Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 1, January -2017

Effect of Soil and Activated Charcoal on Distillery Effluent Quality

Bharat Kumar[1], Abhay Kumar[2], Rohit Sankhyan[3], Sumit Kumar[4]

[1] *Department of Chemistry Doon International School, Dehradun, 248001, U.K., India*
[2,3,4] *Student Class XI 2016-2017, Doon International School, Dehradun, 248001, U.K., India*

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 adsorption treatment by using Soil,Activated Charcoal, Soil + Activated Charcoal (1:1) for purification of distillery effluent. For this, the study encompassing evaluation of reduction of various physical chemical parameters (pH, COD (48.98%), TS (64%), TDS (55.26%), Ca (80.91%), Mg (78.03%), Na (60%) and K (75.30%)) of distillery effluent and it was purified by passing through the columns of Soil, Activated Charcoal, Soil + Activated Charcoal (1:1). Initially distillery effluent was acidic (pH 4.7) and dark brown in color which often cause psychological fear in farmers for irrigation. Activated charcoal treatment of distillery effluent exhibited maximum reduction in COD, TS , TDS, Mg, Ca, Na, K and increase in pH toward pH 7 followed by Soil + Activated Charcoal (1:1). Treated spent has resulted a good growth of wheat seeds.*

Keywords: *"Distillery effluent", "Adsorbent", "Soil", "Activated Charcoal", "Irrigation" , "Chemical parameter".*

1. INTRODUCTION

Modern industrialization for sustaining economic growth and ever increasing population is leading to the pollution of the environment due to the disposal of untreated effluents. Various pollutants produced in industries directly or indirectly results in cumulative pollution of 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 effluent from textile, chemical fertilizers, pulp and paper, petrochemical and breweries, metal processing, automobile manufacturing, leather and tannery industries and power plants including nuclear, thermal, 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 distillery effluent 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 Shrivastava, 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 practical 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 is planned to investigate the treatment of distillery effluent with the following objectives

1. To characterize physico chemical characteristics (pH, Color, Odor, COD, TS, TDS, Ca, Mg, Na, K) of distillery effluent.
2. To study the impact of Activated Charcoal, Soil and Soil + Activated Charcoal (1:1) as adsorbent on distillery effluent quality.

2. SOIL'S PHYSICAL PROPERTIES

The physical aspects of distillery effluent treatment through land systems involve the processes of filtration and dilution. As water moves through soil, suspended particles are removed by filtration and the filtrate may be diluted with soil water. The rate of these processes is affected by soil's physical properties, i.e. the relative proportion of mineral particles of different sizes present in the soil. Sandy soils are said to be 'light' and clayey soils to be 'heavy'. Sandy soils are porous, have high filtration rates and retain less water. In contrast, clayey soils have low infiltration rates, retain much water and may be poorly drained. Soils of intermediate texture such as looms are also intermediate in porosity, drainage and water tension (Foth & Turk 1992).

3. MATERIAL AND METHODS

3.1 Sample collection

Distillery effluent was taken from a distillery, located in Dehradun. The factory uses molasses as the raw material. The effluent flows out into "River Song" that passes through nearby villages. Sample was collected at main outlet of distillery on date 02.11.2016. Samples were collected five times on weekly basis from November to December 2016 in clean sterile plastic containers and stored at $4^{o}C$ in a refrigerator.

3.2Effect of soil as adsorbent on various physico chemical Characteristics of distillery effluent

Eight plastic pots were filled with 2 kg soil each and wheat (Triticum aestivum, Variety UP2329) was grown in six pots. After 20 days of growth, pots were irrigated with treated distillery effluent and the $7^{th}$and 8^{th} pot were used as control. On each irrigation date one liter of treated effluent was poured in each pot. 24 hour treated, 48 hour treated and 72 hour treated distillery effluent was used in pot 1, 2 (soil treated effluent), pot 3, 4 (activated charcoal treated effluent) and pot 5, 6 (soil + activated charcoal 1:1) for irrigation. For treatment, distillery effluent was passed through separate columns of soil, soil + activated charcoal (1:1) and activated charcoal. First samples were retained in columns for 24 hours, second samples for 48 hours and third samples for 72 hours. After taking samples from columns, 100 ml of each was collected in sterile reagent bottles for physico chemical characterization and 500 ml of each was used for irrigation of wheat plants.

3.3 Physico Chemical Parameters Selected for analysis

3.3.1 Physical Parameters pH, TS, TDS.
3.3.2 Chemical parameters COD, Ca, Mg, Na & K.

3.4 Measurement of Total Solids (TS)

Total solids were determined by measuring the residue left after evaporation of unfiltered samples (APHA 1995).

3.4.1 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).

3.5 Total Dissolved Solids (TDS)

Total dissolved solids are determined by measuring the residue left after evaporation of filtered sample (ALPHA 1995).

3.6 Measurement of pH

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

3.7 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.

3.7.1 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.

3.8 Determination of Ca and Mg

It was measured by complexo metric titration using ethylene di amine tetra acetic acid (EDTA). (Schwazenbach) .

