Modified Drawer Compacted Sand Filtration Technique to Treat Grey Water in M-DIT College Canteen, Calicut

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Abstract: ***Modified Drawer Compacted Sand Filter (MDCSF) is a modified design for drawer compacted sand filter (DCSF).DCSF is the modified form of sand filter. In MDCSF, the silver coated sand layer is broken down into several layers and the drawers are placed in such a way that it can be movable for the cleaning and refilling purposes. Placing treatment media in separate movable drawers facilitates the oxygen movement between layers .Grey water which is the waste water generated from kitchen sink, washing, bathing etc. was treated in this study using a modified drawer compacted sand filterer (MDCSF) and efficiency was compared with that of DCSF which is also fabricated in the laboratory. Effect of varying flow rate and depth of sand layers were also studied here. Grey water treatment efficiency of MDCSF and DCSF was studied and the effluent parameter value concentrations are compared with the irrigation standards.***

Keywords: grey water, drawer compacted sand filter, modified drawer compacted sand filter

1. Introduction

80% of the earth is covered with water .but this entire water cannot be used for drinking because the major portion occupies in sea and oceans. The rest of water present in other sources are also not to be safe for usage due to rapid increase of population. Grey water is all the wastewater produced in a household excluding toilet waste water. It is wastewater from baths, showers, hand basins, washing machines and dishwashers, laundries and kitchen sinks. Since grey water is a reflection of household activities, its main characteristics strongly depend on factors such as cultural habits, living standard, household demography, type of household chemicals used etc. The composition of grey water mainly depends on quality and type of available water supply and household activities. Cooking habits as well as amount and type of soap and detergent used significantly determine the level of contamination. Grey water may contain soaps, food particles, grease, oil, lint, hair, pathogens, and traces of other chemicals. Grey water also contains high levels of detergents. These contain surfactants (surface active agents), builders, bleaches, enzymes, preservatives, solvents, fillers etc .

2. Materials

The major raw materials required for the construction of modified drawer compacted sand filter is that sand, silver coated sand and activated charcoal.

2.1 Sand

In ordinary drawer compacted sand filters sand is used as filtering medium. Sand grain size and sand bed depth both has an important role in removing large extend of impurities from water. Each drawers of DCSF are filled with different grades of sand. The purity of water increases with fineness and bed depth of sand.

2.2 Silver coated sand

Antibacterial and filtering property of sand can be considerably enhanced when it is coated with silver**.** The process of coating sand with silver is called impregnation technique. The steps followed for impregnation process are as follows

1) 500gm of graded, washed and dried sand was mixed with 1gm silver nitrate and dissolved in 1lit of distilled water
2) Above ingredients are mixed thoroughly and allowed a maturing time of 1hr.
3) This mixture was then treated with 2gm of NaOH and dissolved in 50ml distilled water and mixed thoroughly
4) The sand was treated with 10ml of 1% ammonium hydroxide solution and 15ml of reducing agent (9% of sugar solution) mixed thoroughly as before and left for 1hr.
5) The treated sand after solar drying was washed with distilled water to pH 7 and finally dried.

2.3 Coconut Shell Activated Charcoal

Coconut shell was treated with NaCl to obtain coconut shell activated charcoal.due to the high adsorption capaciti it be used in water purification technique preperation

1) The activated carbon was produced by chemical activation of charcoal
2) NaCl was carbonized at a temperature of about 100°C
3) Then soak charcoal in NaCl
4) After the production of charcoal, the materials were broken into smaller pieces.
5) Then the pieces were soaked in a 50% solution of NaCl for 24 hours.

6) After that it is allowed to dry in the sun or placed in an oven at 100°C

Figure 1: During impregnation technique

Figure 2: During solar drying

Figure 3: Coconut Shell Activated Charcoals

3. Methods

3.1 Experimental set up

A DCSF unit under laboratory conditions was constructed. A fabricated steel framework and six plastic drawers with dimensions of 50cm x 30cm x 10cm were obtained and placed on the frame. Seperation between the drawers are made as 15 cm. Each drawer except the lowest drawer was perforated with holes (2mm dia) .A distribution manifold was placed over the top drawer and it is connected to the storage tank which contains grey water.

