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Alternative economic technology for treatment of distillery effluent to prevent surface and ground water pollution

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ABSTRACT: The present study was conducted to find out pollution reduction potential of Sand intermittent filtration bed in term of physico-chemical and microbiological characteristics of distillery effluent. The distillery effluent was filtered through Sand intermittent filtration beds of mixture of sand and soil at different ratio *i.e.* 1:1, 1:3, 3:1 and one set of 100% of each sand and soil were also taken. Results revealed that there was a significant pollution reduction in various physico-chemical and microbiological parameters of distillery effluent treated with sand and soil filtration. In general filtration bed containing sand and soil have shown better performance than filtration bed containing only sand or soil for distillery effluent. Maximum pollution reduction was found in the bed containing sand and soil ratio of 3:1 at 2 ft depth than all other ratios and depths. However declined trend of pollution did not remain same for several parameters in the same conditions. Maximum reduced value of pollution load for maximum parameters was recorded at 2 feet dept in sand soil bed of 3:1 ratio i.e. BOD 82.49%, COD 78.96%. Total alkalinity 75.32%, Turbidity 68.94%, Total solids 94.97%, Total dissolved solids 95.29%, Total suspended solids 94.16%, MPN 95.14% and SPC 67.21%. Maximum percentage of reduction in Temperature 59.55% was found at 2 ft depth in soil only. Maximum percentage of reduction in CO_2 73.39% was found at 2 ft depth in sand soil mixed bed of 1:3 ratio. Minimum reduction ability was found in 100% sand bed. @JASEM

It is much obvious that the population growth and human attitude of life has a positive correlation with deterioration of aquatic state of any reservoir than any other environmental state. It has also severely affected the phenomenon of climatic changes in nature and ultimately affected the precipitation behaviour/pattern on the earth planet. Utilization of ground water to fulfill the need of different sectors has become the necessity of twenty first century, but it has severely depleted ground water reservoir due to imbalance of utilization and recharging. Ground water is not being charged due to irregular participation and increasing area of urban and business sectors. An economic growth of the nation seems to be an important factor to provide a better life. Industrial revolution (Industrialization) has become an important tool to achieve and accelerate the national GDP of India. Albeit, industrial growth was started after the independence but in the last two decade of twentieth century and continuing twenty first century hetero industrial development has taken a major role in the national development. Large number of industries *viz*. metals, chemicals, petroleum products, pulp, paper, textiles, sugar and distilleries, nutraceuticals, pharmaceuticals and others are in functioning state to fulfill the needs of national requirements. But this phenomenon has generated different nature of pollutants which has severely affected both in land and the ground water.

Albeit water is most abundant substance on the earth planet but fresh water available for human use covers hardly 0.2% as inland surface water and 0.6% as ground water. This small fragment of fresh water has been contaminated by different ways in most of the countries including developed and developing countries. But the contamination of inland water has become a serious problem in India. Most of the Indian rivers and aquatic reservoirs are receiving heavy discharge of domestic sewage and industrial effluent. Appropriate sewage treatment due to heavy investment is not available in most of the cities and industries. Due to indiscriminate discharge of raw or partially treated sewage without following the guidelines for the available amount of water for dilution has imposed several problems. Both organic and inorganic pollution are causing severe adverse effect on living aquatic biota as well as on human health. Ganges, holy sacred river has become highly polluted and therefore India Government has chalked out 'Ganga Action Plan'.

In India, more than 250 distilleries are using molasses to produce alcohol. These are generating huge quantity of effluents which is highly rich in organic component as organic pollutant and if it is not discharged after proper treatment, may adversely affect not only surface water but also ground water. Perusal of literature indicates that efforts have been made on physical treatment of waste water using sand and soil mixture for the treatment (Huisman and Wood, 1974; Sarkar *et al*.; 1994; Bhagat *et al.,* 1999; Setvik *et al.,* 1999; Weber-Shirk, 2002; Rooklidge and Ketchum 2002; Ausland *et al.,* 2002; Prasad *et al.,* 2006).

As India is a developing country and facing severe energy crises and labour problems and many times

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practically Treatment- plants becomes fail under certain condition. Therefore, in order to solve these problems and to save national economy as well as to utilize wasteland and to protect ground water reservoir by developing overhead stabilization system as an alternative economic technology, the present work has been carried out to develop as preliminary model for the treatment of distillery effluent.

