Novelty Journals

ISSN 2394-7349

International Journal of Novel Research in Engineering and Science
Vol. 3, Issue 2, pp: (53-58), Month: September 2016 - February 2017, Available at: www.noveltyjournals.com

Effect of Activated Charcoal and Fly Ash on Spent Wash Quality

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Abstract: **Adsorption treatment of distillery effluent has great potential as a sustainable method as it is a low cost method. The aim of this investigation is to study the treatment method for purification of distillery spent wash by using Activated charcoal and Fly ash. For this, the study encompassing evaluation of reduction of various physical chemical parameters (color, odor, pH, COD, TS, TDS, Ca, Mg, Na and K) of distillery spent wash was checked by passing through the columns of Activated charcoal and Fly ash. The distillery effluent was acidic (pH 4.7) and dark brown in color which often cause psychological fear in farmers for utilization. Activated charcoal treatment of spent wash exhibited good reduction in COD, TS, TDS, Mg, Na, Ca, after 72 hour treatment and increase in pH toward pH 7 followed by Fly ash. Treated spent wash induced a good growth of wheat seeds and this method can be used for purification of industrial spent wash at commercial level.**

Keywords: **"Spent wash", "Absorbent", "Fly ash", "Activated charcoal", "Chemical parameter", "Irrigation".**

1. INTRODUCTION

Increasing industrialization and ever increasing population is damaging the environment same is done by the disposal of untreated effluents. Various pollutants produced in industries directly or indirectly are accumulating in our environment. These pollutants cause severe degradation in pedosphere, hydrosphere, atmosphere and thus causing a potential menace to the health and welfare of mankind.

Wastes generated from various industries include the effluents from textile, chemical fertilizers, pulp and paper, petro chemical and breweries, metal processing, automobile manufacturing, power–plant including leather and tannery industries and thermal and nuclear power plant etc.

Improper disposal methods and inadequate treatment of toxic constituents from different industries have led to the widespread contamination of surface and ground waters and have made the water resources unfit for usage. Hence there is an urgent need for waste water treatment.

Environmental pollution by distillery industry has recently been the subject of much research. Distillery waste is one of the major wastes of ecological concern. It is a complex, caramelized and recalcitrant waste containing high percentage of organic matter and heavy metal ions (Nemade and Shri vastava, 2000). This causes pollution in receiving waters as well as in land.

To safeguard humanity, we require conductive and congenial environment for which the industrial pollution need to be minimized substantially. To achieve this, several physical, chemical and biological methods/techniques have been developed and being practiced in very few industries along with distilleries (Lin et al 2003). The reason of limited scope of these techniques lies with their adhered economical solution of the pollution abatement problems, adsorption treatment has been one of the cost effective method and being practical unintentionally during crop irrigation. Once the industrial

effluent is suitably treated, it could be applicable for crop irrigation. The application of effluent to short rotation forestry crop is a treatment system which if properly designed and maintained could both increase the productivity of the crops and reduce the waste disposal problem (Sims and Riddell 2001). Keeping this in view, the present study therefore is planned to investigate the land treatment of distillery effluent with following objectives

1. To characterize physico-chemical characteristics (pH, Color, Odor, COD, TS, TDS, Na, K, Mg, and Ca) of distillery spent wash.
2. Effect of Different Textures of Activated Charcoal and Fly ash on Physico Chemical Characteristics of Distillery Spent Wash.

2. ACTIVATED CHARCOAL

Activated charcoal, also called active carbon, is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption. Activated is sometimes substituted with active. Activated charcoal is commonly used on the laboratory scale to purify solutions of organic molecules containing undesired colored organic impurities also used in sugar industries for color removal.

3. FLY ASH

Ash produced in small dark flecks by the burning of powdered coal or other materials and carried into the air is known as fly ash. It is mostly produced from thermal power plants.

4. MATERIAL AND METHODS

4.1 Sample collection:

Effluents waste water (spent wash) was taken from a distillery, located in Dehradun. The factory uses molasses as the raw material. Samples were collected at main outlet of distillery in the first week of November 2016. Samples were collected five times at weekly from November to December 2016 in clean sterile plastic container and stored at 4^{o}C in a refrigerator.

