, industrial and domestic sectors consuming 70, 22 and 8% of the available fresh water, respectively and this has resulted in the generation of large amounts of wastewater containing a number of 'pollutants'. Present water usage of our society cannot be considered sustainable. Part of this problem is due to domestic water usage. Grey water, another kind of domestic waste water which contains different dye or color pigments such as Ethanaminium or 2-[ethyl[4-[(4-nitrophenyl)azo] phenyl] amino]-N,N,N trimethyl-, chloride and indigo. These coloring agents should be removed to reuse the grey water for future use.
Our present work envisages on the analysis of removal of such dye and colour pigments from grey water on synthetic activated carbon procured from the market. . Our present work focuses on the recycle of grey water that is mainly generated from domestic activities such as laundry, dishwashing, and bathing, which can be recycled on-site for uses such as landscape irrigation and constructed wetlands. Various qualitative and quantitative parameters viz.

KEYWORDS:
Grey Water, Ethanaminium, Freundlich isotherm

Composition of grey water: ~

Grey water from Bathroom

Water used in hand washing and bathing generates around 50-60% of total grey water and is considered to be the least contaminated type of grey water. Common chemical contaminants include soap, shampoo, hair dye, toothpaste and cleaning products. It also has some faecal contamination (and the associated bacteria and viruses) through body washing.

Grey water from Cloth Washing

Water used in cloth washing generates around 25-35% of total grey water. Wastewater from the cloth washing varies in quality from wash water to rinse water to second rinse water. Grey water generated due to cloth washing can have faecal contamination with the associated pathogens and parasites such as bacteria.

Grey water from Kitchen

Kitchen grey water contributes about 10% of the total grey water volume. It is contaminated with food particles, oils, fats and other wastes. It readily promotes and supports the growth of micro-organisms. Kitchen grey water also contains chemical pollutants such as detergents and cleaning agents which are alkaline in nature and contain various chemicals. Therefore kitchen wastewater may not be well suited for reuse in all types of grey water systems.

Objective: ~

1 .To find an economical way to treat water.

2. To remove Ethanaminium and other colouring pigments, such as indigo from grey water.

3 .To reject use of chemicals.

4 .To solve the problem of water in water scarce area
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5. To study the kinetics of the adsorption process.

6 .To find the best fit isotherm for this adsorption process.

7. To evaluate physico-chemical treatment process removal of waste water.

8.Recycle and reuse of waste water for economic profits.

Methodology for treatment of grey water:

Usually water treatment plants follow a conventional process of 3 steps – Primary Treatment, Secondary or Bio Treatment & Tertiary Treatment. First, different Parameters of the grey water collected were tested. They are as follows:-

Parameter	*Value*
pH	9.8
TDS	23.2gm/L
TSS	3.52gm/L
BOD_5	130mg/L
Alkalinity	1225mg$CaCO_3$/L
Turbidity	12 NTU
Sulphate	3mg/L

Then the presences of different metals were tested. It was found that the water sample contains Zn, Ca, Fe, Al, Pb, Na & K. The amount of Fe present was 5ppm and Pb was 1ppm.

