

**Distillery Spent Wash Purification with different Textures of Soil, Sand and
Active Carbon**Bharat Kumar^{1*}, Arpit Gupta², Divyanshu Nautiyal³, Raghav Virmani⁴¹ 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: Treatment of distillery spent wash by adsorption technique has great potential as a sustainable method as it is a low cost method. The aim of this investigation is to study the impact of different textures of soil, sand and active carbon as adsorbent for spent wash purification. 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 it through the columns of soil, sand, active carbon, soil+sand (1:1), soil+active carbon(1:1) and sand+active carbon(1:1). The original distillery spent wash was acidic (pH 4.7) and dark black brown in color with foul smell. It creates psychological fear in farmers in its utilization for irrigation. After 72 hour treatment of spent wash, maximum reduction in its physico chemical properties (COD, TS, TDS, Mg, Na, Ca,) is observed with active carbon and increase in pH toward pH 7, followed by soil+active carbon (1:1). Treated spent wash has resulted a good growth of wheat seeds when used for irrigation and reduced demand of chemical fertilizers.

Keywords: "Distillery Spent wash", "Adsorbent", "Soil", "Sand", "Active carbon", "Irrigation", "Chemical parameters".

1. INTRODUCTION

Over increasing industrialization to maintain economic growth and ever increasing population is introducing pollutants in the environment by the disposal of untreated factory effluent. Various pollutants produced in industries are being accumulated in our environment. Which cause severe degradation in pedosphere, hydrosphere, atmosphere and thus causing a potential menace to the health and welfare of mankind.

Inadequate treatment of spent wash produced from distillery 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 spent wash 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 water bodies as well as in land.

To protect our environment for future, pollution needs 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 spent wash is treated, it could be used for crop irrigation. The application of spent wash 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. Keeping this in view, the present study is planned to investigate the treatment method of distillery spent wash with the following objectives

1. To study the impact of different textures of Soil, Sand and Active carbon as adsorbent on distillery spent wash characteristics.

2. PHYSICAL PROPERTIES AND PROCESSES OF SOIL

The physical aspects of waste treatment through soil systems involve the processes of adsorption, filtration and dilution. As water moves through soil, suspended particles are removed by filtration. The rate of adsorption and filtration is affected by physical properties of soil 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, clay soil has low infiltration rates, retains much water and may be poorly drained. Soils of intermediate texture such as looms are also intermediate in porosity, drainage and water tension.

3. PHYSICAL PROPERTIES AND PROCESSES OF SAND

Treatment with sand systems involves the processes of filtration and dilution. As water passes through sand, suspended particles are removed by filtration. 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. ACTIVE CARBON

Active carbon, also called activated carbon, is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption. Active is sometimes substituted with activated. Active carbon 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.

5. MATERIAL AND METHODS

5.1 Sample collection

Distillery spent wash was taken from a distillery, located in Dehradun. The factory uses molasses as the raw material. Sample was collected at main outlet of distillery in the last week of September 2016. Samples were collected five times on weekly basis from September to December 2016 in clean sterile plastic containers and stored at 4°C in a refrigerator.

5.2 Experimental design

Twenty four columns were prepared to treat distillery spent wash for 24 hour, 48 hour and 72 hour. Columns were prepared as given in table: 1.1.

Twenty four plastic pots were filled with 2 kg soil in each and wheat (*Triticum aestivum*, Variety UP 2329) was grown in each pot. Pots were divided into six groups each comprising four pots in each group to check the effect of treated distillery spent wash. Group of pots were named as columns for 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 spent wash, pots SA-1,SA-2,SA-3 were irrigated with 24 hour,48 hour and 72 hours sand treated spent wash, pots AC-1,AC-2,AC-3 were treated with 24 hour,48 hour,72 hour active carbon treated spent wash, pots SS-1,SS-2,SS-3 were irrigated with 24 hour,48 hour and 72 hours soil + sand (1:1) treated spent wash, pots SAC-1,SAC-2,SAC-3 were irrigated with 24 hour,48 hour,72 hour soil + active carbon (1:1) treated spent wash, pots SCD-1, SCD-2,SCD-3 were irrigated with 24 hour,48 hour,72 hour sand + active carbon (1:1) treated spent wash. Pots S-C, SA-C, AC-C, SS-C, SAC-C and SDC-C were irrigated with original spent wash and used as control. On each irrigation day 500 ml of treated spent wash was poured in respective pot. For treatment, distillery spent wash was passed through separate columns of soil, sand and active carbon and other textures. 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. All experiments were conducted at 25-35°C temperature.

