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Study of Distillery Effluent Treatment by Using Soil, Sand and Activated Charcoal

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ABSTRACT: *Adsorbent 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 of distillery effluent on economic level. 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 effluent was treated by passing it through the columns of soil, sand and charcoal. The original distillery effluent was acidic (pH 4.7) and dark brown black in color which often cause psychological fear in farmers for its utilization for irrigation. After 72 hour treatment of effluent, maximum reductions in its physico chemical properties (COD, TS, TDS, Mg, Na, Ca,) are observed with activated charcoal and increase in pH toward pH 7 followed by soil. Treated effluent showed a good growth of wheat seeds when used for irrigation and reduced demand of chemical fertilizers*.

Keywords: *"Distillery Effluent", "Chemical Parameters", "Adsorbent", "Soil", "Sand", "Activated Charcoal", "Irrigation"*

1. INTRODUCTION

Over increasing industrialization for sustaining economic growth and ever increasing population is introducing pollutants in the environment due to the disposal of untreated effluents 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 from textile, chemical fertilizers, pulp and paper, petrochemical and breweries, metal processing units, automobile manufacturing, leather and tannery industries and power plants including nuclear, thermal, etc.

Inadequate treatment of toxic effluent produced from different industries has 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 treatment.

Environmental pollution caused 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 save our environment for future generations and all other species, 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 lays 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 is suitably treated, it could be applicable for crop irrigation. The application of effluent in 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 method of distillery 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 treatment method of distillery effluent by using Soil, Sand and Activated Charcoal.

2. SOIL'S PHYSICAL PROPERTIES AND PROCESSES

The physical aspects of waste treatment through soil systems involve the processes of filtration and dilution. As water moves through soil, suspended particles are removed by filtration and filtrate may be diluted with soil water. The rate of these processes is affected by soils 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 clay soil 'heavy'. Sandy soils are porous, have high filtration rates and retain less water. In contrast, clays 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.

3. SAND'S PHYSICAL PROPERTIES AND PROCESSES

Treatment with sand systems involves the processes of filtration and dilution. As water passes through sand, suspended particles and bio particles are removed by filtration. The rate of filtration is affected by sand's physical properties. Sand is less porous, have high filtration rates and retain less water. In contrast, soily sand has low infiltration rates, retains much water and may be poorly drained.

4. ACTIVATED CHARCOAL

Activated charcoal, also called activated 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 carbon is commonly used on the laboratory scale to purify solutions of organic molecules containing unwanted colored organic impurities.

5. MATERIAL AND METHODS

5.1 Sample collection

Distillery effluent was taken from a distillery, located in Dehradun. The factory uses molasses as the raw material. That 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^oC in a refrigerator.

5.2 Experimental design

Twelve plastic pots were filled with 2 kg soil in each and wheat (Triticum aestivum, Variety UP2329) was grown in each pot. Pots were divided into three groups each comprising four pots. Groups were named as Group soil which includes soil control (SC), soil-1(S-1), soil-2(S-2), soil-3 (S-3),Group sand which includes sand control (SAC), sand-1(SA-1),sand-2(SA-2), sand-3(SA-3) and Group Activated Charcoal including activated charcoal control (ACC),activated charcoal-1(AC-1),activated charcoal-2 (AC-2), activated charcoal-3(AC-3). In the same way columns were prepared for effluent treatment.After 20 days of growth of wheat plants, pots S-1,S-2, S-3 were irrigated with 24 hour,48 hour and 72 hour soil treated effluent same way pots SA-1,SA-2,SA-3 were irrigated with 24 hour,48 hour and 72 hours sand treated effluent also pots AC-1,AC-2,AC-3 were treated with 24 hour,48 hour,72hour activated charcoal treated effluent. Pots SC, SAC and ACC were irrigated with original effluent and used as control. On each irrigation date 500 ml of treated effluent was poured in respective pot. For treatment, distillery was passed through separate columns of soil, sand 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.

5.3 Physico Chemical Parameters Selected for analysis

5.3.1 Physical Parameters Color, Odor, pH, TS, TDS.

5.3.2 Chemical parameters COD, Ca, Mg, Na & K.

5.4 Measurement of Total Solids (TS)

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

5.4.1 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).

5.5 Total Dissolved Solids (TDS)

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

5.6 Measurement of pH

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

5.7 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.

5.7.1 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.

5.8 Determination of Ca and Mg

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

5.9 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.

