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Impact of Distillery Effluent and its Leachate on ground water quality (using lysimeter): An Experimental Approach (Part B)

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ABSTRACT

Distillery effluent is posing threat to the different components of the environment, mainly affecting soil and water characteristics as the chemicals leaches to the ground water table. The organic materials are mobile in the ground water and constitute a major off site pollution hazard. Large volumes of effluent are often discharged on small areas of land, which aggravates leaching. The study reveals that the physico-chemical characterisation of PTDE (primary treated distillery effluent) have high load of pollutants but when it is diluted with 50% of water, the value was decreased but not as per under control conditions. When diluted PTDE was passed through the lysimeter, all the values of physico-chemical parameters revealed great reduction, variation and fluctuation in leachate on different days and these values increased day by day but it was lower than the value of PTDE leachate. It indicates that the physicochemical value of diluted PTDE was also high. From these observations it may be concluded that the soil has capacity to absorb / adsorb the pollutants but their continuous application may reduce the absorbing / adsorbing capacity of soil and continuous disposal of industrial effluents on lands leads to percolation of pollutants to the groundwater through seepage and leaching, causing contamination.

Key words: Leachate, lysimeter, PTDE (Primary treated distillery effluent), Physico-chemical parameters,

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INTRODUCTION

Leachate is any liquid that, in passing through matter, extracts solutes, suspended solids or any other component of the material through which it has passed. The term “leachate” refers to liquids that migrate from the waste carrying dissolved or suspended contaminants. Leachate results from precipitation entering the land and from moisture that exists in the waste when it is disposed. If uncontrolled, leachate can be responsible for contaminating groundwater and surface water.

Leachate can be a major source of contamination to groundwater, surface water and soil. The risks from leachate are due to its high organic contaminant concentrations. Toxic substances may however be present in variable concentration and their presence is related to the nature of waste deposited.

The movement of water along with industrial effluents by diffusion and convection in the soil involves a series of complex processes. These processes are very important for monitoring the contamination of soil, groundwater and for environmental geochemical studies. Many metals and other contaminants migrate into the soil horizontally as well as vertically and cause groundwater pollution that depends on factors like mobility of chemicals and soil conditions[1]. Application of spent wash has resulted in leaching of high amounts of organic and inorganic

contaminants that may pose potential for groundwater contamination. The contamination of groundwater by effluent in the lagoon sites in most of distilleries has been reported widely. In some areas the colour problem in groundwater is so acute that distilleries have to provide potable water to surrounding village.

Physicochemical characteristics of distillery effluents were studied[1]. Monitoring of the physicochemical characterisation of distillery waste has been carried out and stated that molasses is the most common raw material used in distilleries for bio-ethanol production[2,3,4] .

There have been also numerous studies done on impact of distillery effluent on soil and water quality [5,6,7,8,9,10] studies on pollution potential of distillery waste as soil leaching and leaching of liquid waste through soil, physicochemical characterization of leachate and its effects on soil properties and ground water quality[11,12,13] and leachate from landfill lysimeter using different types of soil cover studied[14].

Leachate is the liquid percolation that drains through the waste in the landfill, varies widely depending on waste type and the waste age[15,16,17].

MATERIALS AND METHODS

The physico-chemical parameters PTDE diluted with 50% of water and its leachate from lysimeter were studied. Physico-chemical properties such as Colour, Odour, Total Solids (TS), Total dissolved solids (TDS), Total Suspended Solids (TSS), pH, Electrical Conductivity (EC), Total hardness, Calcium (Ca), Magnesium (Mg), Alkalinity, Chloride (Cl), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonical Nitrogen, Total Phosphorus, and Total Potassium were analysed. All the samples were analyzed for selected relevant physico-chemical parameters according to internationally accepted procedures and standard methods[18].

Methodology used for leachate preparation; Apparatus (lysimeter) -Experimental setup:
The apparatus lysimeter **(figure 1)** was used for leachate preparation. The lysimeter was used for PTDE diluted with 50% of water applied on to the soil filled in lysimeter and the leachate was collected and analysed at different days throughout six months.

For the leachate preparation, lysimeters (device used to measure the rate of moment of water through or from a soil layer) were made. The percolated distillery effluent as leachate at different dilution of distillery effluent from lysimeter were analysed at different time intervals. Lysimeter measures 324 cm. (105 inch long) in length and 194 cm. (78 inch) in diameter. The lower part i.e. 15 cm. of lysimeter was left blank for leachate collection. Above the blank space a steel grill (2cm.) was adjusted for the settlement of gravel and soil layers. Above the grill, gravel (15 cm.) was settled for holding soil layers. On this, the soil was put layer by layer and water was spread at each layer of soil from bottom to top for the compaction of soil in lysimeter. The total height of soil horizons in lysimeter was 267 cm. Top portion of lysimeter (15 cm.) was left blank for filling distillery effluent at different dilution.

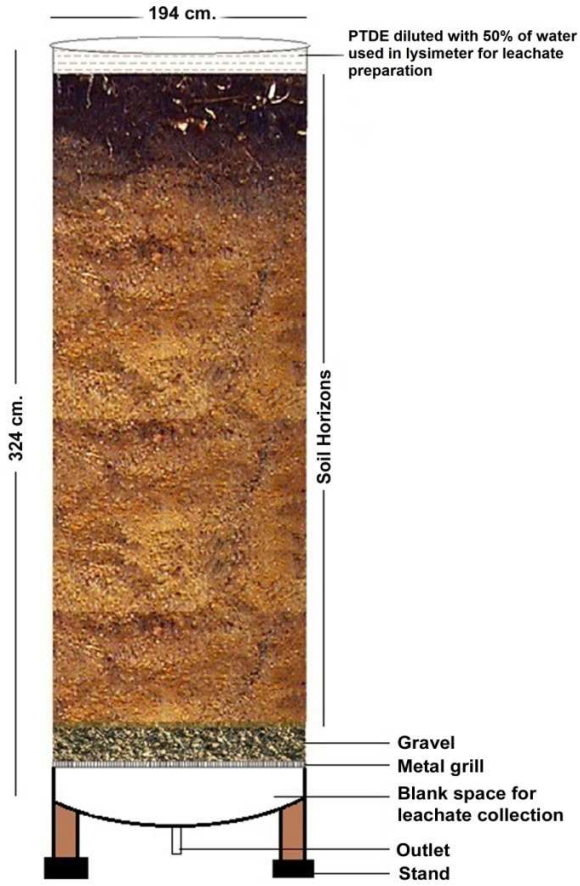


Plate 9: Experimental setup of lysimeter to study the leaching effect (Internal structure)

Metal drum was used for formation of lysimeter. The physico-chemical properties of this soil were analysed. This soil was filled in lysimeter layer by layer as to look like soil horizon (lower horizon of soil filled in bottom then all the remaining soil horizons were filled above that). Blank space in bottom of lysimeter was attached to leachate collector for collecting the leachate.

RESULT AND DISCUSSION

Results are presented in two parts. The first part deals with physicochemical parameters of partially treated distillery effluent and the second part of the study deals with the quality parameters of different day of leachate characteristics.

