Domestic Waste Water Treatment using Flyash - A Case Study

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***Abstract*:- Wastewater treatment and disposal is a serious issue and need attention for protecting the environment. Over the recent years, fly ash has been experimented as an adsorbent for the waste water treatment plants. The abundant availability, high carbon content and adsorption characteristics of fly ash lead to application in waste water treatment methods. In this study, experiments were carried out using fly ash as adsorbent in domestic sewage water treatment. A filter media was prepared with pebbles, sand and fly ash with different thickness, characterized and used for the removal of impurities. The physio-chemical properties of waste water before and after treatment were examined. The experimental results showed significant reduction in the values of BOD from 385 mg/l to 45-55 mg/l, COD from 680 mg/l to 110-150 mg/l, pH from 8.4 to 6.9 and TDS from 715 mg/l to 250-300 mg/l after treatment. Beneficial effects of fly ash utilization as adsorbent was observed for removing various impurities present in wastewater.**

Keywords: Wastewater -Treatment and Disposal - Adsorbent -Fly ash Utilization

INTRODUCTION

Water is a vital component for all known forms of life to be able to survive. Water covers about 71% of earth surface, and is a valuable resource of the earth. There is earth is composed of approximately 30 percent of the world's fresh water is in liquid form and therefore potentially accessible for human use such as drinking to prepare food, washing clothes, and necessary functions which water is a major component. Waste water treatment is the process of converting wastewater (water that is no longer need) into bilge water that can be discharged into the environment. The physio-chemical properties of waste water before and after treatment were examined and reported in this study. Grey water is the water that goes down the drain from a laundry machine, bathroom sinks, shower, tub, and dishwasher. Grey water may have soaps and some minor amounts of biological, but nothing serious. Some consider the kitchen sink to be grey water, while others view it as black water because of the high organic potential, so keep that in mind. Greywater is not clean drinking water, and it is not black water, which is anything that has faces or sewage in it.

Fig 1 Grey Water Sample

Research by the Water Resources Research Center calculated that grey water accounts for 60-65 percent of home water use. By reducing the amount of water leaving our homes and reusing it inside our homes, we can significantly impact our total water consumption. This will more positively impact the environment and save money on your water bills. The objectives of this study are, to reduce the impurities from domestic wastewater by Fly ash use as filter bed. To low cost Filter media is prepared, characterized and used for the removal of impurities such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) from Wastewater.

GENERATION OF WASTE WATER

Approximately 50-70% of the water used in your house results in grey water generation and not even 5% of this is recycled in urban households. Here we see about the various sources of generation of grey water used in this project.

GREY WATER FROM KITCHEN SINKS

Kitchen sinks are the source of a fair amount of water, usually very high in organic matter (food, grease, etc.). Kitchen sinks are not allowed under many grey water codes, but are allowed in some states of foreign countries. This water will clog many kinds of systems. To avoid clogging, we recommend using a branched drain system with mulch basins, organic matter collects in the woodchips and decomposes. Since bathroom sinks don't typically generate much water, they can often combine flows with the shower water. Or, the sink water can be drained to a single large plant, or divided to irrigate two or three plants.

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GREY WATER FROM WASHING MACHINES

Washing machines are typically the easiest source of grey water to reuse because grey water can be diverted without cutting into existing plumbing. Each machine has an internal pump that automatically pumps out the water- you can use that to your advantage to pump the grey water directly to your plants.

CHARACTERISTICS OF DOMESTIC WASTE WATER

Table 1 Typical characteristics of Domestic Waste water

PARAMETER	UNIT	DOMESTIC WASTE WATER
Ph	mg/l	6.5-8.5
Suspended Solids	mg/l	90-400
BOD	mg/l	150-400
COD	mg/l	260-900
TDS	mg/l	200-1000
Oil & Grease	mg/l	10-12
Total Phosphorous	mg/l	5-30
Total Nitrogen	mg/l	40-50

REUSE OF GREY WATER

The reuse applications for grey water are Watering Gardens, Fire Hydrants, Field Irrigation, Toilet Flushing and Cooling Tower makeup.

Grey water treatment and reuse is seldom in practice and not certainly to its potential values in considering the water sources. With growing demand for secondary uses like washing, gardening, ground water recharging etc. grey water can be segregated using dual-piping practice and its treatment and reuse will bring the stress on water sources in all populated domestic locations.