3.9 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 characteristic radiation is proportional to the concentration of Na/K and can be read at 529/768mm by using suitable optical filter device (Tondon 1998).

4. RESULT

Tab 1.1 shows that visible color of distillery effluent was dark brown having foul smell, with acidic nature(4.7) and contain TS-10000mg/l, TDS-7600mg/l, COD-8200mg/l, Ca-2200mg/l, Na-800mg/l, Mg-1730mg/l and K-1700mg/l. Tab 1.2 and 1.3 reveals the removal of pollutants from distillery effluent, which is seen maximum with activated charcoal followed by Soil + Activated Charcoal (1:1). After treatment with activated charcoal, pH of distillery effluent was increased significantly from 4.7 to 6.2 after 72 hours treatment (Table1.2 and 1.3). COD (4184 mg/l), TS (3600 mg/l), TDS (3400 mg/l) were found minimum after 72 hours treatment with activated charcoal (Table1.2 and 1.3), maximum reduction in Ca (420 mg/l), Mg (380 mg/l), Na (320 mg/l), and K (420 mg/l) is seen after 72 hours with activated charcoal (Table1.2 and 1.3) followed by Soil + Activated Charcoal (1:1) with pH (6.0), COD (4600mg/l), TS (40000mg/l), TDS (4000mg/l), *Ca (440*mg/l*), Mg (480*mg/l*), Na (360*mg/l*) and K (540*mg/l*)* and minimum reduction is observed with soil treatment (Table1.2 and 1.3).

5. DISCUSSION

Activated charcoal and Soil + Activated Charcoal (1:1) is an ideal adsorbent for color removal from distillery effluent and referred discoloration up to 99% while discoloration decreased with increasing concentration. Removal of COD from distillery effluent was found maximum 48.98% by using activated charcoal followed by using Soil + Activated Charcoal (1:1) (43.90%) and minimum reduction is seen with soil treatment (39.54%).While TS and TDS were reduced by 64% and 55.26% respectively by activated charcoal and 60% and 47.37% respectively by soil + activated charcoal (1:1).Changed soil characteristics resulted in an altered growth of wheat plant by irrigation with effluent (24, 48 and 72 hour treated). Effluent was purified more with activated charcoal followed by Soil + Activated Charcoal (1:1) after 72hour treatment.

6. CONCLUSION

On the basis of experimental result it can be concluded that adsorbent treatment by using Soil + Activated Charcoal (1:1) and Activated Charcoal is one of the best method for removal of pollutants from distillery effluent and we can reshape the effluent characteristics so it could be used as irrigation water to reduce the pressure of application of fertilizers and normal water irrigation . The study also revealed that the treated effluent could be beneficial for better growth of wheat plant which also enhances wheat seed germination. The adsorbent treatment method of effluent could be profitably practiced for removing the pollutants and thus avoiding the ground water contamination and its environmental impacts. Activated charcoal and Soil + Activated Charcoal (1:1) can be used for this purpose successfully.

7. REFERENCES

1. Abumaizar,R. and Khan, L.I 1996, "Laboratory investigation heavy metal removal by soil washing" in Journal of the Air and Waste Management Association. 46:765-768.

2. APHA , AWWA , WPCA 1995,Starndard Methods for the examination of water and waste water, A.M. Publ. Health Assoc, New York,19th (ed.).

3. Baruah , A.K.:Sharma,R.N Borah ,G.C., 1998, "Impact of sugar mill and distillery effluents on water quality of river Crelabil Assam" in Indian J.of Environ.Health,
3 (94):288-293.

4. Binklay,W.A and Wolform M.L. 1997 , "Composition of Cane juice and Cane final molasses" in Advances in carbohydrate chemistry.Ed C.S.Hundsor and M.L. Wolform Academic Press.Inc. Pub, New York, U.S.A. 8-29.

5. Bharat kumar 2015, "Treatment of Distillery Effluent Using Activated Charcoal, Fly Ash, Wood Ash for Irrigation Purpose",in International Journal of Novel Research in Life Sciences Vol. 2, Issue 2, pp: (27-30).

6. Chandra, R. 1996, "Biodegradation of distillery effluent isolation and characterization of microbial consortium", in Indian J. Env. Prom., 16(5):352-355.

7. Chandra,R. and Panday, P.K.2000, " Decolourisation of anaerobically treated distillery effluent by activated charcoal adsorption method", in Indian J. Env. Prot, 21(2):134-137.

8. Cheriminisinoff, P.N. 1995, Hand book of water and waste water treatment technology, Marcel Dekker Inc. New York.

9. Chhonkar, P.K.Datta, S.P.Joshi, H.C. and Pathak H., 2000, "Impact of industrial effluents on soil health and agriculture. Indian experience: Part I- distillery and paper mill effluent", Journal and Scientific and Industrial Research 59(5):350-361.

10. Jain,S. and Singh, M.K. 1998 water pollution control equipments and instruments. In Industrial safety and pollution control hand book. Ed. J.Nagarey, A joint publication of National Safety Council Associates (Data) Publishers Pvt.Ltd. Secundarabad, India, 291-306.