A. Physicochemical Characteristics of PTDE diluted with 50% of water:

The Physico-chemical parameters of diluted PTDE were analysed and tabulated **(Table 1)**. The study reveals that the physicochemical characteristics of PTDE diluted with 50% of water have high load of pollutants. The effluent was brownish in colour. The colour of spent wash is suspected due to presence of a derivative of caramelized sugar formed during the distillation, termed melanoidin[2]. Odour of samples was alcoholic in nature. Odours compounds from distillery waste water mainly consist of volatile fatty acids such as butyric and valeric acids that have a high odour index**.** The offensive odour of effluent was also reported[1]. It is one of the most complex and cumbersome waste having very high value of Total solids i.16120.2 mg/l, The total dissolve solid of PTDE was 12354.0 mg/l and

the total suspended solids was 3766.0 mg/l. electrical conductivity, hardness, calcium and magnesium compounds, chlorides, BOD and COD content and highly acidic pH, while D.O. was found Nil and contains high organic load of nutrient elements such as nitrogen, potassium and phosphorus but all the values were lower to PTDE.

Table 1: Physicochemical characteristics of PTDE diluted 50% with water which was used in Lysimeter for leachate preparation. (*Mean of triplicate samples (Mean ±Std. error of mean); (Values are in mg/ l unless otherwise stated).*

PARAMETERS	VALUES
Colour	Brown
Odour	Offensive
Total solids	16120.2 ±8.0
Total Dissolve solids	12354.0 ±10.0
Total suspended solids	3766.0 ±0.0
pH	7.6 ±0.6
EC (µmho/cm)	8380.6 ±14.8
Total Hardness	1354.2 ±6.3
Calcium	610.2 ±4.0
Magnesium	992.0 ±8.3
Alkalinity	1880.0 ±10.0
Chloride	2362.4 ±6.0
Dissolve Oxygen	2.6 ±0.4
Biological Oxygen Demand	6890.5 ±16.2
Chemical oxygen Demand	11448.6 ±16.2
Ammonical Nitrogen	412.3 ±6.4
Total Phosphorus	22.4 ±2.3
Total Potassium	2854.2 ±8.2

B. Quality Parameters of Leachate of PTDE diluted with 50% 0f water on different days

The physico-chemical characteristics of leachate on different days from lysimeter which were treated with primary treated distillery effluent (PTDE) were studied. Physico-chemical properties such as Colour, Odour, Total Solids (TS), Total dissolved solids (TDS), Total Suspended Solids (TSS), pH, Electrical Conductivity (EC), Total hardness, Calcium(Ca), Magnesium (Mg), Alkalinity, Chloride (Cl), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonical Nitrogen, Total Phosphorus, and Total Potassium were analysed and tabulated **(Table 2).**

The data revealed great reduction, variation and fluctuation in leachate on different days. The PTDE (Primary Treated Distillery Effluent) leachate shows the higher values at all physico-chemical parameters which are discussed below.

Colour

In lysimeter which was treated with PTDE diluted with 50% of water shows variation in leachate colour day by day. It shows that the leachate colour was colourless from 1st to 4th day and after 4th day it slightly changed to minute creamy on 5th to 15th day and then changed to creamy in colour on 20th to 30th day and further it changed to light yellowish colour on 40th to 70th day and then it changed to yellowish colour on 80th to 140th day and again changed to yellowish brown colour on150th to 180th day.

The distillery effluent was brownish in colour due to the presence of high load of organic matter such as N, P, K and other substances. These substances contain dark brown colour but when it passes through the soil horizon, the soil absorbs these nutrients and organics, and then the colour of leachate gets changed. But with passing time absorbing capacity of soil is reduced.

Odour

In lysimeter which was treated with PTDE diluted with 50% of water also shows that the leachate was odourless from 1st to 120th day and then it slightly changed to minute smell on 130th day and constant till 180th day.

Table (2): Physicochemical characteristics of different days of leachate from lysimeter which was treated with PTDE diluted 50% of water. *Mean of triplicate samples (Mean ±Std. error of mean); (Values are in mg/ l unless otherwise stated).*

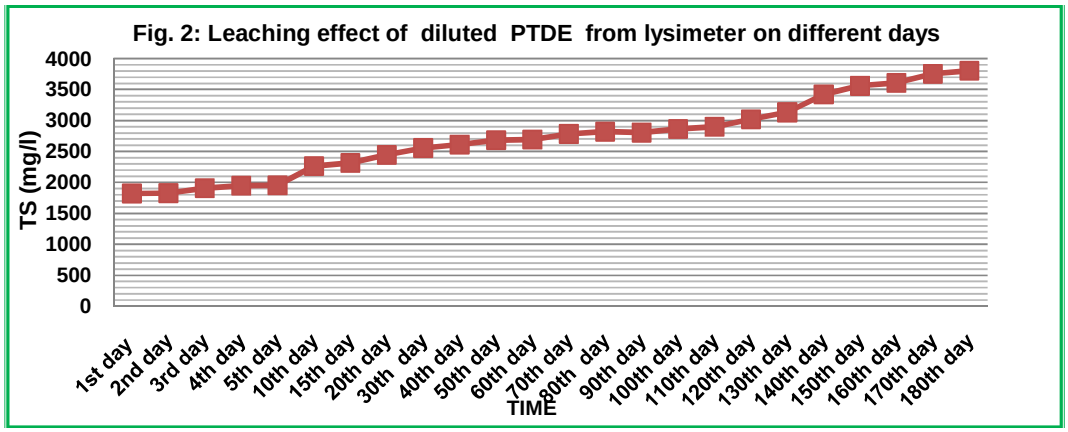
PARAMETERS	Different Days leachate quality of PTDE diluted with 50% of water passes from lysimeter (B)							
	1st day	2nd day	3rd day	4th day	5th day	10th day	15th day	20th day
Colour	colourless	colourless	colourless	colourless	Minute Creamy	Minute Creamy	Minute Creamy	Creamy
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
Total solids	1820.0 ±1.8	1826.4 ±5.2	1904.4 ±4.1	1946.0 ±2.0	1952.2 ±1.8	2263.1 ±2.8	2314.6 ±4.2	2446.4 ±5.2
Total Dissolve solids	1327.9 ±2.1	1328.0 ±3.8	1391.7 ±2.0	1421.6 ±6.2	1432.2 ±1.6	1670.3 ±2.9	1682.2 ±2.6	1806.4 ±6.2
Total suspended solids	492.1 ±0.0	498.4 ±0.0	512.7 ±0.0	524.4 ±0.0	520.0 ±0.0	592.8 ±0.0	632.4 ±0.0	640.0 ±0.0
pH	7.66 ±0.08	7.66 ±0.4	7.66 ±0.1	7.82 ±0.2	7.89 ±0.08	8.32 ±0.05	8.10 ±0.05	8.10 ±0.07
EC (µmho/cm)	1246.2 ±1.6	1246.4 ±4.2	1258.0 ±6.2	1278.2 ±5.0	1278.4 ±2.3	1421.6 ±6.0	1441.0 ±4.6	1424.2 ±5.2
Total Hardness	422.8 ±2.5	436.3 ±6.4	438.4 ±3.2	442.6 ±1.4	464.2 ±1.2	492.1 ±3.5	528.4 ±2.4	534.0 ±2.5
Calcium	162.6 ±3.2	164.2 ±1.4	145.8 ±1.2	152.8 ±1.4	172.8 ±3.2	182.9 ±1.0	196.0 ±2.8	212.6 ±3.2
Magnesium	292.1 ±4.2	296.4 ±5.6	278.6 ±1.4	264.1 ±2.3	286.3 ±1.4	322.5 ±1.2	342.5 ±3.1	345.6 ±4.7
Alkalinity	424.6 ±2.3	448.6 ±9.2	465.0 ±2.1	478.3 ±1.4	466.6 ±6.2	582.0 ±3.2	622.3 ±3.6	642.0 ±2.4
Chloride	240.4 ±2.1	242.2 ±6.8	254.5 ±2.6	264.2 ±1.2	246.2 ±2.0	292.6 ±2.0	328.0 ±2.7	364.3 ±6.2
Dissolve Oxygen	5.6 ±0.06	5.8 ±0.08	5.4 ±0.08	5.4 ±0.06	5.2 ±0.2	5.0 ±0.05	5.0 ±0.1	5.2 ±0.2
Biological Oxygen Demand	124.6 ±2.1	132.6 ±5.4	154.6 ±2.0	146.4 ±2.1	146.2 ±1.4	204.4 ±3.2	245.2 ±2.1	268.4 ±2.4
Chemical oxygen Demand	428.0 ±1.2	432.0 ±6.2	452.8 ±1.2	410.1 ±2.0	446.6 ±5.0	592.2 ±5.2	624.8 ±2.3	702.6 ±2.6
Ammonical Nitrogen	78.60 ±1.4	78.60 ±1.0	72.60 ±1.0	72.60 ±1.2	74.76 ±1.0	92.92 ±1.2	108.12. ±1.4	124.12 ±1.0
Total Phosphorus	8.4 ±0.08	8.4 ±0.6	8.4 ±0.04	8.4 ±0.2	8.4 ±0.6	9.8 ±0.4	10.2 ±0.6	10.4 ±0.08
Total Potassium	186.6 ±2.8	174.4 ±2.3	188.5 ±3.5	192.2 ±1.3	204.2 ±3.5	240.2 ±2.4	264.9 ±2.9	278.2 ±2.4