GENERATION OF FLYASH

Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately ignites, generating heat and producing a molten mineral residue. Boiler tubes extract heat from the boiler, cooling the flue gas and causing the molten mineral residue to harden and form ash. Coarse ash particles, referred to as bottom ash or slag, fall to the bottom of the combustion chamber, while the lighter fine ash particles, termed fly ash, remain suspended in the flue gas. Prior to exhausting the flue gas, fly ash is removed by particulate emission control devices, such as electrostatic precipitators or filter fabric bag houses (see Figure 2.1).

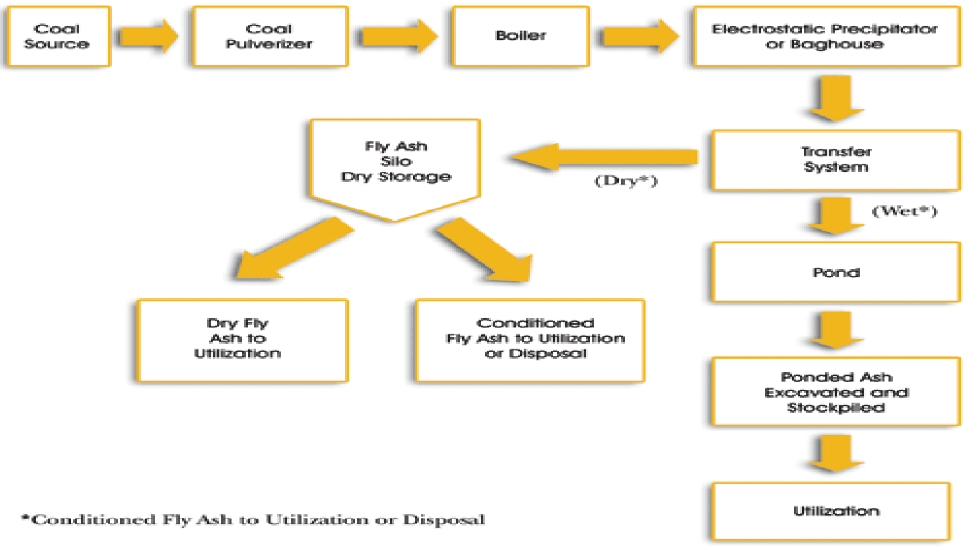

Fig 2 Generation of Fly ash method

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CHEMICAL COMPOSITION	MASS FRACTION
SiO2	56.6
Al2O3	33.71
CaO	1.07
Fe2O3	3.97
Na2O	0.16
MgO	0.42
SO3	0.18

Table 2 Chemical composition of Fly ash Used given below

LITERATURE REVIEW

Syed Farman Ali Shah et al (2015) had conducted experiment in wastewater treatment using bed of coal fly ash for dyes and pigment industry. The treatment bed comprises of briquettes of coal fly ash coupled with commercial coagulant ferrous sulphate lime reduced COD, color, turbidity and TSS of effluent remarkably. In coagulation treatment, coagulant FeSO4- lime influenced reduction of COD, color, turbidity and TSS by 32%, 48%, 50%, and 51% respectively. The CFAB coupled with coagulant, resulted an excessive removal of color, TSS, COD, and turbidity by 88%, 92%, 67%, and 89%. **Dr. Pankaj Singh et al (2014)** studied domestic wastewater treatment using fly ash alone and in combined form. This study reports the use of fly ash alone and in combined state in different ratios with wood ash for the treatment of domestic laundry wastewater. Effect of various parameters such as combination ratio of fly ash and wood ash, contact time, adsorbent design and particles of adsorbent have been studied. It is found that TSS reduced from 350ppm to 15-20ppm, BOD from 250 ppm to 10-20 ppm and pH dropped from highly alkaline range in 8.5-9.5 range.