6. RESULT

Tab 1.1 shows that visible color of distillery as dark brown having foul smell, with acidic nature pH 4.7 and contain TS-10000mg/l, TDS-7600mg/l, COD-8200mg/l, Ca-2200mg/l, Mg-1730mg/l, Na-800mg/l, and K-1700mg/l. Tab 1.2 and 1.3 reveals the removal of pollutants from distillery effluent, which is seen maximum in activated charcoal followed by soil and minimum in treatment with sand. After treatment with soil, sand and activated charcoal, pH of effluent was increased significantly from 4.7 to 6.2 (activated charcoal), from 4.7 to 5.9 (with soil) and from 4.7 to 5.4 (with sand) after 72 hour of treatment (Table 1.2). COD (4184 mg/l), TS (3600 mg/l), TDS (3400 mg/l) were found minimum after 72 hours of treatment with activated charcoal (Table 1.2, 1.3), maximum reduction in Ca (420 mg/l), Mg (380 mg/l), Na (320 mg/l), and K (420 mg/l) were seen after 72 hours with activated charcoal (Table 1.2 and 1.3). While reduction with soil in COD (4384 mg/l), TS (4200 mg/l), TDS (4000 mg/l), Ca (540 mg/l), Mg (440 mg/l), Na (360 mg/l), and K (480 mg/l) are observed (Table 1.2 and 1.3). After 72 hour treatment with sand minimum reduction are observed in physico chemical characteristics of effluent which are COD (5218 mg/l),TS (5800 mg/l) ,TDS (5000mg/l) ,Ca (680 mg/l) ,Mg (580 g/l) ,Na (500 mg/l) and K (880 mg/l) (Table 1.2 and 1.3).

7. DISCUSSION

Activated charcoal is an ideal adsorbent for color removal from waste water and referred discoloration up to 99% while with soil color reduction is 90% and with sand it is reduced to brown color, removal of COD from distillery was found maximum 48.98 % by using activated charcoal, 46.54 % by using soil and 36.37 % by using sand while reduction in TS is observe 64% with activated charcoal, 58% with soil and 42% with sand. Reduction in TDS is observed 55.26% with activated charcoal, 47.37% with soil and 34.21% with sand. Reduction in metallic ions concentration is observed as follows: Ca(80.91%),Mg(78.04%),Na (60%),K(75.30%) with activated charcoal after 72 hour (Table 1.3).Ca (75.46%),Mg (74.57%),Na (55%),K (71.76%) with soil treatment of effluent.Ca(%69.01%),Mg(66.47%),Na(37.5%),K(48.24%) with sand treatment of effluent after 72 hours. Changed soil characteristic resulted in an altered growth of wheat after irrigation with treated (24hrs, 48hrs, and 72 hrs treatment). Effluent was purified more with activated charcoal and soil.

8. CONCLUSION

On the basis of experimental results it can be concluded that adsorbent treatment is one of the best method for removal of pollutants from distillery effluent and we can reshape the 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 could be beneficial for better growth of wheat plant which also enhances wheat seed germination. The adsorbent treatment method of distillery effluent could be profitably practiced for removing the pollutants and thus avoiding the ground water contamination and its environmental impacts. Activated charcoal and soil can be used for this purpose successfully.

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Table: 1.1
Effect of Soil, Sand and Activated Charcoal on Color and Odor of Effluent after 72 hour Treatment

Parameter	Soil			Sand			Activated charcoal		
	24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
Color	DB	B	LB	DB	DB	LB	CL	CL	CL
Odor	MO	MM	MM	MO	MO	MO	MM	OL	OL

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

Table: 1.2
Physico Chemical Characteristics of Distillery effluent Treated with Soil, Sand and Activated Charcoal at Various Irrigation Periods

Parameters	Original sample	Normal Soil			Normal Sand			Activated Charcoal		
		24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
TS	10000	5400	5000	4200	6400	6200	5800	4800	4200	3600
TDS	7600	5490	4800	4000	5400	5200	5000	4400	3800	3400
pH	4.7	5.5	5.7	5.9	5.1	5.3	5.4	5.6	5.8	6.2
COD	8200	5412	4952	4384	5816	5464	5218	5012	4552	4184
Ca	2200	600	580	540	760	720	680	540	500	420
Mg	1730	520	480	440	800	600	580	480	420	380
Na	800	540	420	360	620	540	500	420	360	320
K	1700	720	640	480	1060	1020	880	560	500	420

All values are in mg/l except pH.

Table: 1.3
Percentage Change in Physico Chemical Characteristics of Distillery effluent Treated with Soil, Sand and Activated Charcoal at Various Irrigation Periods

Parameter	Original Sample	Normal Soil			Normal Sand			Activated Charcoal		
		24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
TS	10000	-46	-50	-58	-36	-38	-42	-52	-58	-64
TDS	7600	-27.76	-36.84	-47.37	-28.95	-31.58	-34.21	-42.11	-50	-55.26
pH	4.7	+17.02	+21.28	+25.53	+8.51	+12.77	+14.89	+19.15	+23.40	+31.92
COD	8200	-34	-39.61	-46.54	-29.07	-33.37	-36.37	-38.88	-44.49	-48.98
Ca	2200	-72.73	-73.64	-75.46	-65.46	-67.27	-69.09	-75.46	-77.27	-80.91
Mg	1730	-69.94	-72.25	-74.57	-53.76	-65.32	-66.47	-72.25	-75.72	-78.04
Na	800	-32.5	-47.5	-55	-22.5	-32.5	-37.5	-47.5	-55	-60
K	1700	-57.65	-62.35	-71.76	-37.65	-40.00	-48.24	-67.06	-78.59	-75.30

+ Increase
-Decrease