PARAMETERS	Different Day leachate quality of PTDE diluted with 50% of water passes from lysimeter (B)							
	30th day	40th day	50th day	60th day	70th day	80th day	90th day	100th day
Colour	Creamy	Light Yellowish	Light Yellowish	Light Yellowish	Light Yellowish	Yellowish	Yellowish	Yellowish
Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
Total solids	2556.0 ±3.2	2610.0 ±3.9	2682.4 ±2.1	2690.4 ±4.5	2780.8 ±8.0	2820.8 ±1.4	2805.6 ±2.3	2864.6 ±6.3
Total Dissolve solids	1864.0 ±2.1	1932.0 ±5.2	1938.4 ±2.2	1932.2 ±3.0	2018.4 ±3.2	2028.8 ±2.5	1980.2 ±1.2	2000.0 ±2.8
Total suspended solids	682.0 ±0.0	678.0 ±0.0	744.0 ±0.0	758.2 ±0.0	762.4 ±0.0	792.0 ±0.0	825.4 ±0.0	864.4 ±0.0
pH	8.30 ±0.02	7.90 ±0.04	7.90 ±0.02	7.90 ±0.05	7.90 ±0.04	7.80 ±0.01	8.0 ±0.02	8.2 ±0.04
EC (µmho/cm)	1442.2 ±1.4	1468.0 ±3.5	1490.6 ±1.4	1476.4 ±2.5	1498.0 ±4.5	1502.0 ±2.8	1538.2 ±4.1	1543.4 ±2.4
Total Hardness	553.3 ±3.1	564.6 ±3.0	541.2 ±1.4	582.0 ±5.2	593.3 ±2.6	604.4 ±2.4	614.1 ±2.2	626.4 ±5.6
Calcium	232.0 ±1.2	223.4 ±1.4	236.3 ±2.0	242.0 ±2.4	263.8 ±6.8	254.8 ±1.1	278.6 ±1.1	286.3 ±2.0
Magnesium	392.8 ± 2.0	380.0 ±2.5	369.4 ±5.3	384.4 ±3.1	404.6 ±5.6	417.0 ±4.1	432.3 ±1.0	440.5 ±4.0
Alkalinity	662.2 ±2.4	652.1 ±2.4	642.1 ±4.1	678.6 ±6.2	696.6 ±6.7	685.9 ±4.2	725.1 ±2.3	742.2 ±3.0
Chloride	468.7 ±1.2	472.4 ± 1.4	512.8 ±2.3	552.4 ±2.8	685.0 ± 5.3	626.6 ±6.6	693.2 ±2.3	721.2 ±2.0
Dissolve Oxygen	5.2 ±0.02	5.2 ± 0.7	5.1 ±0.06	4.9 ±0.1	4.6 ±0.1	4.6 ±0.05	4.2 ±0.06	4.2 ±0.04
Biological Oxygen Demand	278.0 ±1.4	294.5 ±2.0	342.4 ±1.8	385.0 ±5.1	386.0 ±2.2	422.0 ±5.6	468.4 ±2.0	460.4 ±6.2
Chemical oxygen Demand	746.6 ±2.0	798.7 ± 3.4	878.6 ±1.6	886.3 ±1.9	926.0 ±2.0	1022.3 ±3.2	1078.6 ±1.4	1162.3 ±2.0
Ammonical Nitrogen	132.4 ±1.0	138.3 ±1.2	122.6 ±1.2	124.7 ±2.0	142.9 ±0.0	146.6 ±2.2	168.3 ±1.0	170.6 ±0.9
Total Phosphorus	12.1 ±0.8	12.3 ±0.5	12.4 ±0.2	13.7 ± 0.6	12.4 ±0.4	14.4 ±0.6	14.4 ±0.7	14.7 ±0.06
Total Potassium	286.8 ±3.5	262.1 ±4.1	292.4 ±3.6	320.6 ±1.4	363.2 ±7.1	378.1 ±7.1	412.6 ±2.6	454.6 ±2.1