Sandeep Thakur, et.al., (2013), reported to reduce surface and ground surface water use in all sectors of uses and to substitute fresh water with alternative resources. The author suggested that Grey water recycling is the variable option that can be very useful in the water arid areas. **Ukpong EC, et. al. (2012)**, reported the design and construction of a filter for greywater reuse for irrigation of not less than one hundred household. Laboratory tests were conducted on these samples and they revealed the presence of BOD, TSS, nitrate pH, coli form etc., whose values were compared with that of the parameters for standard irrigation water. The author suggested that the efficiency of the slow sand filter in the reduction and all the parameters were high due to their tangible nature which enables them to succumb surface forces of the filter media. **Bhausaheb l, Pangarkar, et.al, (2010)** investigated the economical performance of the plant for treatment of bathrooms, basins, and laundries grey water showed in terms of deduction competency of water pollutants such as COD (83%), TDS (70%), TSS (83%), Total hardness (50%), oil and grease (97%), anions (46%) and captions (49%). The author suggested that the technology could be a good alternative to treat grey water in residential rural area.

MATERIALS AND METHODOLOGY

Fly ash

Fly ash is collected from Neyveli Lignite Corporation (NLC).This material is easily available in all thermal power stations. For preparing filter bed with Fly ash it can be sieved through 90 micron sieve. Fig shows 3.1 are the sieved material of fly ash.

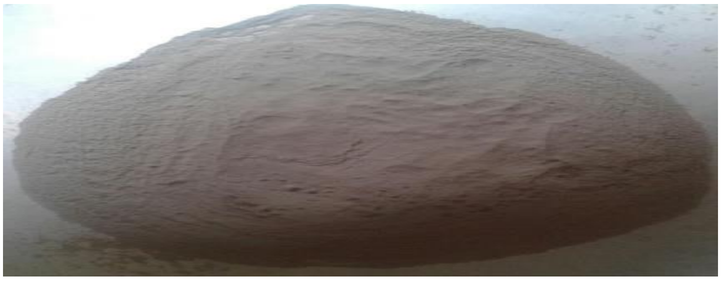

Fig 3 Fly ash sieved through 90micron sieve

Effluent

Waste water was collected from home in kitchen sinks and washing clothes. The sample were collected periodically thrice in a week for a month for this study. It as high concentration of COD, TSS, TDS, pH and the dissolved oxygen level (DO) would be very low.

Fig 4 Collected waste water

Sand

River sand was used in this study to prepare the sand bed in the filtration tank. The river sand was sieved through 2.36 mm sieve before application.

Pebbles

Pebbles are generally considered larger than granules and smaller than cobbles. In this study small size (maximum 10 mm) pebble were used in the filter media. The pebbles were washed with distilled water and dried.

EXPERIMENTAL METHOD

Treatment of Grey water carried out in the laboratory using a reactor make up of two containers of 2 Litre capacities placed one above the other with a filter mesh of less than 0.0001 micron size. Fly ash, sand, pebbles are filled in the filter media for treating the grey water.

Fig 5 Fly ash Filter Setup

PREPARATION OF ADSORBENT

The fly ash was conditioned by washed through distilled water to remove the unstable or water-soluble particles present in it. After washing, the fly ash was allowed to dry in room temperature followed by vacuum desiccator for a day. After this process the dried fly ash was sieved through 900 µm sieve and used in the filter bed.

FILTERATION PROCESS

Initially, the filter bed cleaned well. Fly ash is sieved in micrometer sieve and taken up. The pebbles which are lying in the bottom layer should be wasted with distilled water and dried in the sunlight for few minutes. The river sand taken is sieved in 2.45 micrometer. The untreated effluent should be tested to get initial readings of COD, DO, TSS, TDS and pH. First the bed of 40 mm is made and the laying bottom layer with pebbles then layer of fly ash and top layer is of sand each layer has 40mm thick. Then the effluent is poured into the bed. After 24 hrs left, it has been tested. The tests are determination of COD, DO,

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TSS, TDS and pH. The same procedure is followed for the consecutive layers (30mm, 20mm, 10mm). Finally the effective thickness in which the fly ash will give better results should be determined.

Fig 6 Filtration process

Fig 7 Grey water sample after filtration

Table 3 characteristics of grey water at various sources

Sl. No	Parameter (mg/l) Except pH	Bathroom	Kitchen
1.	pH	7-7.5	7.5-8.9
2.	TS	600-625	650-1132
3.	TSS	54-64	135-600
4.	TDS	275-900	300-850
5.	BOD	125-190	75-1250
6.	COD	225-350	250-600

The following tests were conducted on the sample to know the physical and chemical properties of the grey water.