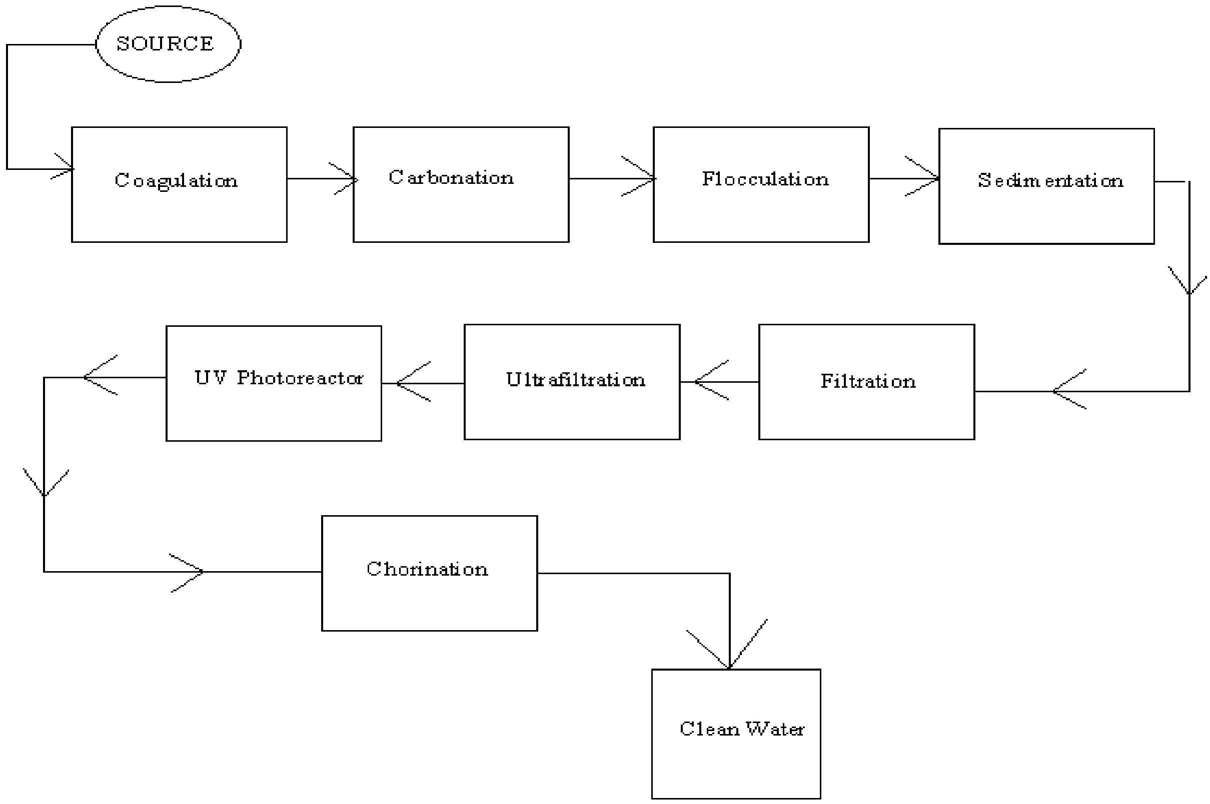
Now we treated the waste water with $Ca(OH)_2$ in a CSTR. Sulphate present in the solution formed CaSO4 and gave a precipitate. Then carbon dioxide was passed through the solution for 5 minutes, which initially gave a turbid solution, on treatment with excess CO2 the sample became clear. During treatment with carbon dioxide, sodium hydroxide present in the solution formed sodium bicarbonate and gave precipitate. The treated water was filtered and collected. Then it was treated with Common Alum, which gave a jelly like precipitate. Chlorides present in the waste water formed such a gelatinous precipitation. NH3 present in the solution gave some precipitate also. Treatment with $Ca(OH)_2$ also destroyed some coliform. After this fuller's earth was added for proper sedimentation, which was carried out in a sedimentation tank. As fuller's earth is a good adsorbent it cleared the water and gave more clear water. The Effluent was collected.

Collected effluent still contained coliform and different pathogens as well as lead. So ultra filtration was used to remove lead and 85% lead was removed. The concentration. of lead was measured again and it was found to be 0.17 ppm.

Then the effluent was passed through a chamber of UV-Ray. This killed most of the living organisms. Finally, it was treated with Na(OCl)Cl, i.e. chlorination was done. This made the water free from bacteria as well as bad odour.

Again the Initial Parameters of the water was tested. And the following result was obtained.

Parameter	***Value***
Ph	7.2
TDS	3.2gm/L
TSS	0.03gm/L
BOD5	4mg/L
Alkalinity	0.21mgCaCO3/L
Turbidity	3 NTU
Sulphate	0.05mg/L



FLOWCHART OF THE TREATMENT OF GREY WATER

METHODOLOGY FOR REMOVAL OF DYE FROM GREY WATER:

Synthetic grey water was stimulated in laboratory, in which known amount of Ethanaminium (Hair dye) was mixed.
Five samples were prepared of varying concentration of dye.

Reading was taken for 48 hours and 72 hours time. Since, it reached equilibrium and hence no more reading was taken.

Equal amount of Activated Charcoal was added in each sample and was stirred in a magnetic stirrer for 15 minutes at 120-130 r.p.m. each.
They were kept undisturbed for 24 hours.
A calibration curve was prepared with the initial concentration vs absorbance data.
10ml of the solution was pipetted out and filtered from each sample and their absorbance was measured in a colorimeter in visible region.

RESULTS & DISCUSSIONS:

Table 1: Concentration & Absorbance of mother solution.

ABSORBANCE	CONCENTRATION
0.09	0.0625 mg/L
0.3	0.125 mg/L
0.44	0.1875 mg/L
0.51	0.25 mg/L
0.76	0.3125 mg/L

Table 2: Observation after 24 hours.