PARAMETERS	Different Day leachate quality PTDE diluted with 50% of water passes from lysimeter (B)							
	110th day	**120th day**	**130th day**	**140th day**	**150th day**	**160th day**	**170th day**	**180th day**
Colour	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown
Odour	Odourless	Odourless	Minute smell	Minute smell	Minute smell	Minute smell	Minute smell	Minute smell
Total solids	2896.0 ±2.1	3020.8 ±1.5	3132.4 ±4.2	3420.6 ±2.5	3560.9 ±2.0	3608.0 ±1.6	3756.9 ±3.6	3804.0 ±6.9
Total Dissolve solids	2013.5 ±1.2	2141.9 ±3.6	2228.4 ±2.0	2498.2 ±2.0	2615.9 ±2.4	2636.0 ±2.8	2804.3 ±4.2	2764.0 ±4.6
Total suspended solids	882.5 ±0.0	878.9 ±0.0	904.0 ±0.0	922.4 ±0.0	945.0 ±0.0	972.0 ±0.0	952.6 ±0.0	1040.0 ±0.0
pH	8.20 ±0.2	7.62 ±0.4	7.90 ±0.1	7.90 ±0.2	8.32 ±0.1	8.2 ±0.02	8.2 ±0.08	8.0 ±0.04
EC (µmho/cm)	1573.2 ±1.4	1578.0 ±0.8	1596.0 ±3.6	1578.5 ±4.2	1628.6 ±3.6	1664.0 ±1.2	1672.4 ±6.3	1686.5 ±4.1
Total Hardness	645.0 ±1.6	668.0 ±1.4	652.8 ±1.8	674.0 ±2.6	630.9 ±2.8	684.3 ±1.4	694.1 ±2.3	712.2 ±4.2
Calcium	295.6 ±1.8	312.4 ±1.8	324.4 ±1.0	342.0 ±2.5	364.2 ±3.2	371.4 ±3.5	376.0 ±2.0	386.5 ±3.0
Magnesium	432.8 ±1.2	454.5 ±1.7	460.0 ±6.2	464.3 ±3.5	471.2 ±1.4	490.5 ±2.0	510.9 ±5.2	522.4 ±3.2
Alkalinity	722.0 ±3.2	736.8 ±2.1	792.6 ±4.0	820.2 ±6.0	848.2 ±1.4	868.2 ±2.0	887.1 ±4.5	890.9 ±1.4
Chloride	774.0 ±1.4	786.0 ±2.3	832.7 ±5.2	852.9 ±8.5	894.6 ±0.8	912.6 ±3.6	942.0 ±8.6	964.4 ±1.8
Dissolve Oxygen	4.5 ±0.2	4.5 ±0.2	4.6 ±0.1	4.4 ±0.3	4.2 ±0.2	4.0 ±0.08	4.0 ±0.1	4.0 ±0.08
Biological Oxygen Demand	489.1 ±4.1	512.8 ±4.5	530.4 ±2.5	593.7 ±4.2	612.7 ±3.1	646.4 ±6.2	674.6 ±6.8	682.6 ±1.4
Chemical oxygen Demand	1228.0 ±2.3	1272.6 ±1.5	1304.3 ±6.3	1371.4 ±1.3	1392.0 ±2.0	1464.6 ±3.4	1476.4 ±3.2	1522.6 ±1.6
Ammonical Nitrogen	172.8 ±1.2	180.6 ±1.8	196.3 ±2.0	206.8 ±1.2	228.3 ±3.2	236.3 ±1.4	243.4 ±1.4	264.6 ±1.2
Total Phosphorus	15.5 ±0.8	15.5 ±0.5	15.6 ±0.6	15.9 ±0.9	16.1 ±1.2	16.6 ±0.8	16.2 ±1.0	16.8 ±1.0
Total Potassium	484.3 ±1.8	522.2 ±1.6	536.0 ±1.8	596.0 ±2.5	626.4 ±1.4	696.2 ±6.4	721.4 ±2.0	746.0 ±3.2

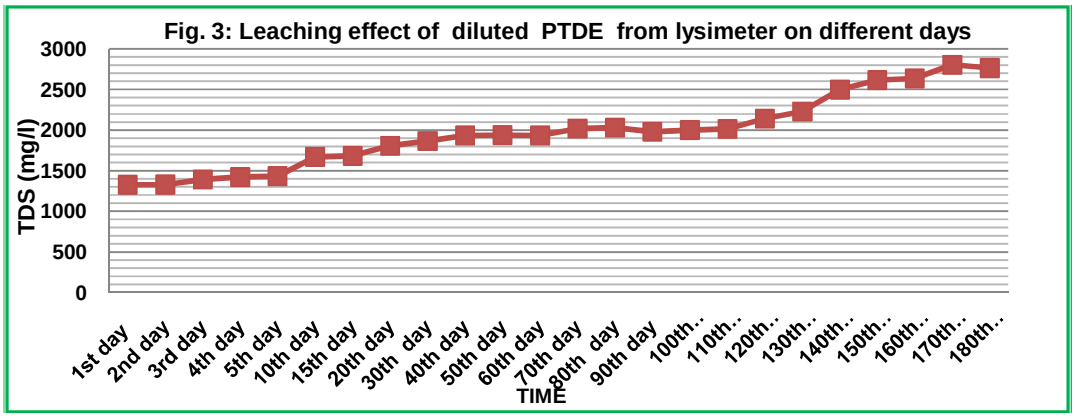
Total Solids

Distillery effluents contain huge amount of solids, which shows great variation and reduction when it passes through the lysimeter **(Figure 2)**. Lysimeter which was treated with PTDE diluted with 50% of water contained 1820.0 mg/l of solids on 1st day of leachate. On 2nd to 5th day the value of solids in leachate slightly increased i.e. 1826.4, 1904.4, 1946.0 and 1952.2 mg/l on 2nd ,3rd ,4th and 5th day respectively. But after 5th day of it rapidly increased to 2263.1 mg/l on 10th day and continuously increased with time i.e.2682.4 mg/l on 50th day, 2864.6 mg/l on 100th day and finally raised to 3804.0 mg/l on 180th day.



Total Dissolved Solids

The lysimeter shows great reduction in total dissolved solid of leachate. It was 1327.9 mg/l on 1st day and slightly increased with time. The TDS on 5th day was 1432 mg/l, but after 5th day it rapidly increased day by day and reached to 2028.8 mg/l on 80th day, then it slightly decreased to 1980.2 mg/l on 90th day, then again slightly increased to 2000.0 mg/l on 100th day to 2804.3 mg/l on 170th day and decreased to 2764.0 mg/l on 180th day.



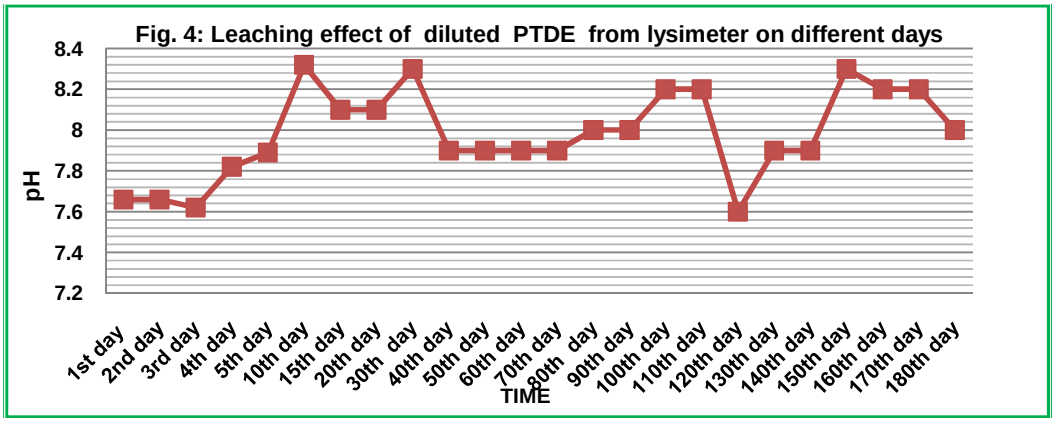
Total Suspended Solids

The lysimeter shows the great reduction in total suspended solid of leachate. It was 492.1 mg/l on 1st day and its value slightly increased with time and reached to 520.0 mg/l on 5th day and then it rapidly increased day by day and reached to 682.0 mg/l 0n 30th day. The value of TSS slightly decreased to 678.0 mg/l on 40th day to 744.0 mg/l on 50th day, and then slightly increased day by day and reached 882.5 mg/l on 110th day. The value again decreased to 878.9 mg/l on 120th day and then rapidly increased and reached 972.0 mg/l on 160th day. The value again decreased to 952.6 mg/l on 170th day and then increased to 1040.0 mg/l on 180th day.