11. Kadirvelu, K.:Palanivel, M.Kaltana,R. and Rajes wari, S.2000 b. "Activated carbon prepared from agricultural bi product for the treatment of dyeing waste water" , Bioresource Technol.75:25-27.

12. Khoshoo, T.N.1999, Environmental priorities in India and sustainable development, Presidential address, 73rd session. Indian Science Congress Association, New Delhi. 224.

13. Lee, C.K,Low.K.S. And Gan, P.y. 1999, "Removal of some organic dyes by acid spent beleaching earth", Environ.Technol, 20:99-104.

14. Lin, S.H. and Kiang, C.D.2003, "Combined physical chemical biological treatment of waste water containing organics from a semi conductor plant", Journal of Hazardous material,97(1-3): 159-171.

15. Menambal, T.1999, "Experimental coagulants responses in dicolourization of treated distillury effluent", in Advances in waste water treatment ed. T.K. Goel, Techno science Publication Jaipur, India, 240-249.

16. Nemade, P.N and Shrivastava, V.S. 1997, "Metals in different effluents and their impacts on ground water and plant tissues", Indian J.Env.Prot, 17(2):133-136.

17. Nriagu, J.O.and Pacyna. J.M.1998, "Quantitative assessment of worldwide contamination of air water and soil by trace metals", Nature, 333:134-139.

18. Pathade, G.R., 2001 "A review of current technologies distillery waste water treatment", in Advances in industrial waste water treatment ed.P.K. Goel, Techno science Publication.

19. Royguard, J.K.F. Green, S.R.Clophier,V.E.:Sims, R.E.H. and Bolan,N.S.1999, " Short rotation and forestry for land treatment", in Australian Journal of soil Research 37(5):983-991.

20. Sahu, A.K. and Patel, M.1997, "Effluent treatment technologies based on adsorption and coagulation for environment in pulp and paper industry", IPPTA,7(1):18-28

21. Sharma O.P., Bangar K.S., Jain R. and Sharma P.K 2004, "Heavy metal accumulation in soil irrigated by municipal and industrial effluent", J.Environ.Science and Engg. 46(1):65-73.

22. Srivastava A. and Pathak A.N, 1998, "Modern technologies for distillery effluent treatment", J. of Scientific and Industrial Research, 57:388-392.

TABLE: 1.1

Effect of Different Combinations of Activated Charcoal and Soil on Color and Odor of Distillery Effluent

Parameter	Original Sample	Activated charcoal (100%)			Soil (100%)			Activated Charcoal and Soil (1:1)		
		24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
Color	DB	CL	CL	CL	DB	B	LB	LB	CL	CL
Odor	MO	MMO	MMO	OL	MO	MMO	MMO	MMO	MMO	OL

CL: Colorless, DB: Dark Brown, LB: Light Brown, BB: Brownish Black
MMO: Mild molasses odor, MO: Molasses odor, OL: Odorless

TABLE: 1.2
Physico Chemical Characteristics Distillery Effluent Treated with Activated Charcoal and Soil.

Para-meters	Original sample	Activated charcoal			Soil			Soil + Charcoal (1:1)		
		24hr	48rh	72hr	24hr	48rh	72hr	24hr	48hr	72hr
TS	10000	4800	4200	3600	5400	5000	4200	5400	4600	4000
TDS	7600	4400	3800	3400	4800	5400	4000	4800	4400	4000
pH	4.7	5.6	5.8	6.2	5.5	5.7	5.9	5.2	5.5	6.0
COD	8200	5012	4552	4184	5412	4952	4384	5320	4928	4600
Ca	2200	540	500	420	600	580	540	560	520	440
Mg	1730	480	420	380	520	480	440	540	500	480
Na	800	420	360	320	540	420	320	460	400	360
K	1700	560	500	420	720	640	480	620	580	540

TABLE: 1.3
Percent Change in Physic Chemical Characteristics of Distillery Effluent Treated with Activated Charcoal and Soil at Various Irrigation Periods

Para-meters	Original sample	Activated charcoal			Soil			Soil + Charcoal		
		24hr	48rh	72hr	24hr	48rh	72hr	24hr	48rh	72hr
TS	10000	-52	-58	-64	-46	-50	-48	-46	-54	-60
TDS	7600	-42.11	-50	-55.26	-36.84	-28.36	-47.37	-36.84	-42.11	-47.37
pH	4.7	+19.15	+23.40	+31.91	+17.02	+21.27	+25.53	+10.63	+17.02	+27.66
COD	8200	-38.88	-44.49	-48.98	-34	-39.61	-46.54	-35.12	-39.90	-43.90
Ca	2200	-75.45	-77.27	-80.91	-72.72	-73.64	-75.45	-74.54	-76.36	-80
Mg	1730	-72.25	-75.72	-78.03	-69.94	-72.25	-74.57	-68.79	-71.11	-72.25
Na	800	-47.5	-55	-60	-32.5	-47.5	-60	-42.5	-50	-55
K	1700	-67.06	-78.59	-75.30	-57.65	-63	-71.76	-62.53	-65.88	-68.24