4.2 Research Design:

Twelve plastic pots were filled with 2 kg soil in each, and wheat was grown (Triticum aestivum) Variety UP 2329 .After 20 days of growth, three pots of each group were irrigated with 72 hour, 48 hour and 24 hour treated spent wash respectively and the 4^{th} pot of each was used as control. On each irrigation date 500 ml of treated effluent (24 hour treated, 48 hour treated and 72 hour treated) was poured in each pot as previously discussed. Same time treated samples were collected in sterile reagent bottles for physical and chemical tests and stored at 4^{o}C.

Twelve columns of activated charcoal, fly ash and activated charcoal + fly ash (1:1) were prepared for treatment of distillery spent wash as follows:

Table: 1.1 Designs of Columns of Activated Charcoal, Fly ash and Activated Charcoal + Fly ash (1:1)

Columns filled with	Set-1	Set-2	Set-3	Set-4
	(24 hr treatment)	(48 hr treatment)	(72 hr treatment)	CONTROL (C)
Activated Charcoal (AC)	AC-1	AC-2	AC-3	AC-C
Fly ash (FA)	FA-1	FA-2	FA-3	FA-C
Activated Charcoal + Fly ash (1:1)	ACF-1	ACF--2	ACF-2	ACF-C

4.3 Physico Chemical Parameters Selected for analysis:

4.3.1 Physical Parameters: Color, Odor**,** pH, TS, TDS.

4.3.2 Chemical parameters: COD, Ca, Mg, Na & K.

4.4 Measurement of Total Solids (TS): Total solids were determined by measuring the residue left after evaporation of unfiltered samples (APHA 1995).

4.4.1 Calculations Total Solids (mg/l) = (A-B) x 1000 / Vol. of sample (ml).

Where A= Dry weight of residue + Dish (mg)

B=Weight of Dish (mg).

4.5 Total Dissolved Solids (TDS): Total dissolved solids are determined by measuring the residue left after evaporation of filtered sample (APHA 1995).

4.6 Measurement of pH: The pH of effluent was measured by pH meter using a glass electrode pH meter and also by using universal pH indicator solution.

4.7 Measurement of COD: It is the maximum amount of oxygen that can be consumed by the organic matter in the sample for complete oxidation. It is measured by method described in APHA (1995).

In this ferrous ammonium sulphate (0.25M) and potassium dichromate ($K_2Cr_2O_7$) of 0.04167 M are used for titration.

4.7.1 Calculations: COD (mg/l) = (A-B) x M x1000/ volume of Sample in ml.

Where A = Volume of FAS used for blank in ml.

B = Volume of FAS used for sample in ml.

M = Molarity of FAS.

FAS = Ferrous Ammonium Sulphate.

4.8 Determination of Ca and Mg: It was measured by complexo metric titration using ethylene di amine tetra acetic acid (EDTA).

4.9 Determination of Na and K : A characteristic light is produced due to excitation of electrons when the samples with Na/K sprayed into a flame. The intensity of this characteristics radiation is proportional to the concentration of Na/K and can be read at 529/768mm by using suitable optical filter device (Tondon 1998)

5. RESULT

Table 1.4 shows that visible color of distillery effluent was dark brown having foul smell, with acidic nature (pH 4.7) and contain TS-10000 mg/l, TDS-7600 mg/l, COD-8200 mg/l, Ca-2200 mg/l, Mg-1730 mg/l, Na-800 mg/l, and K-1700 mg/l. Table 1.4 reveals the removal of pollutants from distillery spent wash, which is seen maximum after 72 hour treatment with Activated charcoal followed by 48 hour and minimum in 24 hour treatment while minimum changes are seen with Fly ash treatment. After treatment with Activated charcoal at various time intervals, pH of spent was increased significantly from 4.7 to 6.2 after 72 hour treatment (Table 1.4). COD (4184 mg/l), TS (3600 mg/l), TDS (3400 mg/l) were found minimum after 72 hour treatment with Activated charcoal (Table 1.4), maximum reductions in Ca (420 mg/l), Mg (380 mg/l), Na (320 mg/l), and K (420 mg/l) are seen after 72 hour treatment with Activated charcoal (Table 1.4).Maximum reduction in TS, TDS, COD, pH and metallic ions is observed after 72 hour treatment following by 48 hour treatment and minimum change after 24 hour treatment. While after treatment with Fly ash, pH changed to 6.0 ,TS (4167 mg/l),TDS (3918 mg/l),COD (4727 mg/l) ,Ca (351 mg/l),Mg (500 mg/l),Na (272 mg/l) and K (483 mg/l).After 72 hour treatment with Activated charcoal + Fly ash (1:1) pH change to 6.0,TS (3850 mg/l), TDS (3640 mg/l),COD(4450 mg/l),Ca (380 mg/l),Mg (450 mg/l),Na (290 mg/l) and K (450 mg/l),Table 1.4.