MATERIAL AND METHODS

Experimental design of Sand Intermittent Filtration tank-A septic metal tank of 35cm diameter with 5 ft height (Total Volume of tank- 0.147 m^3) with strong stand and a sieve of 0.5 mm fitted 1 ft above from base was constructed. A device was also made at the base of the tank to take out treated water for analysis of physico-chemical and bacteriological characteristics .

Filter-media – Agricultural porous yellow-brownish granular soil was taken below 1' depth from upper surface of the earth. The sand of medium sized particles obtained from river Ganges was used for making filtration beds. Filtration bed used in the present study contained 100% sand and 100% soil separately while in other sets different mixtures of sand and soil i.e. 1:1, 3:1, 1:3 were used in the preparation of Sand Intermittent Filtration bed in the tank. Different depths i.e. 1 ft, 1.5 ft and 2 ft of each kind of filtration bed were used for filtration of distillery effluent. No pre-leaching treatment was given at the time of experiments.

Sampling site and sample collection – Doon Valley distillery, located at Kuwanwala, 10 Km from Dehradun on Dehradun-Haridwar road (Uttaranchal), was selected for the collection of distillery effluent. Sampling was made four times in the morning during the time-period between 7.30 to 11.00 AM and at a time composite sample was collected in plastic container and brought to the laboratory for analysis. At a time, 10 liters of effluent was poured in the Sand intermittent filtration tank.

Analysis of effluent and filtered Distillery effluent - Distillery effluent and filtered Distillery effluent through different Sand intermittent filters were analyzed for their various physico-chemical and bacteriological characteristics by standard methods (APHA, 1998).

RESULTS AND DISCUSSION

The values of different parameters of distillery effluent i.e. temperature, turbidity total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), pH, total alkalinity (TA), dissolved oxygen (DO), Biochemical oxygen demand (BOD), chemical oxygen (COD), most probable number (MPN), and standard plate count (SPC) are given in table 1.

Maximum values for percentage reduction in each parameter have been found in the filtration bed containing sand and soil mixture at ratio of 3:1. Temperature of distillery effluent before filtration (raw effluent) was found 62.51ºC. Maximum temperature reduction *i.e.* 59.55% was found at 2 ft depth of filtration bed containing sand and soil at ratio 3:1. Minimum fall in temperature was found at 1 ft depth of sand bed indicated positive co-relation of retention time of effluent and in temperature fall. The significant fall in temperature in the filtered effluent may perhaps be due to influence of climatic factors as effluent was stored in steel filtration tank for overnight and analysis was performed in the next morning. It is obvious that temperature during night was lowered in natural way besides retention time compared with day time.

TS, TDS and TSS of raw distillery effluent were found 65066.66, 46800 and 18266.66 mg/lit respectively (Table 1). Maximum percentage removal of TS, TDS and TSS was recorded 94.97, 95.29 and 91.97 respectively in the filtered effluent. Maximum depletion in values of TS, TDS and TSS were found due to retention of these solid particles above and in the filtration bed which can be the real cause of significant depletion of these parameters. Filtered effluent has shown a tremendous reduction of turbidity. Since the turbidity is directly related with different kinds of particles, these were retained in the filtration bed due to which a significant fall in the turbidity occurred. The used technology in the present investigation is mainly employing physical treatment and does not require any kind of energy, workers or labour. Hence it is more significant.

pH of raw distillery effluent was recorded 3.98 but it was enhanced 26.13% in the filtered effluent. More pH in filtered effluent may be due to biological activity related with secondary metabolites produced by hetero group of microorganisms and may be containing alkaline based substances. CO_2 in raw effluent was found to be 3996.66 mg/l, but it was reduced by 73.39% after filtration. TA of raw effluent was found 6416.66 mg/lit and was reduced by 75.32% after passing through sand intermitted filtration bed.

DO in raw effluent and filtered effluent was found nil and the treatment could not facilitate improvement of DO (Table 1). BOD in raw effluent was found 5390mg/lt and was depleted by 82.49 % in filtered effluent. Minimum fall in BOD was 38.03 % in only sand bed at one ft depth. Supporting reports of these findings in terms of BOD reduction ability of filtration bed have been reported by Ellis (1987) who also found more than 65% reduction in BOD. Albeit filtration ability of filtration bed was found to be more superior than sand filtration technique adopted by Ellis. It may probably be due to variation of filtration bed components in term of size and ratio. Pure sand filtration bed could reduce BOD only 59.30% at 2 ft depth in our case but filtration bed containing soil could enhance BOD reduction ability. At the same time filtration bed containing sand and soil at 3:1 ratio could reduce 78.69% BOD. Among all combinations used in the present study at different depths, 3:1 ratio at 2 ft depth showed maximum utilization of organic components present in the effluent. Even more reduction of BOD in filtered effluent could not change in DO value. However, significant reduction was found in MPN and SPC which showed a positive correlation.