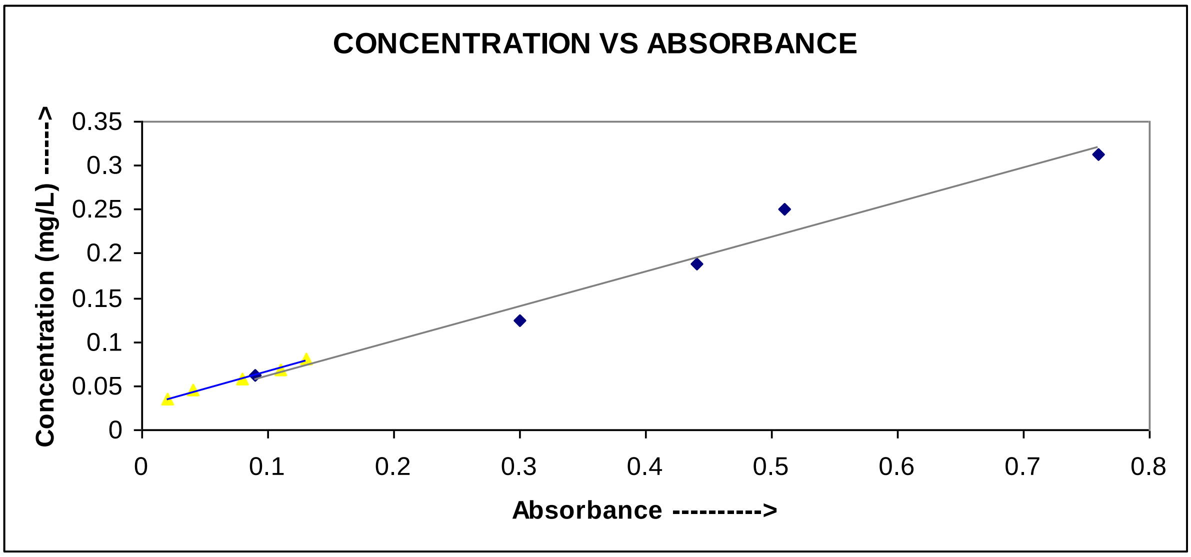
ABSORBANCE	CONCENTRATION
0.03	0.04
0.06	0.05
0.16	0.0875
0.20	0.1025
0.27	0.1275

Table 3: Observation after 48 hours.

ABSORBANCE	CONCENTRATION
0.02	0.035
0.04	0.045
0.08	0.0575
0.11	0.0675
0.14	0.08

Table 4: Observation after 72 hours.