pH

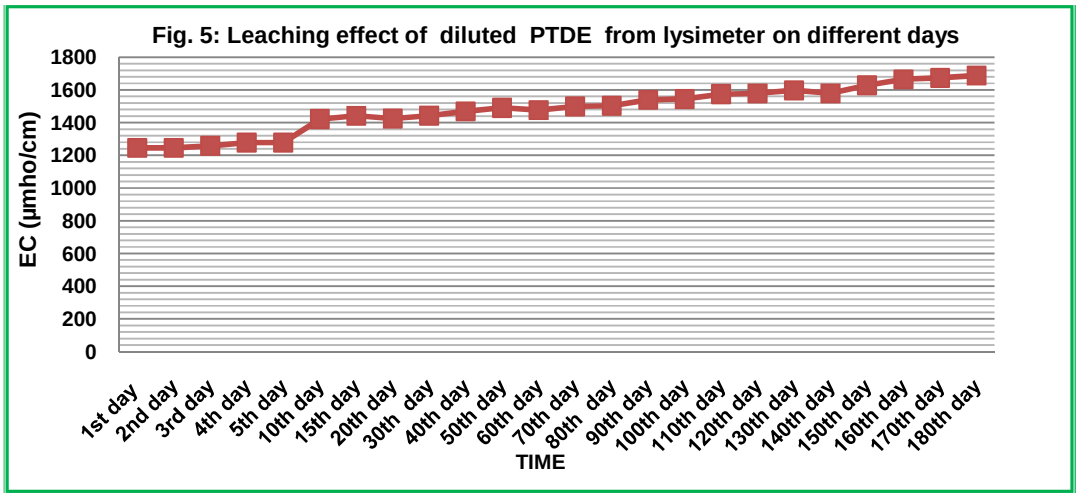
The lysimeter also showed slight variation in pH in leachate on different days. It was 7.6 on 1st, 2nd day and 3rd day of leachate and then it increased to 8.30 on 30th day. The pH value rapidly decreased to 7.90 on 40th day to 70th day

and 7.80 on 80th day then it slightly increased to 8.20 on 110th day. The pH again decreased to 7.62 on 120th day and rapidly increased to 8.32 on 150th day and then it slightly decreased to 8.20 on 170th day to 8.0 on 180th day.



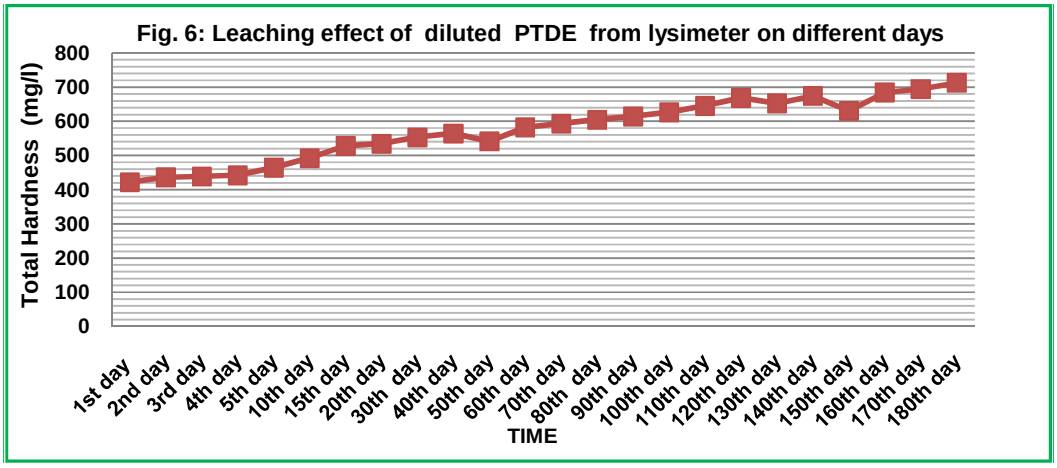
Electrical Conductivity

The lysimeter also showed variation of electrical conductivity of leachate on different days. The value of EC in leachate was 1246.2 (µmho/cm) on 1st and 2nd day and it slightly increased to 1258 (µmho/cm) on 3rd day to 5th day and then rapidly increased to 1421.6 (µmho/cm) on 10th day to1490.6 (µmho/cm) on 50th day. The EC decreased to 1476.4 (µmho/cm) on 60th day and on 70th day, the electrical conductivity again increased to 1498 (µmho/cm) to 1596 mg/l on 130th day and then it slightly decreased to 1578.5 (µmho/cm) on 140th day and then rapidly increased to 1686.5 (µmho/cm) on 180th day.



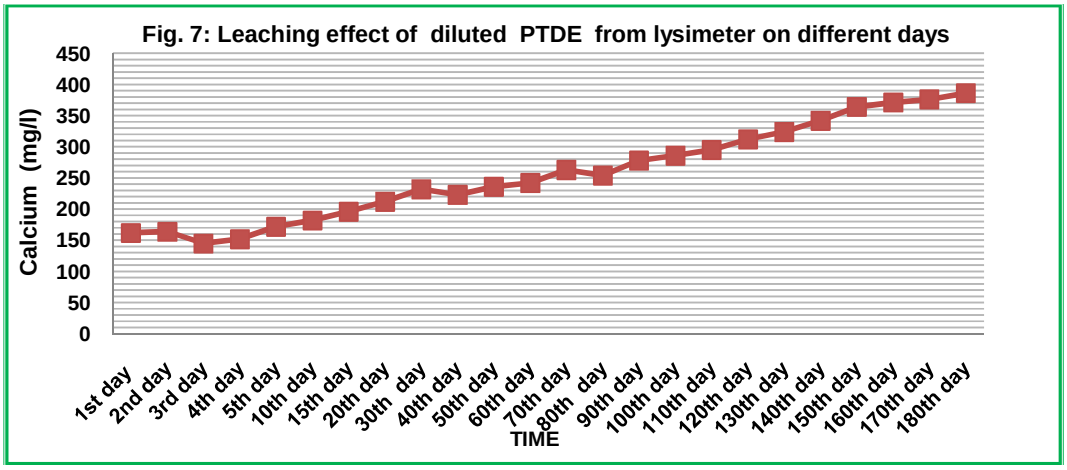
Total Hardness

The lysimeter showed variation in total hardness of leachate. It varied from 422.8 mg/l on 1st day to 712.2 mg/l on 180th day. The leachate contained 436.3 mg/l of total hardness on 2nd day, 438.4 mg/l on 3rd day, 442.6 mg/l on 4th day and 464.2 mg/l on 5th day. But with passing time it increased to 492.1 mg/l on 10th day, 626.4 mg/l on 100th day and finally reached to 712.2 mg/l on 180th day. It shows the effluent was initially absorbed by soil but continuous application reduced the absorbing capacity of soil.



