IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 11, Issue 3 Ver. III (May. – Jun. 2016), PP 34-39
www.iosrjournals.org

Domestic Waste Water Treatment Using Fly Ash Alone or in Combined Form

Dr. Pankaj Singh[1], Pooja Tripathi[2], Shubhra Chauhan[3], Dr. Arti Mishra[4]

[1]Professor & Head, Department Of Civil, Accurate Institute Of Management & Technology, Greater Noida, U.P., India
[2]Research Scholar,Department Of App .Sc., Mahatma Gandhi Viswavidyalaya, Chitrakoot, M.P.,India
[3]Research Scholar, Department Of App. Sc., Mahatma Gandhi Viswavidyalaya, Chitrakoot, M.P.,India
[4]Assistant Professor,Department Of Chemistry, Kanoria P.G.Mahila Mahavidalaya, Jaipur, India

Abstract: *Fly ash and wood has been separately studied for their adsorption properties. A lot of work has been reported on the adsorption and other construction related uses of fly ash. But a little or no work so far has been reported for the use of fly ash for the treatment of domestic laundry waste water. The present study reports the use of fly ash alone and in combined state in different ratios with wood ash for the treatment of domestic laundry waste water. Effect of various parameters such as combination ratio of fly ash and wood ash, contact time, adsorbent dosage and particle size of adsorbent have been studied. It is found that TSS(total suspended solids) is reduced from 350 ppm to 15-20ppm, total BOD from 250ppm to 10-20 ppm and pH dropped from highly alkaline range to 8.5-9.5 range, reduction of 80% in total soap content, FOG(fats, oils and grease)from visible turbid level to non turbid and clear solution. It is also reported here that for efficient treatment of domestic wash water waste adsorbent dosage of 40g/L is recommended.*

Key words: *fly ash, wood ash absorption & adsorption, laundry waste water*

I. Introduction

In general domestic waste water includes black water (fecal sewage) and grey water (wash water from dish washers, washing machines sinks and bath tubs etc.). Black water accounts 32.5% of domestic waste water while grey water accounts for 67.5%. Domestic waste water is categorized as organic pollutant. Laundry waste water contains substances mainly from three sources

- Substances from raw water (tap, well etc.) -- Salts
- Detergents – sulphates, phosphates silicates etc
- Dirt from clothes –particles, fats oils, colour, metal, threads and linters etc

Some additional ingredients like fragrances, coloring agents, herbal compounds, bleach, fabric softener, antiredeposition agents to prevent soil redeposit ion on the clothes are also common.

The domestic sewage is found to have composition as shown below in table 1 Typical pollutant composition of domestic sewage

Pollutant	Measurement(mg/L)
Total suspended solids	200-300
5 Day biological oxygen demand(BOD5)	200-250
Chemical oxygen demand (COD)	350-450
Total nitrogen as N	25-60
Total phosphorus as P	5-10
Fats, oils and grease	80-120

Source: CEP Report No.40, 1998 p-8

Fats, oils and grease (FOG) as well s total suspended solids are major concern .These impurities are derived from the solids which are removed from the clothing as well as chemicals which are used for the manufacture of laundry soaps and detergents.

A measure of organic water quality contamination is its BOD. Most municipalities have set limits of BOD between 300-350ppm and FOG limit between 100-150ppm.Undissolved or insoluble matter, floating or suspended in water imparts a cloudy or turbid appearance to it and is referred to as TSS. High TSS is also responsible for the growth of harmful bacterias and pathogens as they attach themselves to the suspended particles and are not readily disinfected. Therefore treatment of domestic waste water is necessary. A lot of work has been reported on the waste water treatment [1-5]. A basic problem persists with all these sewage treatment plants and that is their high expertise, high running and mentainence cost. So there is a need for some cost effective substance to treat domestic wash water at small scales.

Fly ash which has been widely studied for its adsorption properties and is available in plenty in India from coal fired power plants can be employed for the purpose of treatment of domestic wash water. Present study is aiming towards the use of fly ash and wood ash as a potential domestic wash water treatment substance. India produces about 70 million tons of coal ash per year from burning of 200 million tons of coal for electric power generation. Fly ash has been widely used in road construction [6-9], concrete manufacture [10-12] and as a replacement of Portland cement [13-14] due to its pozzolanic properties. Fly ash also finds use in the soil development. Due to its highly porous, soft and absorptive nature fly ash also find use in various surface applications. It has been successfully used for the adsorption of gases [15-17], Dyes [18-19] and metal ions [20-23]. Fly ash has also been widely used in zeolite preparations for their micro porous structures. Present study is taken because there is only a little or no work done on the treatment of domestic grey water. Domestic grey water treatment should be done by a low cost adsorbent and fly ash and wood ash both are cost effective adsorbents available in plenty.