Chemical Oxygen Demand

The 20 ml of waste water is taken in 500 ml round bottom end flask. Add H_2SO_4 and few glass beets followed by 20 ml of 0.1 N potassiumdichromate solution add slowly 10 ml of conc. H_2SO_4 + Ag_2SO_4 reagent and mix thoroughly. The flask is fitted with a reflux water condenser and the mixture is refluxed for 2 hours. The mixture is transferred to a conical flask, diluted to 100 ml and 5 drops of ferrite indicator is added. The nonreactive dichromate is titrated against standard ferrous ammonium sulphate taken in the burette till the color changes to the blue green to red brown.

Total Suspended Solids

Take the empty crucibles and clean it thoroughly, make itperfectly dry. Take the weight of the empty crucible say W1, W2. Take sample 1 and 2, 10 ml without filtered in crucible W1 and filter the sample with filter paper no.44 respectively in the crucible W2. Dry the crucible in the muffle furnace at the temperature of 105°C till the crucible gets complete dry and cool. Weight the crucible and record the crucible weight as W3 and W4 and calculated.

Total Dissolved Solids

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pH

Wash the combined electrode of pl meter with distilled water and clean the same with distilled water. Dip the combined electrode in the buffer solution of pH value 4.02. Adjust the temperature by the adjustment knob to an ambient (room) temperature. If the instrument shows the reading as 4.02 then it is in order if not, adjust the reading to 4.02 by calibration adjustment knob. Wash the electrode of pH meter with distilled water and clean the same with distilled water and

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dip it to the buffer solution of pH value 9.12. Note the reading if the instrument shows the reading as 9.12 then it is in order otherwise uses the calibration adjustment knob and bring the reading to 9.12. Repeat the above procedure until the meter shows reading as 4.02 when electrode is dip in buffer solution of pH 4.02 and shows reading as 9.12 when electrode is dip in buffer solution of pH value 9.12. 6. Now the instrument is calibrated. Dip the electrode into the sample solution, stir the solution and wait up to 1 minute for steady reading. Directly record the reading from the meter without doing any adjustments.

RESULTS AND DISCUSSION

The experimental results were presented in table 4. Comparison among the pretreated and treated domestic waste water were presented in the following paragraph.

Table 4 Physio-chemical properties of Treated and
Pre-treated waste water

Parameter	Pre-treated water quality	After treatment			
		10 cm	20 cm	30 cm	40 cm
COD	300	80	140	200	250
TSS	2000	700	800	1313	1500
TDS	3500	80	200	750	1000
pH	7.58	5.6	6.7	7.02	7.33

Removal of COD from the waste water

Chemical oxygen demand is a measurement of the oxygen required to oxidize soluble and particulate organic matter in water. Before treatment the level of COD is above than permissible limit 300mg/l. After treatment, the CODvalue decreased to a 80 mg/l in the thickness of 10 mm. It is clear that the effective thickness is 10-20 mm as shown in Fig 8.

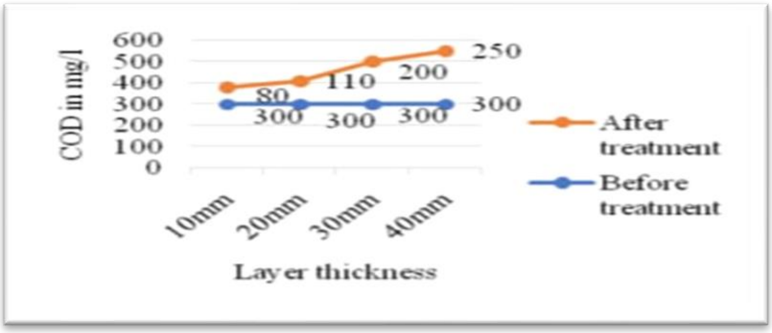

Fig 8 Amount of COD before and after treatment

Removal of TDS from the waste water

The term total dissolved solid refers to materials that are completely dissolved in water. These solids are filterable in nature. Estimation of total dissolved solids is useful to determine whether water is suitable for drinking purpose , agriculture and industrial purpose. Before treatment the level of TDS is above than permissible limit 2000mg/l. After treatment, the TDS value decreased to a 700 mg/l in the thickness of 10 mm. It is clear that the effective thickness is 10-20 mm as shown in Fig 9.