COD of raw sewage was found 10933.33 mg/lit and was reduced by 78.96% in filtered effluent. Similarly 76-82% removal of COD from waste water using sand intermittent filtration bed has been reported by Van Buuren *et al.* (1986). Our findings are also similar to the findings reported by Rao *et al.* (2003). Both MPN and SPC of raw effluent were found 350/100 ml and $61x10^5$ / ml respectively. Significant decline in both MPN and SPC values in filtered effluent was found to be 95.14% and 67.12 % respectively. Even in absence of dissolved oxygen, bacterial population was much higher in raw effluent and surprisingly it declined in filtered effluent as evident by recorded data (Table-1). The reduction in bacterial population in treated effluent may directly be related with consumption of organic components, their retention and death while passing through the filtration bed. But in the present conditions, it could not be stated whether existing bacteria are aerobic / anaerobic/ facultative aerobic/ facultative anaerobic in nature.

The present findings established a positive co-relation between temperature, BOD, MPN and SPC. The declined trend in temperature is in accordance with decline in BOD, MPN and SPC. It may be because of the influence of temperature as governing factor in each step of physiological behaviour of bacterial species inhabited in the effluent. However depletion of all these are also related with retention time. Christianae *et al*. (1998) also reported that water detention time is important factor in removing of organic matter from wastewater when it was passed through intermittent filter containing non-woven textile coupons.

Conclusions: Summarily a speedy removal of all kinds of solids, depletion in BOD, COD, MPN and SPC was found very significant after treating with sand – soil bed is an evident of economic technology which does not involve any kind labour and energy during filtration process except filtration bed cost. The findings of present study are encouraging and suggest that application of sand and soil in the filtration bed would always be more effective than sand and soil alone. But further investigation regarding optimization of sand size, different soil types and more depth on large scale and mathematical modeling are highly needed to accelerate effective filtration capacity for liquid waste management in the national interest. Definitely an intensive research in this area would not only help to solve the liquid waste management problem but would be effective in preventing surface and ground water pollution in the affected geographical areas/countries and would enable in sustaining water quality up to certain extent on this earth planet.

REFERENCES

APHA (1998): In: Standard methods of examination water and waste water, American Public Health Association, American Water Works Association and Water pollution control federation, Washington DC.

Ausland G, Stevik T.K., Hanseen J.F., Jkohler J.C. and Jenssen P.D. (2002). Intermittent filtration of wastewater – removal of fecal coliforms and fecal Streptococci. *Wat. Res*., 36:3507-3516.

Bhagat,M., Dewedar, A. and Zayed, A. (1999). Sand filter used for wastewater treatment : Buildup and distribution of microorganisms. *Wat.Res.,* 33: 1949-1955

Christiane, Ray, Rechard, Auger and Chessier Robert (1998). Use of non woven textile in intermittent filters. *Wat.Sci.Tech,*. 38: 159-165

Ellis K.V. (1987). Slow sand filtration as a technique for the tertiary treatment of municipal sewages *Wat. Res*., 21: 403-410.

Huisman L, and Wood W.E. (1974). Slow sand filtration. Geneva: World health Organization: 20-46.

Prasad, G., Rajeev Rajput and Chopra A.K. (2006). Sand intermittent filtration technology for safer domestic sewage treatment. *Journal of Applied Science and Enviro. Management,* 10: 73-77.

Rao, R. Ravinder, Reddy, R.C. Rama Rao, K.G. and Kelkar P.S. (2003). Assessment of slow sand filtration system for rural water supply schemes – A case study. *Indian J. Environ. Hlth*., 45 : 59 – 64.

Rooklidge, S.J. and Ketchum Jr. L.H. (2002). Corrosion control enhancement forms a dolomite-amended slow sand filter. *Wat. Res*., 36 : 2689-2694.

Sarkar A.K., Georgiou G., Sharma M.M. (1994). Transport of bacteria in porous medi. I An experiment investigation. *Biotechnol. Bioeng.,* 44:489-497.

Setvik T.K., Ausland G. Jenssen. P.D. and Siegrist R.L. (1999). Removal of *E.coli* during intermittent filtration of wastewater effluent as affected by dosing rate and media type . *Wat. Res.,* : 33- 2088-2098.