II. Materials And Method

Fly ash used in the present study is procured from NTPC Rihand UP. Wood ash is procured from a local nearby village. Fly ash and wood ash obtained are ground and sieved using different meshes after the preliminary treatment as described below and stored in labeled and air tight containers. These are taken as and when required. All the studies are performed in batches using 250ml borosil conical flasks.

2.1 Preparation of adsorbent

Both the fly ash and wood ash are washed with doubly distilled water to remove any contamination and dried at 110 ^{0}C for 5 hours separately. Both the fly ash and wood ash are treated with conc. H_2SO_4 in 1:1 weight ratio and is kept in an oven at a temperature range of 150 ^{0}C for 24 hours. The ashes are again washed with doubly distilled water to remove free acid and dried in an oven. Wash water waste (grey water) is obtained from the home of researcher. Wash waters used for the study are taken from the washing machine and dish washer.

2.2 Batch studies

Wash water is first allowed to stand undisturbed for 24 hours so that the large and particulate impurities may settle down and then decanted. Decant is then filtered through an ordinary sieve to remove any suspended particulate impurity which may other wise cover and block the active adsorption sites of the adsorbents.

The experiments are carried out in 250 ml borosil conical flasks maintained at 25 ^{0}C in thermostat fitted with a shaker. Each time 50 ml of wash water is taken and weighed amount of adsorbent is added to it. The solution is kept for 7 hours because the studies have shown that no considerable adsorption takes place after 7 hours.

Two parameters are used to judge the soap content in the waste water

(a) pH of the solution

(b) Total alkali content as the basis of estimation of total soap content by titrating the solution against standard 0.5 N HNO_3 .

Both the parameters are measured before and after the treatment (adsorption on adsorbent) and difference between the two values are taken as the removal efficiency of the adsorbent.

Removal efficiency is expressed in percentage by using a simple formula

% fall in pH = pH_1-pH_2 /ph_1 ×100

% fall in total soap content= Soap $content_1$ – soap $content_2$/ Soap content $_1$ ×100

% fall in BOD5 = BOD_1-BOD_2/BOD_1 × 100

% fall in TSS = TSS_1-TSS_2 /TSS_1 × 100

Where subscript 1 and 2 are the measurements before and after the treatment of wash water respectively.

III. Results And Discussions

3.1 Effect of adsorbent when used in different ratios with wood ash.

A 100 ml of pretreated waste water (discussed in sec 2.2) is taken into 250 ml borosil conical flask and weighed amount of adsorbents in fixed ratios is added. The flasks are kept in a thermostat at 20 0C fitted with a mechanical shaker for 6 hours to reach the equilibrium. An Adsorbent dose of 40g/L has been added in different ratios. The results are shown graphically in fig1

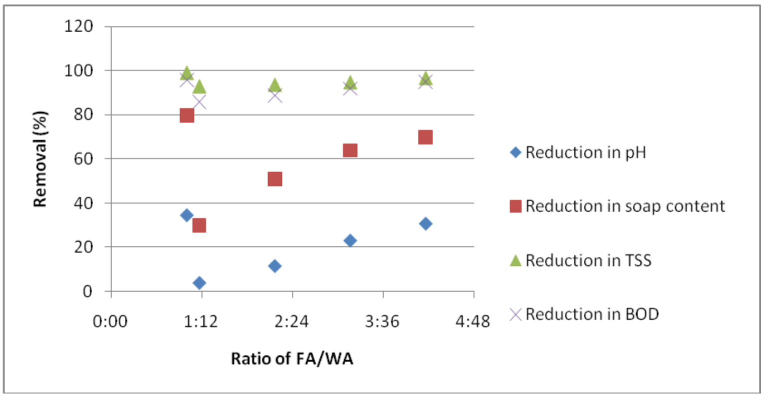


Fig.1 Effect of ratio of fly ash and wood ash on the removal percentage.

It can be easily concluded form the figure that increasing the ratio of wood ash in the adsorbent does not increase the fall in pH considerably so we can say wood ash is not good adsorbent as far as pH is concerned. Soap content again is not adsorbed by the wood ash considerably and therefore use of wood ash can not be recommended for the removal of soap from the waste water. Reduction in the TSS and BOD are fairly good for wood ash also. The reason for such observation could be that small particular size and porosity of fly ash is greater for fly ash as compared to wood ash. Also fly ash is rich in SiO_2, Al_2O_3 and Fe_2O_3 with high surface area proves to be an excellent adsorbent [20, 24]. Fly ash in pure is taken to carry out the further studies reported in the present paper.