ABSORBANCE	CONCENTRATION
0.02	0.034
0.04	0.045
0.08	0.0575
0.11	0.0675
0.13	0.0775



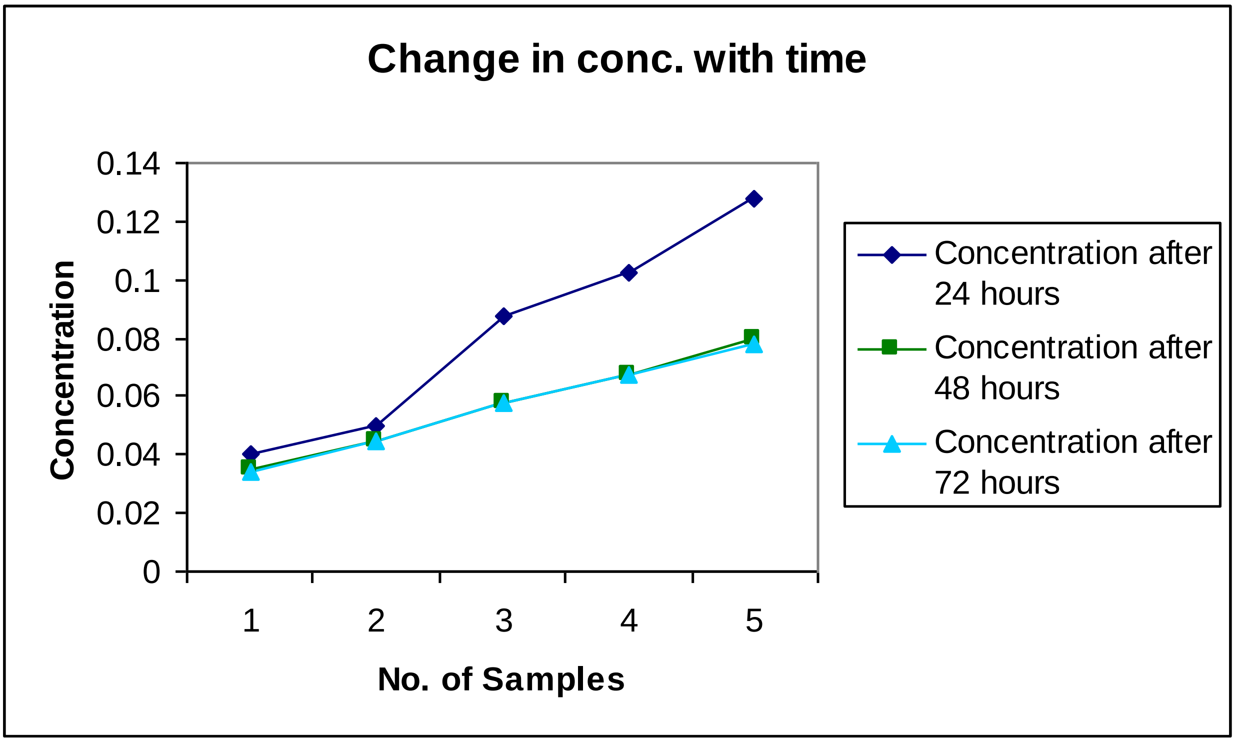


Table 5: Calculation Table 1

Ce	q	1/ce	1/q *10^(-3)
0.034	114	29.41	8.77
0.045	320	2.23	3.125
0.0575	520	17.4	1.923
0.0675	730	18.81	1.37
0.0775	940	12.9	1.063

KINETICS

A study on kinetics of this process was done. After working with several models it was found that this process follows the pseudo second order kinetics with a R^2 value of 0.99. It was found that the adsorption process fits the Freundlich Isotherm.