Van Buuren, J.C.L., Willers, H.,Luyten, L. and Van Manen, M. (1986). The pathogen removal from UASB – effluent by intermittent slow sand filtration. In: Anaerobic treatment a grown-up technology, conference papers. *Aquatec.,* 86: 707-709.

Weber-Shirk, M.L. (2002). Enhancing slow sand filter performance with an acid soluble seston extract. *Wat.Res*., 36: 4753-4756.

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Table- 1

Pollution Reduction Potential of Sand intermittent filtration at different ratio and depth of sand and soil bed

Parameter	Before Filtration	After filtration from sand intermittent bed														
		Sand/soil= 1:1 Depth			Sand/Soil=1:3 Depth			Sand / Soil = 3:1 Depth			Sand 100 % Depth			Sand 100% Depth		
		1"	1.5"	2"	1"	1.5"	2"	1"	1.5"	2"	1"	1.5"	2"	1"	1.5"	2"
Temperature (ºC)	62.51 ±0.21	32.15 ±0.05 (-48.56)	28.45 ±0.10 (-54.55)	25.81 ±0.09 (-58.71)	31.76 ±0.15 (-49.16)	28.2 ±0.22 (-55.88)	25.5 ±0.16 (-59.20)	3026 ±0.10 (-51.59)	27.95 ±0.08 (-55.28)	26.38 ±0.07 (-57.79)	35.73 ±0.05 (-42.84)	32.15 ±0.05 (-48.56)	26.96 ±0.10 (-56.87)	32.41 ±0.09 (-48.15)	30.78 ±0.12 (-50.75)	25.28 ±0.04 (-59.55)
Turbidity (JTU)	950 ±54.77	591.66 ±37.63 (-37.72)	388.33 ±7.52 (-59.12)	365 ±5.47 (-61.57)	466.66 ±25.81 (-50.87)	386.66 ±8.16 (-59.29)	336.66 ±18.61 (-64.56)	385 ±5.47 (-59.47)	353.33 ±6.32 (-62.80)	295 ±10.48 (-68.94)	950 ±54.77 (0)	783.33 ±40.82 (-17.54)	575 ±27.38 (-39.47)	733.33 ±51.63 (-22.80)	558.33 ±20.41 (-41.22)	475 ±27.38 (-50.00)
TS (mg/l)	65066.66 ±326.59	9133.33 ±163.29 (-85.96)	5533.33 ±301.10 (-91.49)	5333.33 ±206.55 (-91.80)	8200 ±219.08 (-87.39)	5066.66 ±326.59 (-92.21)	4666.66 ±206.55 (-92.82)	7933.33 ±163.29 (-87.80)	4200 ±219.09 (-93.54)	3266.66 ±393.27 (-94.97)	1066.66 ±206.55 (-83.60)	9600 ±309.83 (-85.24)	8866.66 ±467.61 (–86.37)	9600 ±309.83 (-85.24)	6066.66 ±301.10 (-90.67)	5400 ±219.08 (-91.70)
TDS	46800 ±357.59	5933.33 ±301.10 (-87.32)	3800 ±219.08 (-91.88)	3733.33 ±206.55 (-92.02)	5466.66 ±206.55 (-88.31)	3466.66 ±206.55 (-92.59)	3133.33 ±163.29 (-93.30)	5066.66 ±206.55 (-89.17)	2733.33 ±163.29 (-94.15)	2200 ±334.66 (-95.29)	7266.66 ±163.29 (-84.47)	6400 ±357.77 (-86.32)	6133.33 ±206.55 (-86.89)	6800 ±357.77 (-85.47)	4133.33 ±326.59 (-91.16)	3533.33 ±163.29 (-92.45)
TSS (mg/l)	18266.66 ±206.55	3266.66 ±393.27 (-82.11)	1733.33 ±206.55 (-90.51)	1600 ±357.77 (-91.24)	2733.34 ±301.10 (-85.03)	1600 ±252.98 (-91.24)	1533.33 ±163.29 (-91.60)	2866.66 ±301.10 (-84.30)	1466.66 ±326.59 (-91.97)	1066.66 ±206.55 (-94.16)	3400 ±334.69 (-81.38)	3200 ±473.28 (-82.48)	2733.33 ±588.75 (-85.03)	2800 ±178.88 (-84.67)	1933.33 ±163.29 (-89.41)	1866.66 ±206.55 (-89.75)