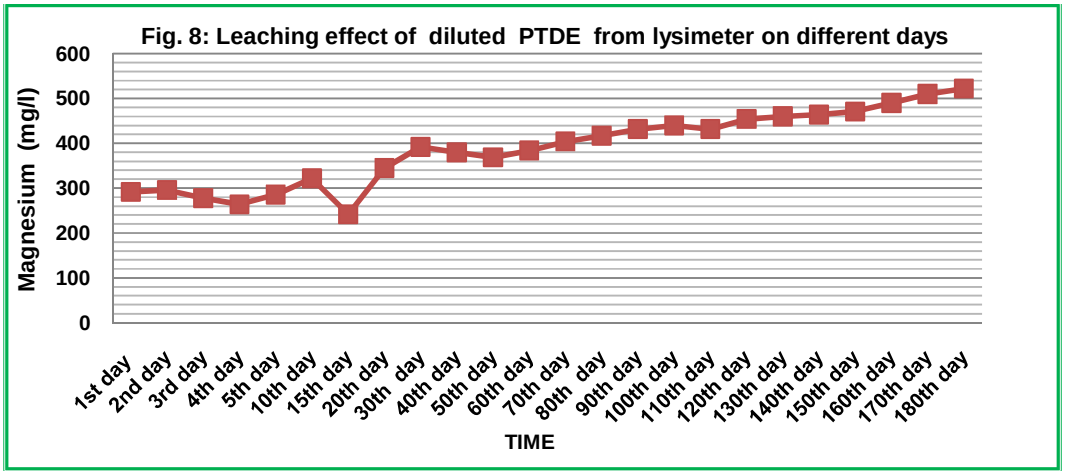
Calcium

The lysimeter also shows the variation in value of calcium in different days of leachates. It was 162.6 mg/l and 164.2 mg/l on 1st and 2nd day of leachate. But on 3rd day it slightly decreased to 145.8 mg/l and then the value increased to 172.8 mg/l, on 5th day to 232.0 mg/l on 30th day. The value was slightly decreased to 223.4 mg/l on 40th day and then rapidly increases day by day. The value was 236.3 mg/l on 50th day to 286.3 mg/l on 100th day and finally reached to 386.5 mg/l on 180th day.



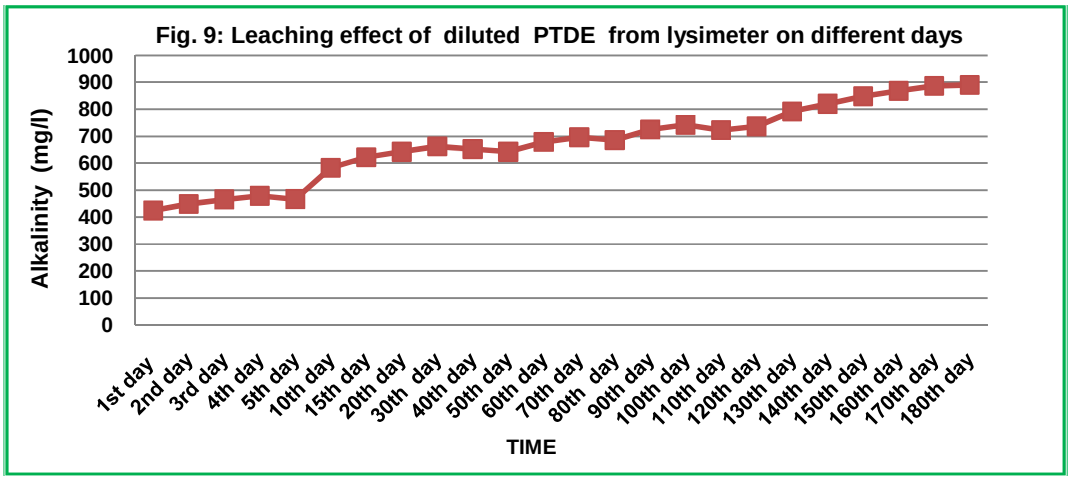
Magnesium

The lysimeter showed the variation in value of magnesium on different days of leachate observed. It was 292.1 mg/l and 296.4 mg/l on 1st and 2nd day and it decreased to 278.6 mg/l to 264.1 mg/l on 3rd and 4th day. The value of magnesium in leachate slightly increased to 286.3 mg/l on 5th day to 392.8 mg/l on 30th and decreased to 380.0 mg/l and 369.4 mg/l on 40th and 50th day respectively. The value rapidly increased to 384.4 mg/l on 60th day to 440.5 mg/l on 100th day and then it slightly decreased to 432.8 mg/l on 110th day. The value rapidly increased day by day to 454.5 mg/l on 120th day to 522.4 mg/l on 180th day.



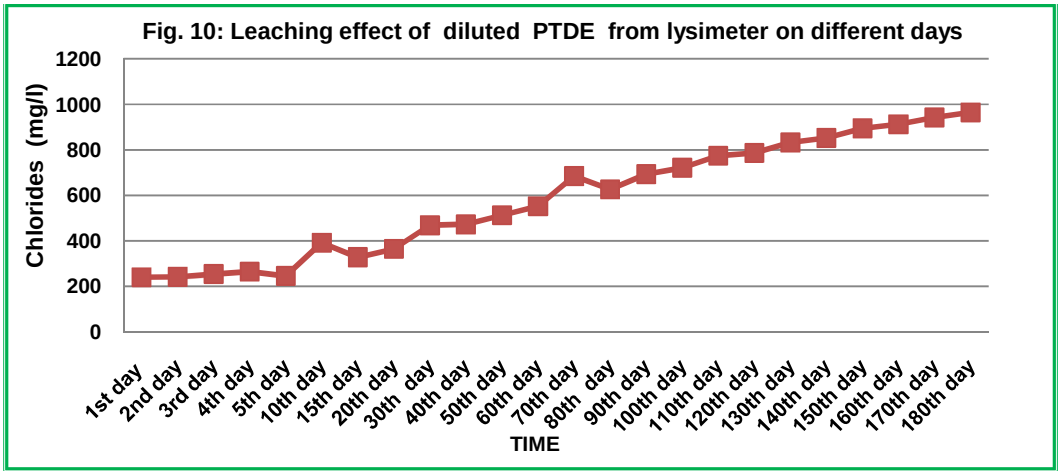
Alkalinity

The lysimeter also showed the variation in alkalinity of leachates on different days. It was 424.6 mg/l on 1st day and slightly increased day by day i.e. 448.6 mg/l on 2nd day, 465 mg/l on 3rd day, 478.3 mg/l on 4th day and 466.6 mg/l on 5th day. This observation shows that there was constant fluctuation in alkalinity from 1st day to 5th day. But with time the value rapidly increased to 582.0 mg/l on 10th day of leachate and increased day by day and reached to 742.2 mg/l on 100th day to 848.2 mg/l on 150th day and finally reached to 890.9 mg/l on 180th day.