Table: 1.1 Design of Different Columns of Soil, Sand and Active carbon
 (Same design is used for naming pots for irrigation)

Groups	Set-1 (For 24 hour treatment)	Set-2 (For 48 hour treatment)	Set-3 (For 72 hour treatment)	Set-4 Control
Soil	Soil-1 (S-1)	Soil-2 (S-2)	Soil-3 (S-3)	Soil-C (S-C)
Sand	Sand-1 (SA-1)	Sand-2 (SA-2)	Sand-3 (SA-3)	Sand-C (SA-C)
Active Carbon	Active Carbon-1 (AC-1)	Active Carbon-2 (AC-2)	Active Carbon-3 (AC-3)	Active Carbon-C (AC-C)
Soil + Sand (1:1)	Soil + Sand-1 (SS-1)	Soil + Sand-2 (SS-2)	Soil + Sand-3 (SS-3)	Soil + Sand-C (SS-C)
Soil+ Active Carbon (1:1)	Soil+ Active Carbon -1 (SAC-1)	Soil+ Active Carbon -2 (SAC-2)	Soil+ Active Carbon -3 (SAC-3)	Soil+ Active Carbon -C (SAC-C)
Sand + Active Carbon (1:1)	Sand + Active Carbon -1 (SCD-1)	Sand + Active Carbon -2 (SCD-2)	Sand + Active Carbon -3 (SCD-3)	Sand + Active Carbon -C (SCD-C)

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 spent wash was measured by pH meter using a glass electrode and also by using universal pH indicator solution.

5.7 Measurement of COD

It is the maximum amount of oxygen that can be consumed by the organic and inorganic matter in the given water 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 complexometric titration using ethylene diamine tetra acetic acid (EDTA). (Schwazebach)

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 529/768nm by using suitable optical filter device.

6. RESULT

Tab 1.2 shows that visible color of distillery spent wash 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 color and odor from distillery spent wash, which is seen maximum in active carbon followed by soil + active carbon (1:1) and minimum in treatment with sand. After 72 hour treatment with soil, sand and active carbon, pH of spent wash was increased significantly from 4.7 to 6.2 (active carbon), from 4.7 to 5.9 (with soil) and from 4.7 to 5.4 (with sand) (Table 1.4). COD (4184 mg/l), TS (3600 mg/l), TDS (3400 mg/l) were found minimum after 72 hours of treatment with active carbon (Table 1.4), maximum reduction in Ca (420 mg/l), Mg (380 mg/l), Na (320 mg/l), and K (420 mg/l) are seen after 72 hours with active carbon (Table 1.4). 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 1.4). After 72 hour treatment with sand minimum reduction are observed in physico chemical characteristics of spent wash 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 1.4). While after treatment with different combinations, reductions are seen as COD (4696 mg/l), TS (5200 mg/l), TDS (4700 mg/l), Ca (580mg/l), Mg (520 mg/l), Na (520 mg/l), K(700 mg/l) after 72 hour treatment with soil + sand (1:1), with soil + active carbon (1:1) 72 hour treatment following observations were observed COD (4600mg/l), TS (4000mg/l), TDS (5000 mg/l), Ca (440 mg/l), Mg (480 mg/l), Na (380mg/l) and K (540 mg/l) and with sand + active carbon (1:1) following results were noticed: COD (4950 mg/l), TS (4800 mg/l), TDS (5000 mg/l), pH (5.8), Ca (640 mg/l), Mg (660 mg/l), Na (420 mg/l) and K (780 mg/l) (Table 1.5).

7. DISCUSSION

Active carbon 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 spent wash was found maximum 48.98% by using active carbon, 46.54% by using soil and 36.37% by using sand while reduction in TS is observed 64% with active carbon, 58% with soil and 42% with sand. Reduction in TDS is observed 55.26% with active carbon, 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 active carbon after 72 hour (Table 1.6). Ca (75.46%), Mg (74.57%), Na (55%), K (71.76%) with soil treatment of spent wash. Ca (69.01%), Mg (66.47%), Na (37.5%), K (44.24%) with sand treatment of spent wash after 72 hours (Table:1.6). while with soil + sand (1:1), reductions after 72 hour treatment are observed as COD (42.73%), TS(48%), TDS(42.11%), Ca (73.64%), Mg (69.94%), Na (35%), K (58.82%). With soil + active carbon(1:1) reduction are seen as COD (43.90%), TS (60%), TDS (34.47%), Ca (80%), Mg (72.25%), Na (52.5%), K (68.24%) after 72 hour treatment. With sand + active carbon following results are observed COD (39.54%), TS (52%), TDS (34.21%), Ca (70.91%), Mg (61.85%), Na (47.5%) and K (54.12%). (Table:1.7). Changed soil characteristic resulted in an altered growth of wheat after irrigation with treated spent wash (24hrs, 48hrs, and 72 hrs treatment). Spent wash was purified more with active carbon 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 spent wash and we can reshape the spent wash characteristics so it can be used for irrigation in