Figure 4: Experimental setup done in the laboratory

Table 1: Design parameters of the laboratory set MDCSF

Filter media	Size of sand
Drawer 1	Gravels; effective size 2.4 mm
Drawer 2	Gravels; effective size 1.2 mm
Drawer 3	Gravels; effective size 2.4&1.2 mm
Drawer 4	Gravels; effective size passing through 1.2 mm
Drawer 5	Granular activated carbon

3.2 Operating Conditions and Procedure

The modified drawer compacted sand filter was fabricated then it was operated under room temperature, after each treatment under varying hydraulic loading rate and depth of sand layer the effluent were tested for COD, BOD, E- coli, Hardness, turbidity and TDS. After that Drawer compacted sand filter with same cross sectional area and grades of sand were fed with grey water. They were operated under room temperature. After each treatment under varying hydraulic loading rate and depth of sand layer the effluent were tested for COD, BOD, E- coli, Hardness, turbidity and TDS. Finally the efficiency of both set ups were compared.

3.3 Sample Collection and Storage

The grey water is collected daily from the the M Dit college canteen and was fed into the DCSF and MDCSF. It was subjected to various operating conditions and after each treatment the effluent was collected in bottles and was tested for various parameters.

4. Results and Discussions

The performance of the Drawer Compacted Sand Filter (DCSF) in the grey water treatment was studied and was compared with Modified Drawer Compacted Sand Filter (MDCSF) with silver coated sand and the results of the study are reported as follows

Figure 5: The influent and effluent

4.1 Performance of DCSF under varying hydraulic loading rate with thickness of sand layer 2.5cm

The DCSF was operated under varying hydraulic loading rate of 70, 100, 130 l/m^2/day with thickness of sand bed 2.5cm. Effluent was collected and characteristics of effluent were determined. Experimental data is given in the table1

Table 1: Experimental data of the DCSF operated with variation in hydraulic loading rate

Parameter	Influent	Hydraulic loading rate (l/m^2/day)	Effluent	% Removal
Turbidity (NTU)	35	70 100 130	25 28 28	28.6 20 20
Hardness (mg/l)	95	70 100 130	50 54 60	47.36 43.15 36.84
TDS (mg/l)	630	70 100 130	350 396 402	44.44 37.14 36.19
BOD (mg/l)	240	70 100 130	150 163 170	37.5 32 29.16
COD (mg/l)	628	70 100 130	66 80 88	89.49 87.26 85.99
E-Coli (CFU/100ml)	$11x10^6$	70 100 130	$64x10^4$ $93x10^4$ $120x10^4$	94.19 91.55 89.09

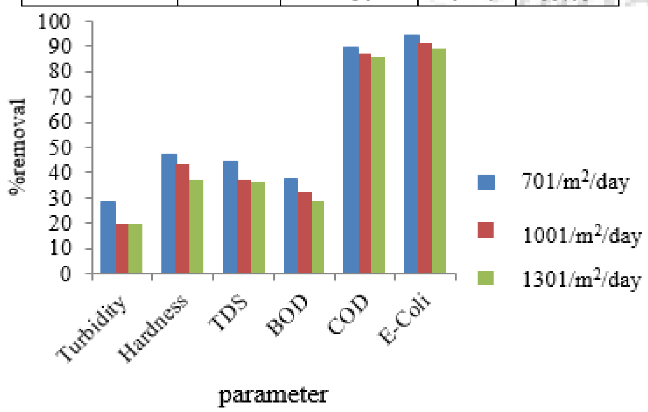

Figure 6: Effect of varying hydraulic loading rate on removal of BOD, Turbidity, Hardness, COD, TDS and E-coli in DCSF

Table 2: Variation in COD, BOD, TDS and Hardness by percolating through the drawer

Parameter	Influent	Dr1	Dr2	Dr3	Dr4
Turbidity (NTU)	35	35	32	28	25
Hardness (mg/l)	95	90	82	70	50
TDS (mg/l)	630	628	550	312	350
BOD (mg/l)	240	239	200	185	150
COD (mg/l)	628	514	356	152	66
E-Coli (CFU/100ml)	$11x10^6$	$460x10^4$	$210x10^4$	$120x10^4$	$64x10^4$