6. DISCUSSION

Activated charcoal is a good adsorbent for color removal from spent wash and referred discoloration up to 99% while discoloration decreased with increasing concentration, reduction in COD from distillery effluent was found maximum 48.98% by using Activated charcoal while metallic ions are reduced as Ca (80.91%),Mg (78.04%), Na (60%) and K (75.30%) after 72hour treatment. While with fly ash reductions are seen as COD (42.35%),TS (58.33%),TDS (48.45%),Ca (84.05%),Mg (71.10%), Na (66%),K (71.79%) after 72 hour treatment. With (activated charcoal + fly ash (1:1)) following reductions are seen as COD (45.73%),TS (61.5%),TDS (52.11%),Ca (80.73%), Mg (73.99%),Na

(63.75%) and K (73.53%) after 72 hour treatment. Changed distillery spent wash characteristic result in an altered growth of wheat plant and growth of wheat was increased by irrigation with 72 hour treated effluent treated with activated charcoal and activated charcoal + fly ash (1:1). Effluent was purified at a good level by Activated charcoal.

7. CONCLUSION

On the basis of experimental result it could be conclude that treatment of distillery effluent by using Activated charcoal is one of the best adsorption methods for removal of pollutants from distillery spent wash and it can reshape the effluent characteristics so it could be used as irrigation water to reduce the pressure of application of chemical fertilizers and normal water irrigation. The study revealed that the diluted effluent could be beneficial for better growth of wheat plant which also enhances wheat seed germination. The adsorbent treatment method could be profitably practiced for removing the pollutants from distillery effluent and can reduce the ground water contamination. Activated charcoal can be used for this purpose successfully at commercial level in industries. While fly ash also gave good results. Fly ash is a major problem of thermal power stations. Results of this investigation says that fly ash can be a good option for distillery spent was treatment thus it can reduce pollution in water as well as pollution caused by fly ash. Solid waste adsorbed by fly ash can be used to produce organic manure which needs further research.

ACKNOWLEDGEMENT AND ADDITIONAL INFORMATION

The project was not funded by any agency and was performed in 2016.

COMPETING INTERESTS Authors have declared that no competing interests exist.

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Novelty Journals

ISSN 2394-7349

International Journal of Novel Research in Engineering and Science
Vol. 3, Issue 2, pp: (53-58), Month: September 2016 - February 2017, Available at: www.noveltyjournals.com

APPENDICES

Table: 1.2: Initial Physico Chemical Characteristics of Distillery Spent Wash before Treatment

Parameters	Value
Color	Dark Black Brown
Odor	Foul Molasses
TS	10000 mg/l
TDS	7600 mg/l
pH	4.7
COD	8200 mg/l
Ca	2200 mg/l
Mg	1730 mg/l
Na	800 mg/l
K	1700 mg/l

Table: 1.3: Effect of Activated charcoal and Fly ash on Color and Odor of Spent Wash

Parameters	Activated Charcoal			Fly ash			Activated Charcoal+Fly Ash (1:1)		
	24hr AC-1	48hr AC-2	72hr AC-3	24hr FA-1	48hr FA-2	72hr FA-3	24hr ACF-1	48hr ACF-2	72hr ACF-3
Color	LB	CL	CL	B	LB	CL	LB	CL	CL
Odor	MO	MM	OL	MO	MM	OL	MO	MM	OL

LB: Light Brown, B: Brown, CL: Colorless, MO: Molasses Odor, MM: Mild Molasses, OL: Odorless

Table: 1.4: Physico Chemical Characteristics of Distillery Spent Wash treated with Activated Charcoal and Fly ash