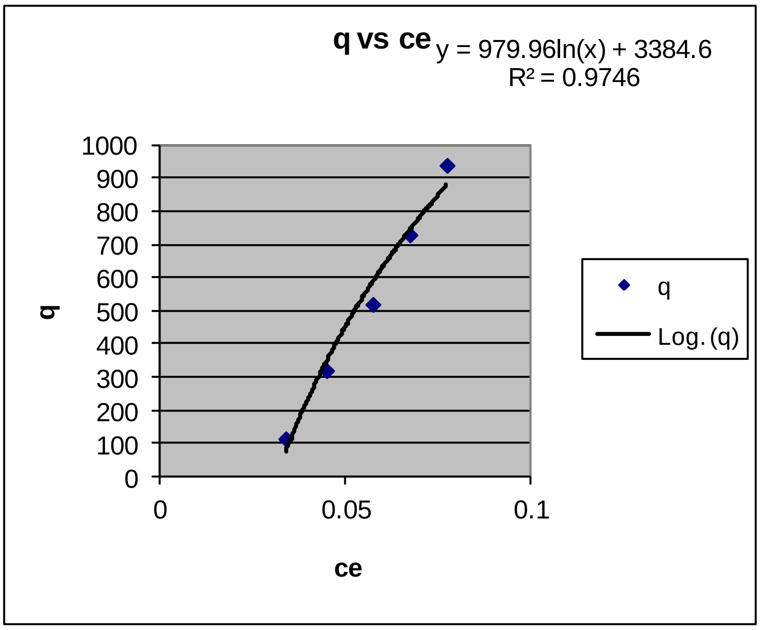
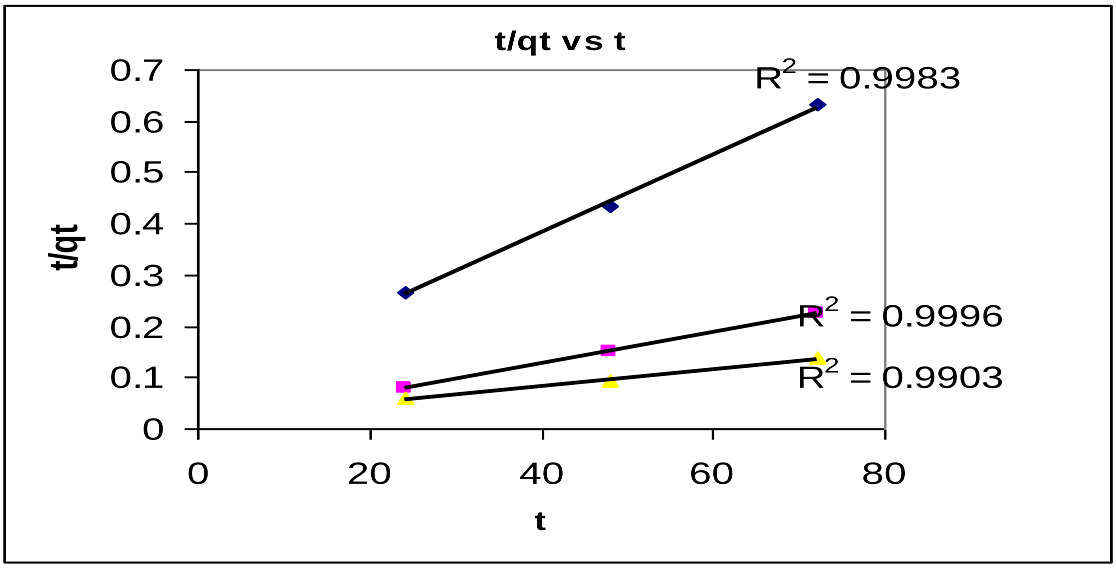
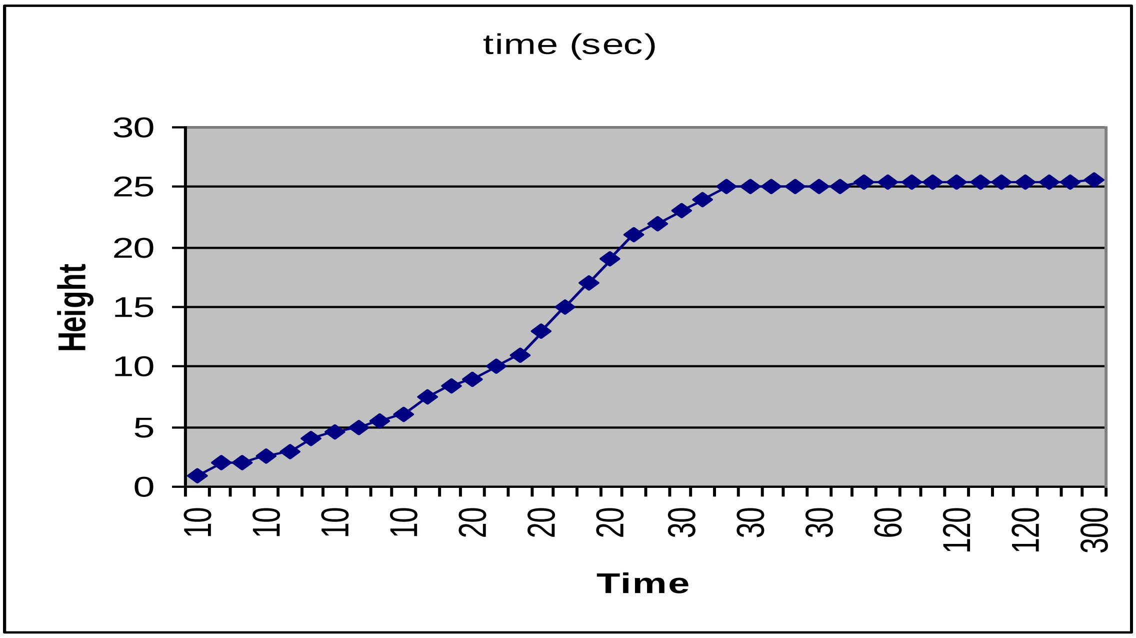


Table 6: Calculation Table 2.

t (time)	t/q_t (at t=24 h)	t/q_t (at t=48 h)	t/q_t(at t=72h)
24	0.267	0.08	0.06
48	0.436	0.15	0.0923
72	0.631	0.225	0.138


t/qt vs t
R2 = 0.9983
R2 = 0.9996
R2 = 0.9903
t/qt
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
t


time (sec)
Height
30
25
20
15
10
5
0
10
10
10
10
20
20
20
30
30
30
60
120
120
300
Time

Conclusion: ~

The study concluded that the cost of the system may be recovered in two years furthermore; Studies by Godfrey et al (2007) indicate a reduction of the number of disability adjusted life years (DALYs) of 10 to 10 based on an improved availability of grey water in schools. This translate to 56 as average life expectancy in MP compared to 80 used global (difference of 24) years. Therefore the system results in10 to 10 (24-12) =12 years of improved a life years. Additionally, the system provides secondary benefit such as improved education, clean environment and time available for other activities. Indirect economical benefits therefore include more assistance children in day to day activity. In this paper an attempt has been made to develop a water regeneration recycle which can minimize freshwater consumption and wastewater discharge to the maximum extent. Various qualitative and quantitative parameters for both raw water and treated water have been compared. The results for treated water are good enough to be directly pumped to the overhead tank for supply to be used. Thus grey water treatment systems can play a very important role in future water management and prospective sustainable living.

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