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Effect of Sand and Activated Charcoal on Properties of Distillery Effluent

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Abstract: **Absorption 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 absorption treatment method for purification of distillery spent wash. For this, the study encompassing evaluation of reduction of various physical chemical parameters (pH, COD, TS, TDS, Ca, Mg, Na and K) of distillery spent wash was checked by passing effluent through the column of sand, activated charcoal and sand +activated charcoal (1:1) . The original distillery effluent was acidic (pH 4.7) and dark brown in color which often cause psychological fear in farmers for utilization. Treatment of spent wash with activated charcoal and sand +activated charcoal (1:1) exhibited maximum reduction in COD, TS, TDS, Mg, Na, Ca, and increase in pH toward pH 7. Treated spent wash resulted in a good growth of wheat seeds.**

Keywords: **"Spent wash", "Adsorbent", "Sand", "Activated Charcoal", "Chemical parameter", "Irrigation".**

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

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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 Sand, Activated Charcoal and Sand + Activated Charcoal (1:1) as adsorbent on distillery effluent quality.

2. SAND'S PHYSICAL PROPERTIES AND PROCESSES

The physical aspects of waste treatment through sand systems involve the processes of filtration and dilution. As water moves through sand, suspended particles are removed by filtration and filtrate may be diluted with water. The rate of these processes is affected by sand's physical properties i.e. the relative proportion of mineral particles of different sizes present in the sand. Soily sand is less porous, have low filtration rates and retain more water. In contrast, soily sand has low infiltration rates, retains much water and may be poorly drained.

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 Sand, Activated Charcoal and Sand + Activated Charcoal (1:1) onphysio-chemical Characteristics of distillery effluent:

Ten plastic pots were filled with 2 kg soil each and wheat (Triticum aestivum, Variety UP2329) was grown in each pot. After 20 days of growth, nine pots were irrigated with treated distillery effluent and 10^{th} pot was 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, 3 (sand treated effluent), pot 4, 5, 6 (activated charcoal treated effluent) and pot 7, 8, 9 (sand + activated charcoal 1:1) for irrigation. For treatment, distillery effluent was passed through separate columns of sand, sand + 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 as dark brown having foul smell, with acidic nature and contain TS-10000mg/l, TDS-7600mg/l, pH-4.7, 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 spent wash, which is seen maximum in activated charcoal followed by sand + activated charcoal (1:1) and minimum in treatment with sand. After treatment with sand, activated charcoal and sand + activated charcoal (1:1), pH of spent wash was increased significantly from 4.7 to 6.2 (activated charcoal), from 4.7 to 5.8 (sand + activated charcoal) and from 4.7 to 5.4 (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) is seen after 72 hours with activated charcoal (Table 1.2 and 1.3). While reduction with sand + activated charcoal (1:1), COD (4958 mg/l), TS (4800 mg/l), TDS (4600 mg/l), Ca (640 mg/l), Mg (660 mg/l), Na (420 mg/l), and K (780 mg/l) are observed.

5. DISCUSSION

Activated charcoal is an ideal adsorbent for color removal from waste water and referred discoloration up to 99% while with sand plus activated charcoal (1:1) color reduction is 90% by sand and with sand it reduced to brown color, removal of COD from distillery effluent was found maximum 48.98 % by using activated charcoal, 39.54% by using sand plus activated charcoal (1:1) and 48.98% by using sand while reduction in TS is observe (42%)sand, (52%) sand +activated charcoal (1:1) and (64%) with activated charcoal. Reduction in TDS is observed (34.12%) with sand, (55.26%) with activated charcoal and (39.47%) with sand +activated charcoal (1:1) Changed soil characteristic resulted in an altered growth of wheat after irrigation with treated effluent (24hrs, 48hrs, 72hrs treatment). Effluent was purified more with activated charcoal and sand +activated charcoal (1:1).

6. CONCLUSION

On the basis of experimental result it can be concluded that adsorbent treatment is one of the best method for removal of pollutants from distillery spent wash 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 sand + activated charcoal (1:1) can be used for this purpose successfully.

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APPENDIX - A

TABLE: 1.1 Effect of different combinations of activated charcoal and sand on color and odor of spent wash

Parameter	***Original sample***	***Activated charcoal (100%)***			***Sand (100%)***			**Sand +*Activated* Charcoal (1:1)**		
		24hr	***48hr***	***72hr***	***24hr***	***48hr***	***72hr***	***24hr***	***48hr***	***72hr***
Color	***DB***	***CL***	***CL***	***CL***	***DB***	***B***	***B***	***B***	***LB***	***CL***
Odor	***FS***	***MM***	***MM***	***OL***	***MO***	***MO***	***MO***	***MO***	***MM***	***OL***

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

TABLE 1.2 Physico chemical characteristics of 100% distillery spent wash treated with activated charcoal and sand at various irrigation periods.

Para-meters	**Original sample**	**Activated charcoal**			**Sand**			**Sand +Activated Charcoal (1:1)**		
		24hr	**48rh**	**72hr**	**24hr**	**48hr**	**72hr**	**24hr**	**48rh**	**72hr**
TS	10000	4800	4200	3600	6400	6200	5800	6000	5400	4800
TDS	7600	4400	3800	3400	5400	5200	5000	5000	4800	4600
pH	4.7	5.6	5.8	6.2	5.1	5.3	5.4	5.0	5.3	5.8
COD	8200	5012	4552	4184	5816	5464	5218	5464	5164	4958
Ca	2200	540	500	420	760	720	680	720	700	640
Mg	1730	480	420	380	800	600	580	680	660	660
Na	800	420	360	320	620	540	500	500	460	420
K	1700	560	500	420	1060	1020	880	840	820	780

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TABLE 1.3 Percent Change in physic chemical characteristics of distillery spent wash treated with different charcoal and sand at various irrigation periods .

Para-meters	Original sample	Activated charcoal			Sand			Sand +Activated Charcoal (1:1)		
		24hr	48rh	72hr	24hr	48rh	72hr	24hr	48rh	72hr
TS	10000	-52	-58	-64	-36	-38	-42	-40	-46	-52
TDS	7600	-42.11	-50	-55.26	-28.95	-31.58	-34.12	-34.21	-36.84	-39.47
pH	4.7	+19.15	+23.40	+31.91	+5.51	+12.77	+14.89	+6.38	+12.77	+23.40
COD	8200	-38.88	-44.49	-48.98	-29.07	-33.36	-36.36	-33.39	-37.02	-39.54
Ca	2200	-75.45	-77.27	-80.91	-65.45	-67.27	-69.09	-67.27	-68.18	-70.91
Mg	1730	-72.25	-75.72	-78.03	-53.76	-65.31	-66.47	-60.69	-61.84	-61.84
Na	800	-47.5	-55	-60	-22.5	-32.5	-37.5	-37.5	-42.5	-47.5
K	1700	-67.06	-78.59	-75.30	-37.65	-40	-48.24	-50.59	-51.76	-54.12

(+Increase,-Decrease)