pH	3.98 ±0.98	4.46 ±0.05 (+12.06)	4.76 ±0.08 (+19.59)	4.91 ±0.07 (+23.36)	4.53 ±0.08 (+13.81)	4.8 ±0.08 (+20.6)	4.96 ±0.08 (+24.62)	4.71 ±0.04 (+18.34)	4.98 ±0.07 (+25.12)	5.03 ±0.08 (26.38)	4.31 ±0.04 (8.29)	4.41 ±0.04 (+10.8)	4.53 ±0.05 (+13.81)	4.35 ±0.05 (+9.29)	4.78 ±0.04 (+20.1)	4.86 ±0.10 (22.11)
CO_2 (mg/l)	3996.66 ±165.51	2896.66 ±89.81 (-27.52)	2053.33 ±113.6 (-48.62)	1576.66 ±89.81 (-60.55)	2750 ±181.84 (-31.19)	1870 ±120.49 (-53.21)	1063.33 ±165.61 (-73.39)	2310 ±269.44 (-42.20)	1700 ±123.93 (-57.46)	1503.33 ±89.8 1 (62.38)	3630 ±120. 49 (-9.17)	3336.66 ±89.81 (-16.51)	2346.66 ±227.61 (-41.28)	3263.33 ±268.6 (-18.34)	2750 ±120.49 (-31.19)	1943.33 ±165.51 (-51.37)
Total Alkalinity (mg/l)	6416.66 ±376.38	4250 ±273.86 (-33.76)	2666.66 ±258.19 (-58.44)	2083.33 ±204.12 (-67.53)	2416.66 ±376.38 (-62.33)	1916.66 ±204.12 (-70.12)	1833.33 ±258.19 (-71.42)	2000 ±316.22 (-68.83)	1833.33 ±258.19 (-71.42)	1583.33 ±376.29 (-75.32)	5666.66 ±258.19 (-11.68)	5083.33 ±204.12 (-20.77)	4416.66 ±376.38 (-31.16)	4583.33 ±204.12 (-28.57)	3250 ±273.86 (-49.35)	2250 ±258.19 (-64.93)
DO (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
BOD(mg/l)	5390 ±120.49	2701.66 ±168.21 (-49.87)	2563.33 ±103.27 (-52.44)	2396.66 ±150.55 (-55.53)	2361.66 ±167.38 (-56.18)	2021.66 ±220.96 (-62.49)	1786.66 ±81.64 (-66.85)	2125 ±115.02 (-60.57)	1653.33 ±150.55 (-69.32)	943.33 ±163.49 (-82.49)	3340 ±109.54 (-38.03)	2873.33 ±81.64 (-46.69)	2193.33 ±155.0 (-59.30)	3055 ±268.6 (-44.24)	1920 ±109.54 (-64.37)	1148.33 ±85.73 (-78.69)
COD (mg/l)	10933.33 ±301.10	7366.66 ±150.55 (-32.62)	5566.66 ±150.55 (-49.08)	3766.66 ±150.55 (-55.53)	7033.33 ±150.55 (-35.67)	4733.33 ±103.27 (-56.70)	3233.33 ±150.55 (-70.42)	6300 ±109.54 (-42.37)	3933.33 ±150.55 (-64.02)	2300 ±167.33 (-78.96)	8133.33 ±163.29 (-25.60)	6700 ±109.54 (-38.71)	5766.66 ±150.55 (-47.25)	7666.66 ±163.29 (-29.87)	5800 ±178.88 (-46.95)	3900 ±109.54 (-64.32)
MPN (MPN/100ml)	350	180 (-48.77)	49 (-86)	33 (-90.57)	280 (-20)	63 (-83)	27 (-92.28)	110 (-68.57)	23 (-93.42)	17 (-95.14)	280 (-20)	170 (-51.42)	26 (-92.57)	220 (-37.14)	170 (-51.42)	34 (-90.42)
SPC (Bacteria/ml)	$61X10^5$	$48X10^5$ (-21.31)	$45X10^5$ (-26.22)	$40X10^5$ (-34.42)	$51X10^5$ (-16.39)	$51X10^5$ (-16.39)	$49X10^5$ (-32.78)	$37X10^5$ (-39.34)	$22X10^5$ (-63.93)	$20X10^5$ (-67.21)	$57X10^5$ (-6.55)	$45X10^5$ (-26.22)	$41 X10^5$ -32.78	$50 X10^5$ (-18.03)	$37 X10^5$ (-39.34)	$33 X10^5$ (-45.90)

± SD , % Increase / Decrease given in parentheses.

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