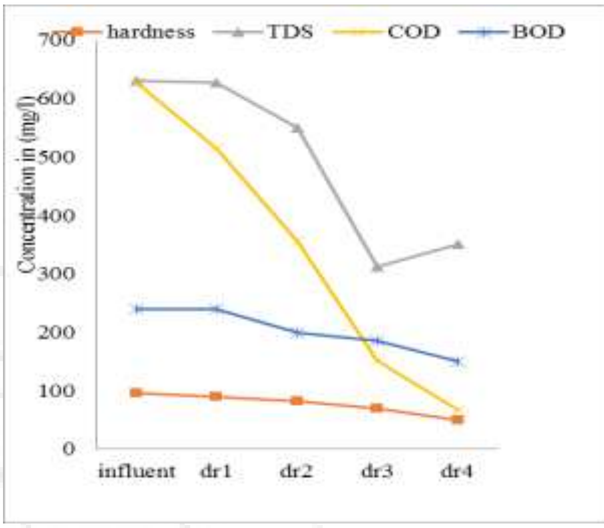

Figure 7: Variation in COD, BOD, TDS and Hardness by percolating through the drawer

4.2 Performance of MDCSF under varying hydraulic loading rate and thickness of sand layer 2.5cm

The Modified DCSF was operated under varying hydraulic loading rate of 70, 100, 130 l/m^2/day with thickness of sand bed 2.5cm. Effluent was collected and characteristics of effluent were determined. Experimental data is given in the table 3

Table 3: Experimental data of the MDCSF operated with variation in hydraulic loading rate

Parameter	Influent	Hydraulic loading rate (l/m^2/day)	Effluent	% Removal
Turbidity NTU)	57	70 100 130	30 37 47	47.36 35.08 26.31
Hardness (mg/l)	98	70 100 130	408 397 405	32.00 33.83 32.50
TDS (mg/l)	600	70 100 130	60 62 70	38.77 36.73 28.53
BOD_5 (mg/l)	241	70 100 130	11 15 20	95.43 93.78 91.70
COD (mg/l)	628	70 100 130	76 80 88	89.49 87.26 85.99
E-Coli (CFU/100ml)	$11x10^6$	70 100 130	3 7 11	99.99 99.99 99.99

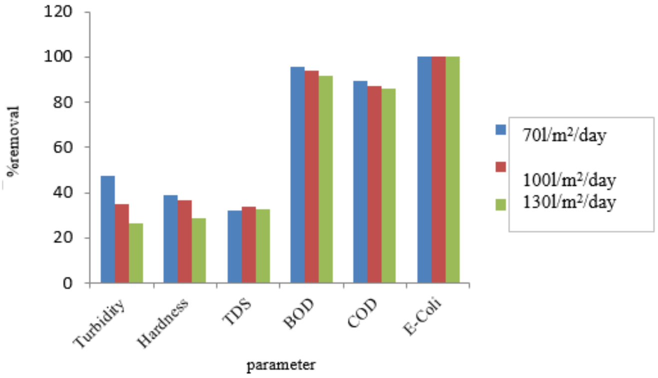

Figure 8: Effect of varying hydraulic loading rate on removal of BOD, Turbidity, Hardness, COD, TDS and E-coli in MDCSF with thickness of sand layer 2.5cm

Table 4: Variation in COD, BOD, TDS and Hardness by percolating through the drawer

Parameter	Influent	Dr1	Dr2	Dr3	Dr4	Dr5
Turbidity (NTU)	57	45.5	38	32.8	31.5	30
Hardness (mg/l)	98	90.8	76.4	66.4	63	60
TDS (mg/l)	600	568.5	480.5	412.5	410	408
BOD (mg/l)	241	205	102	53	365	11
COD (mg/l)	628	540	390	210	105	66
E-Coli (CFU/100ml)	$11x10^6$	$21x10^4$	$12x10^4$	500	48	3