Para-meters	Original Sample	Activated Charcoal			Fly Ash			Activated Charcoal+Fly ash (1:1)		
		24hr AC-1	48rh AC-2	72hr AC-3	24hr FA-1	48rh FA-2	72hr FA-3	24hr ACF-1	48hr ACF-2	72hr ACF-3
TS	10000	4800	4200	3600	5625	4792	4167	5200	4390	3850
TDS	7600	4400	3800	3400	4701	4309	3918	4560	4250	3640
pH	4.7	5.6	5.8	6.2	5.2	5.5	6.0	5.4	5.6	6.0
COD	8200	5012	4552	4184	5467	5065	4727	5230	4800	4450
Ca	2200	540	500	420	447	414	351	490	450	380
Mg	1730	480	420	380	562	521	500	520	470	450
Na	800	420	360	320	347	302	272	380	330	290
K	1700	560	500	420	555	519	483	557	520	450

NOTE: All values in mg/lit except pH

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ISSN 2394-7349

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TABLE: 1.5: Percent Change in Physico Chemical Characteristics of Distillery Spent Wash Treated with Activated charcoal and Fly ash

Para-meters	Original Sample	Activated Charcoal			Fly ash			Activated Charcoal+Fly ash (1:1)		
		24hr	48rh	72hr	24hr	48rh	72hr	24hr	48hr	72hr
TS	3600	-52.00	-58.00	-64.00	-43.75	-52.08	-58.33	-48.00	-56.10	-61.50
TDS	7600	-42.11	-50.00	-55.26	-38.15	-43.30	-48.45	-40.00	-44.08	-52.11
pH	4.7	+19.15	+23.40	+31.92	+10.64	+17.02	+27.66	+14.89	+19.15	+27.66
COD	8200	-38.88	-44.49	-48.98	-33.33	-38.23	-42.35	-36.22	-41.46	-45.73
Ca	2200	-75.45	-77.27	-80.91	-79.68	-81.18	-84.05	-77.73	-79.55	-80.73
Mg	1730	-72.25	-75.72	-78.04	-67.51	-69.88	-71.10	-69.94	-72.83	-73.99
Na	800	-47.50	-55.00	-60.00	-56.63	-62.25	-66.00	-52.50	-58.75	-63.75
K	1700	-67.06	-78.59	-75.30	-67.35	-69.47	-71.59	-67.24	-69.41	-73.53

(+Increase,-Decrease)

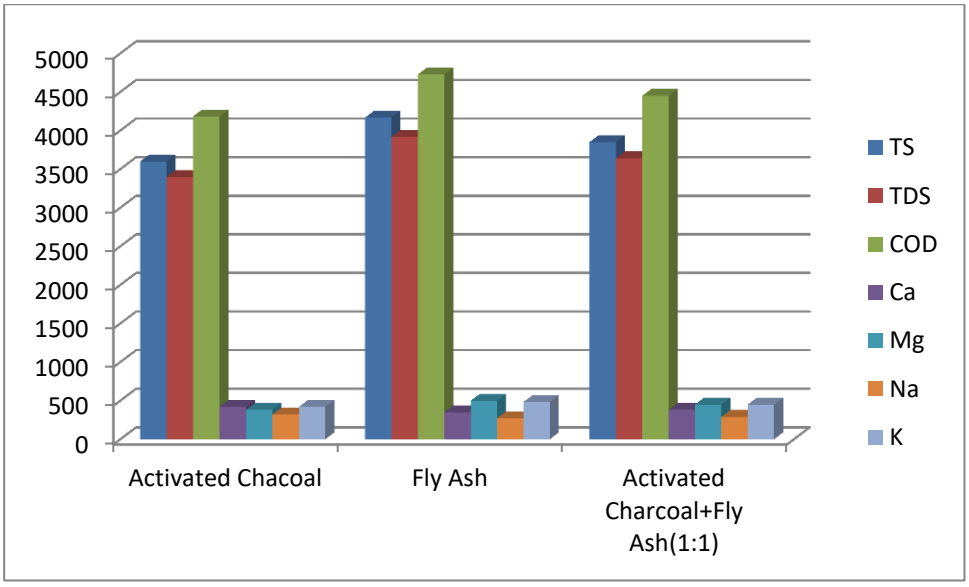

Fig: Physico Chemical Characteristics of Distillery Spent Wash treated with Activated Charcoal and Fly ash after 72 hour Treatment