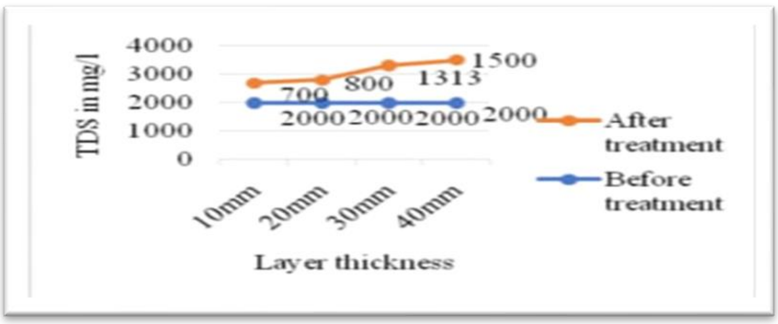

Fig 10 Amount of TDS before Treatment and after treatment

Removal of TSS from the waste water

The term total suspended solids refers to materials which are not dissolved in water and are non filterable in nature. It is defined as residue upon evaporation of non-filterable sample on a filter paper. In industries, use of water with high amount of dissolved solids may lead to scaling in boilers, corrosion and degraded quality of product. Before treatment the level of TSS is above than permissible limit 3500mg/l. After treatment, the TSS value decreased to a 80 mg/l in the thickness of 10 mm. It is clear that the effective thickness is 10-20 mm as shown in Fig 11.

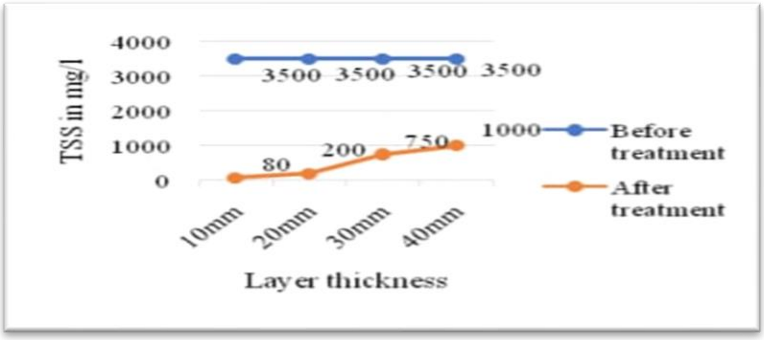

Fig 11 Amount of TSS before treatment and after treatment

Reduction of pH content of the sample

Reduction of pH level in the consecutive layers as shown in Fig 12.

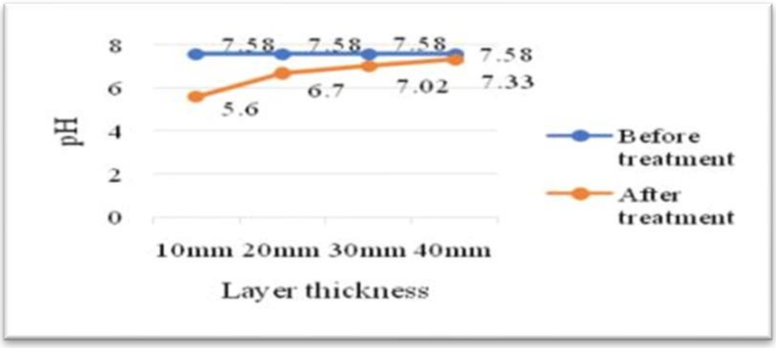

Fig 12 pH content before and after treatment

CONCLUSION

Coal fly ash bed is an inexpensive and effective for removal of COD, TSS, TDS and pH reduction due to its high porosity and adsorption capacity. Fly ash is available in abundance at coal fed electric power plants can be effectively used for treatment of wastewater. When fly ash is used as filter bed of 10mm, 20mm, 30mm, and 40 mm thickness, the parameter value is reduced to great extent from initial value in 10-20 mm thick. It is concluded that the fly ash is better option for the treatment of waste water treatment. The obtained result values are within the permissible limits. Environmental pollution issues can also be minimized by using coal fly ash bed in waste water treatment.

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