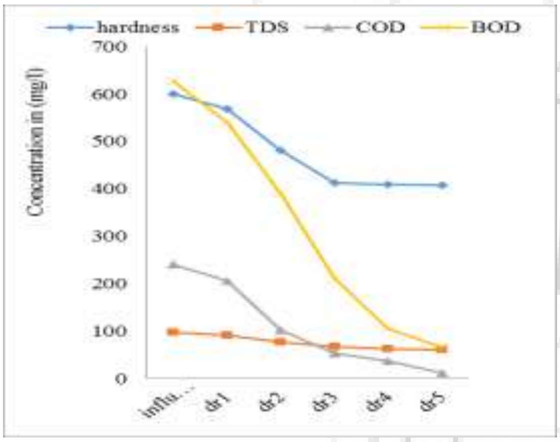

Figure 9: Variation in COD, BOD, TDS and Hardness by percolating through the drawers

4.3 Performance of DCSF under varying hydraulic loading rate and thickness of sand layer 5cm

Table 4: Experimental data of the DCSF operated with variation in hydraulic loading rate

Parameter	Influent	Hydraulic loading Rate ($l/m^2/day$)	Effluent	% Removal
Turbidity (NTU)	37	70 100 130	2.6 3 3.6	92.97 91.89 90.27
Hardness (mg/l)	110	70 100 130	370 355 396	36.36 30.90 34.54
TDS (mg/l)	630	70 100 130	70 76 72	41.27 43.65 37.14
BOD_5 (mg/l)	241	70 100 130	29 31 34	87.97 87.14 85.89
COD (mg/l)	628	70 100 130	68 76 92	89.17 87.90 85.35
E-Coli (CFU/100ml)	$11x10^6$	70 100 130	$39x10^4$ $75x10^4$ $93x10^4$	96.45 93.90 91.54

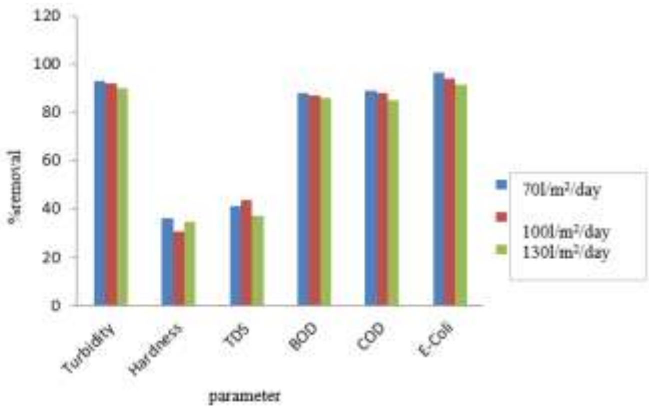

Figure 10: Effect of varying hydraulic loading rate on removal of BOD, Turbidity, Hardness, COD, TDS and E-coli in MDCSF with thickness of sand layer2.5cm

Table 5: Variation in COD, BOD, TDS and Hardness by percolating through the drawer

Parameter	Influent	Dr1	Dr2	Dr3	Dr4
Turbidity (NTU)	37	25.9	12.1	7.2	2.6
Hardness (mg/l)	110	104	92	86	70
TDS (mg/l)	630	597	528	433	370
BOD (mg/l)	241	196	138	95	29
COD (mg/l)	628	512	364	256	68
E-Coli (CFU/100ml)	$11x10^6$	$460x10^4$	$210x10^4$	$120x10^4$	$93x10^4$

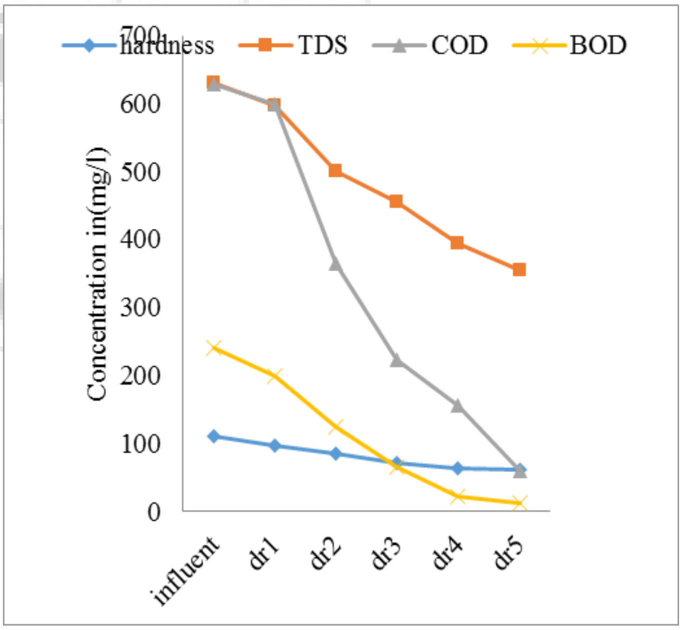

Figure 11: Variation in COD, BOD, TDS and Hardness by percolating through the drawers

4.4 Performance of MDCSF under varying hydraulic loading rate and thickness of sand layer 5cm

Table 6: Experimental data of the DCSF operated with variation in hydraulic loading rate.