3.2 Effect of contact time

Keeping the adsorbent dose and amount of wash water waste constant contact time have been varied. The samples are taken out for estimation of pH, TSS BOD and soap content after every hour till no change in all these parameters is observed. It has been noticed that rate of adsorption is higher at the beginning and then slows down and reaches a constant value after 6 hours. This may be due to the availability of more adsorption sites in the beginning which than goes on decreasing with the time resulting in decreased rate of adsorption. Therefore it can be concluded that6-7 hours are enough to attain the equilibrium. The results are shown graphically in fig2

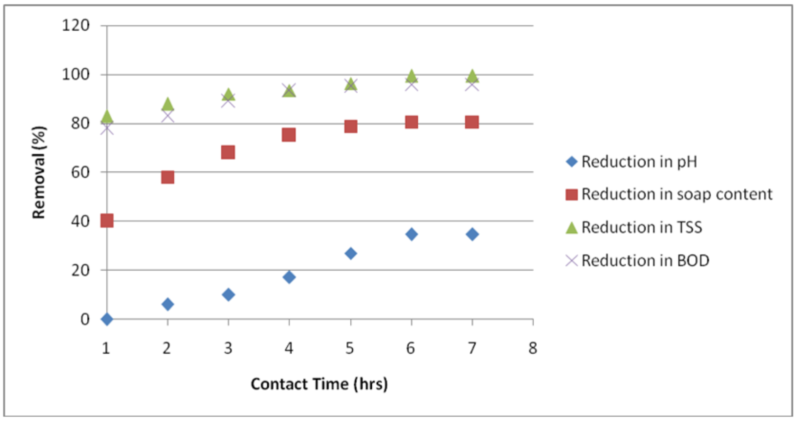


Fig.2 Effect of contact time on the removal percentage

3.3 Effect of particle size

Particles of an adsorbent play an important role in the adsorption and removal of contaminants from wash water waste. In the present study sieves of different numbers available commercially are used. The sieve number and approximate size of the particles are given in table 1 below.

Mesh no.	80	100	120	140	200	230	270	325
Approx. size of particles (μm)	44	53	62	74	105	125	149	177

In the present study sieves of mesh number 80, 100,120,140 and 200 are used. Fly ash after sieving through the mentioned sieves has been stored separately in air tight containers. The results obtained are shown graphically in fig 3. It is observed that pH is not affected much by the change of size of particles. TSS is effected most as finer the size of particles better will be the adsorption of contaminants on it. Soap content also showed increased removal percentage with decrease in the size of adsorbent particles. Soap content is related to the long chains of fatty acids which gets adsorbed on to the particles of the adsorbent and thus gets removed from the solution. With the decrease in the particulate size number of active adsorption sites increase and higher removal percentage of contaminants is observed. Results are shown in fig 3

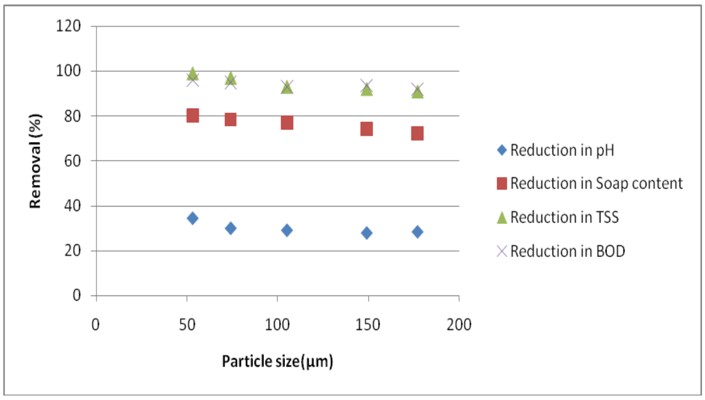


Fig 3. Effect of particle size of adsorbent on the removal percentage.

3.4 Effect of adsorbent dosage

Amount of adsorbent affects the removal percentage of contaminants to a large extent. With the increase in the adsorbent dosage fall in the pH, BOD, TSS and soap contents of the wash water waste also increased. This behavior is observed due to the fact that more the number of adsorption sites more will be the adsorption of contaminants. It has been observed that for an optimum treatment of domestic wash water waste 40g/L of the adsorbent is enough. The results are shown graphically in fig 4.