farming to reduce the pressure of chemical fertilizers and water irrigation. The study also revealed that the treated spent wash could be beneficial for better growth of wheat plant which also enhances wheat seed germination. The adsorbent treatment method of spent wash can be profitably practiced for removing the pollutants and thus avoiding the ground water contamination and its environmental impacts. Active Carbon and soil + Active Carbon can be used for this purpose successfully.

9. REFERENCES

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Table: 1.2

Effect of Soil, Sand and Active Carbon on Color and Odor of Spent Wash after 72 hour Treatment

Parameter	Soil			Sand			Active Carbon		
	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: 1.3

Effect of Soil + Sand (1:1), Soil + Active Carbon (1:1) and Sand + Active Carbon on Color and Odor of Spent Wash after 72 hour Treatment

Parameter	Soil + Sand(1:1)			Soil + Active Carbon (1:1)			Sand + Active Carbon (1:1)		
	24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
Color	DB	B	LB	LB	CL	CL	LB	CL	CL
Odor	MO	MM	MM	MM	MM	OL	MO	MM	MM

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

Table: 1.4

Physico Chemical Characteristics of Distillery spent Wash Treated with Soil, Sand and ACTIVE CARBON at Various Irrigation Periods

Parameters	Original sample	Normal Soil			Normal Sand			ACTIVE CARBON		
		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: 1.5

Physico Chemical Characteristics of Distillery spent Wash Treated with Soil + Sand (1:1), Soil + Active Carbon (1:1) and Sand + Active Carbon (1:1) at Various Irrigation Periods

Parameters	Original Sample	Soil + Sand (1:1)			Soil + Active Carbon (1:1)			Sand + Active Carbon (1:1)		
		24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
TS	10000	6200	5600	5200	5200	4600	4000	6000	5400	4800
TDS	7600	5200	4900	4700	5000	4800	4500	5500	5200	5000
pH	4.7	5.3	5.5	5.7	5.2	5.5	6.0	5.0	5.3	5.8
COD	8200	5680	5208	4696	5320	4928	4600	5464	5164	4958
Ca	2200	620	600	580	560	520	440	720	700	640
Mg	1730	600	580	520	540	500	480	680	660	660
Na	800	580	520	500	460	400	380	500	460	420
K	1700	820	780	700	620	580	540	840	820	780

All values are in mg/l except pH.

Table: 1.6

Percentage Change in Physico Chemical Characteristics of Distillery spent Wash Treated with Soil, Sand and Active Carbon at Various Irrigation Periods

Parameter	Original Sample	Normal Soil			Normal Sand			Active Carbon		
		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

Table: 1.7

Percentage Change in Physico Chemical Characteristics of Distillery spent Wash Treated with Soil + Active Carbon (1:1), Soil + Sand (1:1) and Sand + Active Carbon (1:1) at Various Irrigation Periods

Parameter	Original Sample	Soil + Sand (1:1)			Soil + Active Carbon (1:1)			Sand + Active Carbon (1:1)		
		24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
TS	10000	-38	-44	-48	-48	-54	-60	-40	-46	-52
TDS	7600	-31.58	-35.53	-38.16	-34.21	-36.84	-40.79	-27.63	-31.58	-34.21
pH	4.7	+12.77	+17.02	+21.28	+10.64	+17.02	+27.66	+6.38	+12.77	+23.40
COD	8200	-30.73	-36.49	-42.73	-35.12	-39.90	-43.90	-33.37	-37.02	-39.54
Ca	2200	-71.82	-72.73	-73.64	-74.55	-76.36	-80	-67.27	-68.18	-70.91
Mg	1730	-65.32	-66.47	-69.94	-68.79	-71.10	-72.25	-60.69	-61.85	-61.85
Na	800	-27.5	-35	-37.50	-42.5	-50	-52.5	-37.5	-42.5	-47.5
K	1700	-51.77	-54.12	-58.82	-62.53	-65.88	-68.24	-50.59	-51.77	-54.12

Figure: Samples collected after treatment.



Graph: Changes in Physico Chemical Characteristics of Distillery Spent Wash after 72 hour Treatment.(Values are in mg/l)
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