Parameter	Influent	Hydraulic loading rate (l/m^2/day)	Effluent	%Removal
Turbidity (NTU)	37	70 100 130	1.5 2.2 2.5	95.94 94.05 93.24
Hardness (mg/l)	110	70 100 130	62 70 76	43.63 36.36 30.90
TDS (mg/l)	630	70 100 130	355 402 436	43.65 36.19 30.79
BOD_5 (mg/l)	241	70 100 130	12 14 16	95.45 94.19 93.36
COD (mg/l)	628	70 100 130	68 76 92	90.44 89.64 88.53
E-Coli (CFU/100ml)	11x10^6	70 100 130	39x10^4 75x10^4 93x10^4	99.99 99.99 99.99

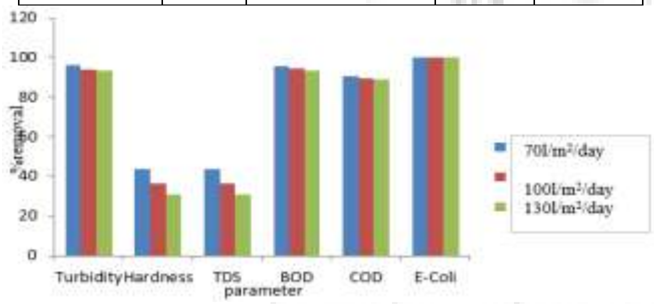

Figure 12: Effect of varying hydraulic loading rate on removal of BOD, Turbidity, Hardness, COD, TDS and E-coli in MDCSF with thickness of sand layer2.5cm

Table 7: Variation in COD, BOD, TDS and Hardness by percolating through the drawer

Parameter	Influent	Dr1	Dr2	Dr3	Dr4
Turbidity (NTU)	37	25.9	12.1	7.2	2.6
Hardness (mg/l)	110	104	92	86	70
TDS (mg/l)	630	597	528	433	370
BOD (mg/l)	241	196	138	95	29
COD (mg/l)	628	512	364	256	68
E-Coli (CFU/100ml)	11x10^6	460x10^4	210x10^4	120x10^4	93x10^4

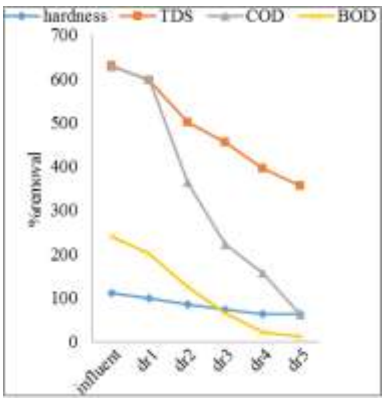

Figure 13: Variation in COD, BOD, TDS and Hardness by percolating through the drawers

5. Conclusion

Grey water which is the waste water generated from kitchen sink, washing, bathing etc. was treated in this study using a modified drawer compacted sand filterer(MDCSF) and efficiency was compared with that of DCSF which is also fabricated in the laboratory. Effect of varying flow rate and depth of sand layers were also studied here. Grey water treatment efficiency of MDCSF and DCSF was studied and the effluent parameter value concentrations are compared with the irrigation standards and found that grey water after the treatment using DCSF and MDCSF met the irrigation standards. And also recognized that Modified DCSF is found more efficient than DCSF. Efficiency in maximum when the hydraulic loading rate is less. E-coli removal increased due to the antibacterial property of silver. BOD and turbidity removal also increased in the case of silver coated sand. There is a decreased removal efficiency in TDS is due to silver leaching. Depth of sand layer also increases the removal efficiency.

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