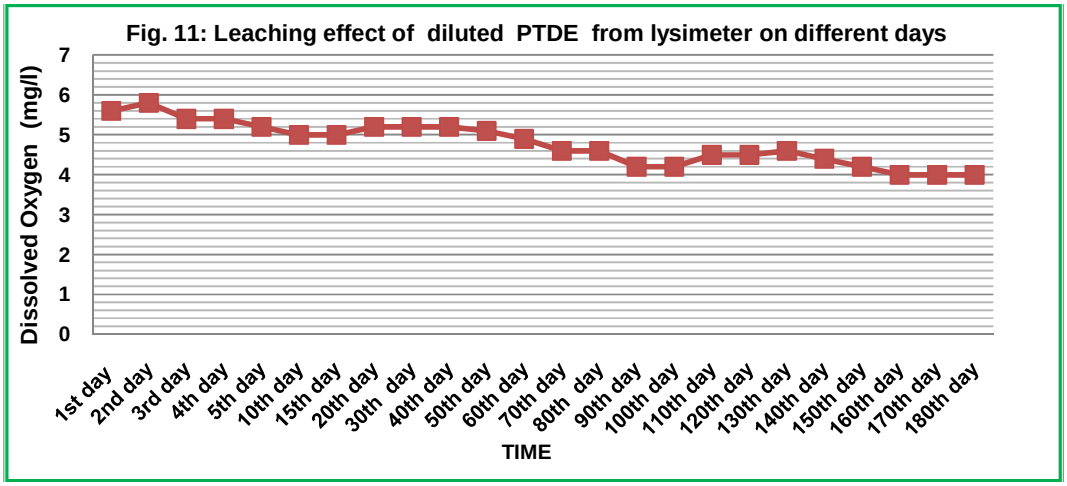
Chloride

The lysimeter also showed the variation in value of chloride of leachate on different days. It was 240.4 mg/l on 1st day and slightly increased to 264.2 mg/l on 4th day then it decreased to 246.2 mg/l on 5th day. But with time, value of chloride rapidly increased to 292.6 mg/l on 10th day to 685.0 mg/l on 70th day and then decreased to 626.6mg/l on 80th day. The value of chloride again increased day by day i.e. 721.2 mg/l on 100th day to 894.6 mg/l on 150th day and finally reached to 964.4 mg/l on 180th day.



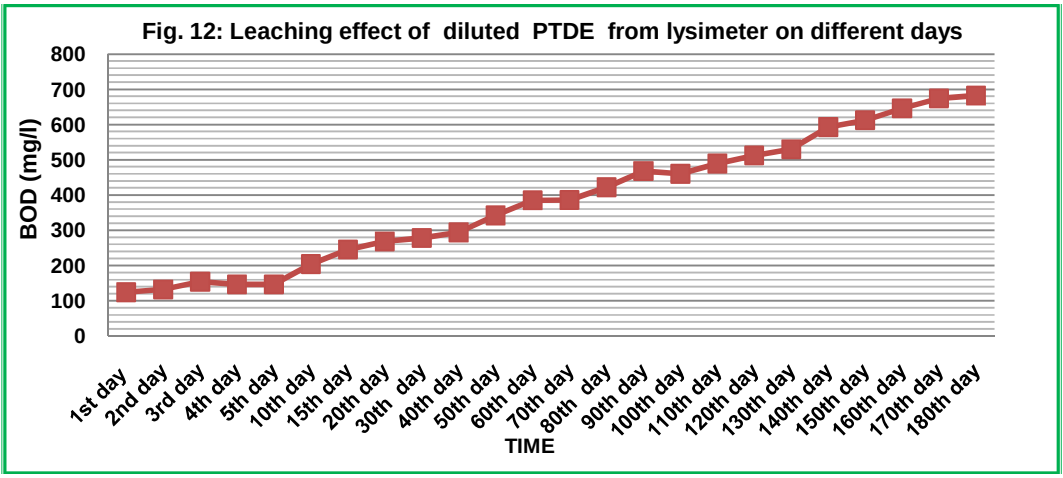
Dissolve Oxygen

The lysimeter also showed the variation in dissolved oxygen of leachate on different days. It was 5.6 mg/l on 1st day and increased to 5.8 mg/l on 2nd day. After 2nd day DO slightly decreased day by day i.e. 5.4 mg/l on 3rd day to 5.0 mg/l on 15th day and then it increased to 5.2 mg/l on 20th day. After 20th day it slightly decreased with time i.e. 4.9 mg/l on 60th day to 4.2 mg/l on 100th day. The DO was again increased to 4.5 mg/l on 110th day to 4.6 mg/l on 130th day and then slightly decreased day by day i.e. 4.2 mg/l on 150th day and constant to 4.0 from 160th day to 180th day.



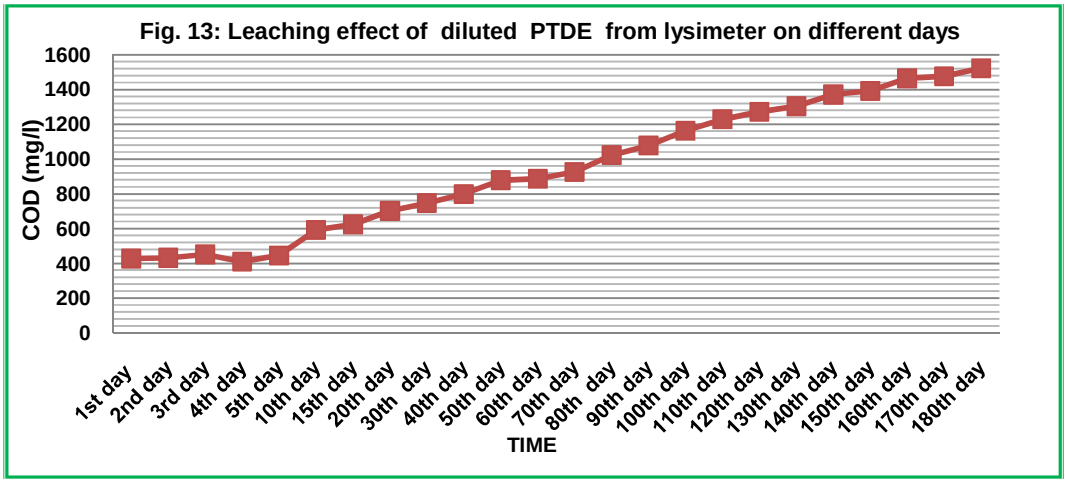
Biological Oxygen Demand

The lysimeter shows the variation in BOD on different day of leachates. The BOD was 124.6 mg/l on 1st day and increased to 154.6 mg/l on 3rd day. But on 4th and 5th day it decreased to 146.4 mg/l. The value of BOD rapidly increased to 204.4 mg/l on 10th day and increased day by day and reached to 172.8 mg/l on 90th day then it decreased to 460.4 mg/l on 100th day. The value again increased day by day and finally reached to 682.6 mg/l on 180th day.