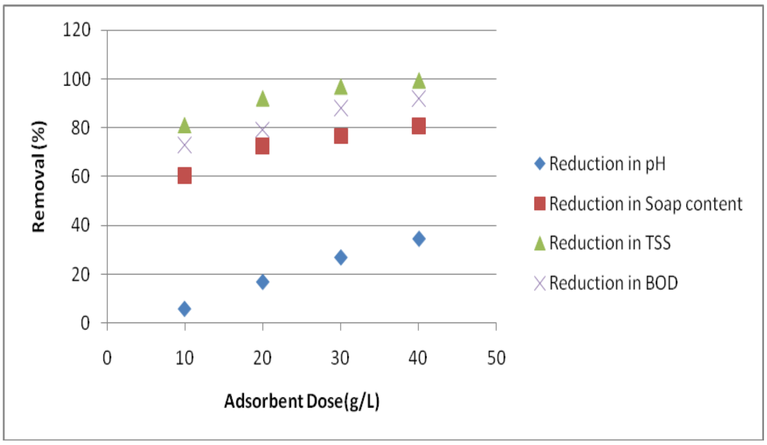


Fig.4 Effect of adsorbent dosage on removal percentage.

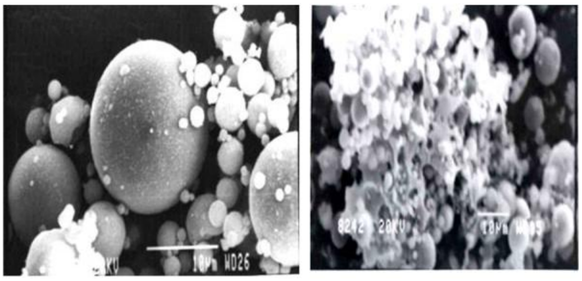
3.5 Mechanism of adsorption

Since fly ash consist of metal oxides like, large surface areas and high porosity [24],t these features are expected to increase the adsorption on the fly ash. Fly ash also consists of hollow particles called cenospheres [25] which holds the small contaminant particles which are thus removed from the solution. This phenomenon is expected to be responsible for the fall in TSS, BOD and soap content from the solution.

Fly ash is primarily composed of aluminosilicates glass, mulite ($Al_6Si_3O_3$) and quartz (SiO_2). These materials are chief components of commercial zeolites used for waste water treatment [20]. Low Si/Al ratios as in zeolites are excellent sorbents for their high cation exchange capacities and large pore volumes. Alumina and silica of fly ash act as active adsorbents and remove contaminants from the aqueous solutions.

Soaps and detergents mainly consist of long organic fatty acid chains (hydrophobic end) and a cation generally Na or K or any other alkali or alkaline earth metal.

The organic fatty acid part must be getting adsorbed on to the active sites on quartz, alumina and mullite [22-24] of fly ash and the metallic cations must get adhered to the cenospheres [25]. SEM pictures of raw fly ash and fly ash with adsorbate particles on as shown below also indicates the same.



SEM microgram of adsorbed Fly ash

IV. Conclusion

Fly ash which is available in abundance at the coal fed electric power plants in abundance can be efficiently used foe the treatment of domestic wash water waste. Fly ash when used in combination with wood ash did show much improvement in the adsorption properties. It is therefore concluded that fly ash is a better option for the treatment of domestic wash water treatment. An ideal dosage and time for the treatment of domestic wash water waste is 40g/L and 6 hours. A considerable reduction in the TSS, BOD, Soap content and pH has been seen in the treated water.

References

[1]. Kadam,A.; Ozha,G.; Nemade,P.; Dutta,S.; Shankar,H.S. (2008). Municpal waste water treatement using novel constructed soil filter system. Chemosphere(elesevier) 71(5) 975-981.

[2]. Nemade,P.; Kadam,A.M.; Shankar,H.S.(2009). Waste water renovation using constructed soil filter(CSF) Novel approach. Journal of Hazardous materials(elesevier) 170 (2-3) 657-665.

[3]. Annachhatre,A.P.(2005). Advanced appropriate and affordable technologies for domestic waste water treatment and reuse in tropical regions. Proceedings of UNESCO workshop on integrated water management on humid tropics, Igeusu Falls,Brazil 2-3 April 2005.

[4]. Day,D.K.; Guha,S. (2007). Determination of Community structure through convolution of PLF-FAME signature of mixed population. Biotechnology Bioengineering 96(3) 409-420.