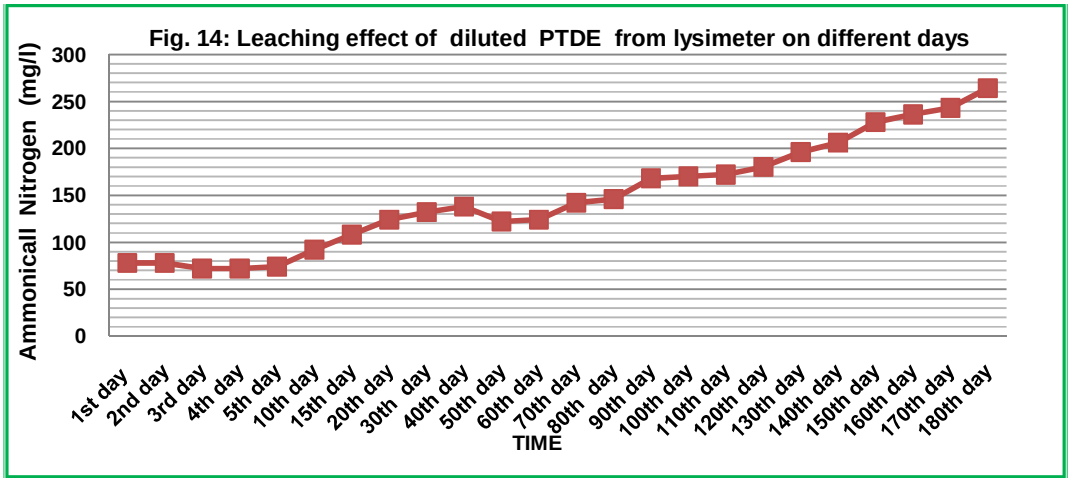
Chemical Oxygen Demand

The lysimeter shows the variation in COD at different day of leachates. The COD was 428.0 mg/l on 1st day and increased to 452.8 mg/l on 3rd day and then it decreased to 410.1 mg/l on 4th day and again increased to 446.6 mg/l on 5th day. The value of COD in leachate rapidly increased with time i.e. 592.2 mg/l on 10th day to 1162.3 mg/l on 100th day and finally reached 1522.6 mg/l on 180th day.



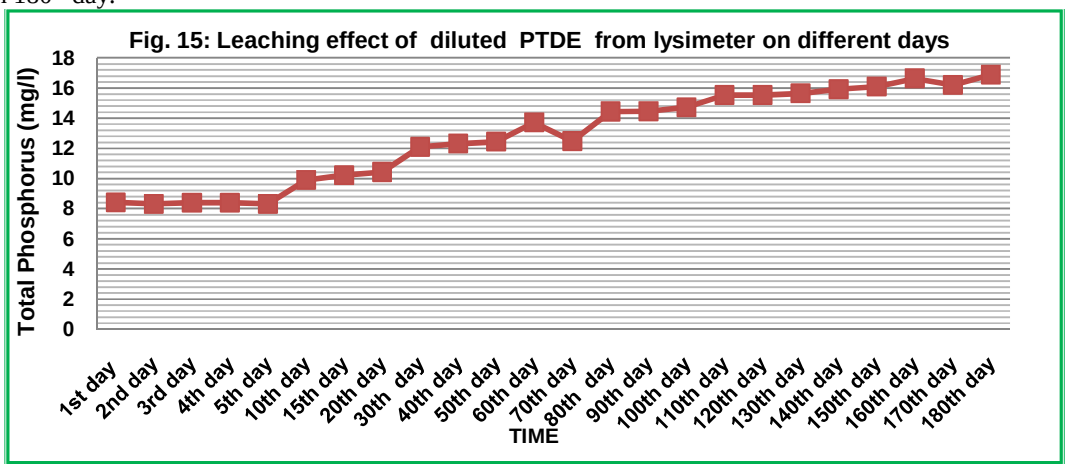
Ammonical Nitrogen

The lysimeter showed variation in value of nitrogen of leachates on different days. It was 78.6 mg/l on 1st day and slightly decreased to 72.6 mg/l on 2nd day, then slightly increased to 74.5 mg/l on 5th day. The value rapidly increased to 92.9 mg/l on 10th day and continuously increased with time. On 50th day it showed slight reduction in value of nitrogen i.e. 122.6 mg/l and then it rapidly increased day by day and reached 170.6 mg/l on 100th day, 228.3 mg/l on 150th day and finally reached 264.6 mg/l on 180th day.



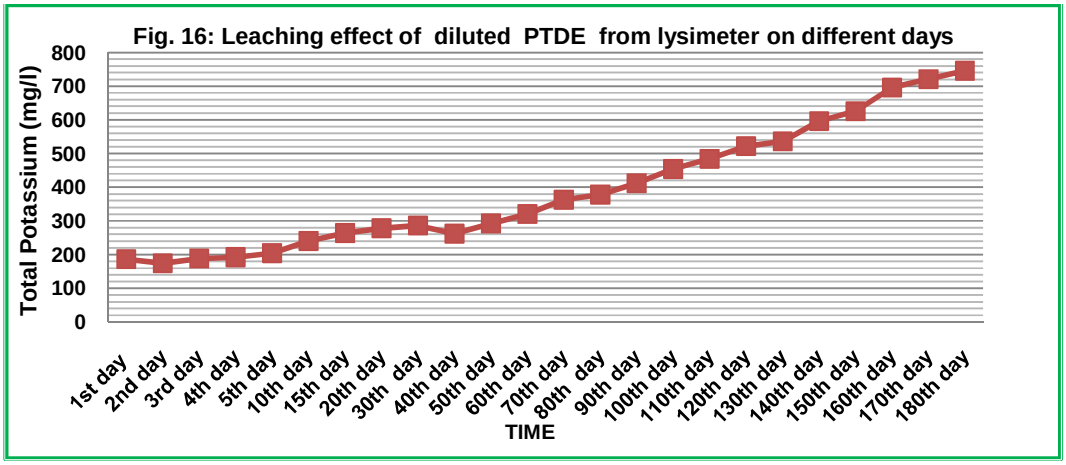
Total Phosphorus

The lysimeter showed the variation in value of total phosphorus of leachate on different days. It was constant at 8.4 mg/l from 1st day to 5th day then it slightly increased to 9.8 mg/l on 10th day and slightly increased day by day. The value of phosphorus in leachate increased to 12.4 mg/l on 50th day, 14.7 mg/l on 100th day and finally reached 16.8 mg/l on 180th day.



Total Potassium

The lysimeter showed the variation in potassium of leachates on different day. It was186.6 mg/l on 1st day and decreased to 174.4 mg/l on 2nd day then it slightly increased day by day to 204.2 mg/l on 5th day. The value of potassium in leachate rapidly increased to 240.2 mg/l on 10th day and it increased with time and raised to 286.8 mg/l on 30th day then it decreased to 262.1 mg/l on 40th day. The value again increased to 292.4 mg/l on 50th day then it rapidly increased day by day i.e. 292.4 mg/l on 50th day to 454.6 mg/l on 100th day and finally reached to 746.0 mg/l on 180th day.



CONCLUSION

The lysimeter study reveals leaching effect of distillery effluent which affects the soil and groundwater quality. The value of PTDE which was diluted with 50% of water was low as compared to PTDE and when diluted PTDE passed through lysimeter various chemical constituents of leachate initially showed great reduction but with passing time all the values of physicochemical constituent were increased. Initially great variation and reduction were recorded in all parameters of leachate, but with time, the values of leachate increased. From these observations it may be concluded that the soil has capacity to absorb the pollutants but the continuous application of distillery effluent may reduce the absorbing capacity of soil and increases the risk of ground water pollution by distillery leachate.

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