[5]. Tiwari,M.K;Guha,S.;Harendranath,C.S.;Tripathy,S.(2006). Influence of extrinsic Factors on Granulation in USAB Reactors. Applied Microbiology and Biotechnology 71(2) 145-154.

[6]. Hilmi,A. and Aysen,M.(2006). Analysis and design of Fly ash as pavement base material . Fuel 85(16)2359-2370.

[7]. Kolias,S.;Karahalios A.(2005) Analytical Designs of pavements incorporating capping layer of stabilized soil with high calcium fly ash or cement. Proceedings of 1st conference for the utilization of industrial by proucts in building construction. Theisaloniki 37-46.

[8]. Mouratidis,A. (2004). Stabilization of pavements with fly ash. Proceedings of the conference on use of industrial by products in road construction. Theisaloniki 47-57.

[9]. Eskioglou,P.; Oikonomou,N. (2008). Protection of environment by the use of fly ash in road construction. Global NEST journal 10 (1) 108-103.

[10]. Scott; Aallan,N.;Thomas; Micheal, D.A.(2007). Evaluation of fly ash from combustion of coal and petroleum coke for use in concreate. ACI Material journal (American conareate institute) 104(1) 62-70.

[11]. Liu Baoju et al (2000)Influence of ultrafine fly ash composit on fluidity and compressive strength of concrete. Cement concrete research 30 1489-1493.

[12]. Duxon,P. Provis,J.L.;Lukey,G.C. Van Deventer,J.S.J. (2007). The role of inorganic polymer technology in development of green concreate. Cement and concreate research37 (12) 1590-1597.

[13]. Chiana,F.;Ferares; Karthik H.;Obland Russel Hull(2001). Influence of mineral admixtures on rheology of cement Paste conrete. Cement Concrete research 31 245-255.

[14]. Li Yijin, Zou Shiqiong,Yin Jian and Yingli (2002). The effect of fly ash on the fluidity of cement paste, mortar and concrete. International workshop on sustainable development and concrete technology. 339-345.

[15]. Indrek kulatos,Yu Ming Gao,Robert H Hurt and Eric M Suuberg(2001). Adsorption of ammonia on coal fly ash. International ash utilization symposium ,Center for applied energy research, University of Kentucky Paper 59.

[16]. Ling Li, Maohong fan, Rober c Brown,Jacek A Koziel and J (Hans) Van Leeuwan (2010). Kinetics of SO_2 Absorption with fly ash slurry with concomitant production of useful waste water coagulant. J Env Engg 136(3) 308-315.

[17]. Lu,G.Q. and Do.D.D.(1991) Adsorption prperties of fly ash particles for NO_x removal from flue gases. Fuel processing technology 27(1) 95-107.

[18]. Kara, S.;Aydiner,C.;demirbos,E.;Kobya,M.Dizge,N. (1007). Modelling the effect of adsorbent dose and particle size on adsorption of reactive textile dyes by fly ash. Desalination 212 282-293.

[19]. Tabrez a Khan, Imran Ali, Ved Vati Singh and Sangeeta Sharma (2009). Utilization of fly ash as low cost adsorbent for the removal of methylene blue, malachite green and rhodamine B from textile waste water. Journal of Environmental Protection Science 3 11-22.

[20]. Woolard,C.D. ;Petrus,K. and M van der Horst (2000). The use of a modified fly ash as an adsorbent for lead. Water SA 26(4) 531-536.

[21]. Wang,S.; Li and Zhu, J (2007). Solid state conversion of fly ash to effective adsorbent for Cu removal from waste water. J Hazard mater. 139 (2) 254-259.

[22]. Alinnor,I.J.(2007). Adsorption of heavy metal ions from aqueous solutions by fly ash. Fuel 86(5-6) 853-857.

[23]. Tabrez A Khan, Imran Ali and Ved Vati Singh (2009). Sorption of Cd(II), Pb(II), and Cr(VI) metal ions from waste water using bottom fly ash as low cost sorbent. Journal of Environmental Protection Science 3 124-132.

[24]. Shakhapure,J.; Vijayananda,H.; Basavaraja, S.; Hiremath,V.; Venkatraman,A.;(2005). Uses of αFe_2O_3 and Fly ash as solid adsorbents. Bull.Mater. Sci. 28(7) 713-718.

[25]. Shigemeto,M.; HayasgiH and Miyaura,K. (1993). Selective formation of Na-X Zeolite from Coal fly ash by fusion with Na prior to hydrothermal reaction. Environ. Sci. Technol.29 1748-1753.