Treatment of industrial leachate through stabilization ponds

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Abstract: The treatment system through stabilization ponds is a simple, efficient and inexpensive way of treating effluents. Its configurations can vary according to desired requirements, such as the available area for its implementation. This process is frequently used for the treatment of domestic, industrial and animal effluents. As there is no study for this type of treatment for a possible industrial landfill leachate pollutant the objective of this Project is to evaluate the treatment of leachate formed in the industrial landfill of a textile company through stabilization ponds. The pilot system consists of 4 ponds, connected in series. During the first month the samples were collected weekly and, then fortnightly in the following months. The sample collection points were: Gross effluent (P1), L1(P2) outflow, L2 (P3) outflow, L3 (P4) outflow. The parameters evaluated were: pH, dissolved oxygen, temperature, conductivity, turbidity, oxygen chemical demand, total nitrogen, nitrate, nitrite, total phosphorus, dissolved solids and chlorophyll. The pond system presented good removal efficiency of the potential pollutant from the effluent.

Keywords: leachate, industrial landfill, stabilization ponds.

Introduction

Generally speaking, the solid residues generated in effluent treatment stations at companies go to municipal or private landfills. Over time these residues decompose and form the leachate. For Pineda (1998), the formation of leachate liquids basically depends on the precipitations recorded in the region, the humidity and residue composition, as well as the permeability presented by the landfill. It is a mixture of organic and inorganic compounds in their dissolved and colloidal forms, formed during residue decomposition, being a potential pollution problem for surface waters and, more importantly, for subterranean waters.

Management of the leachate must include, among others, monitoring of the quality and of the quantities produced (Campbell, 1993). There is little information in Brazil about its quantity and quality (Jura, 2001). Tatsi and Zouboulis (2003) report in their studies that the leachate is an important source of pollution in surface and subterranean waters due to presenting variations, both in the quantity as well as in the chemical composition. The composition and the concentration of the contaminants are derived from the type of residues deposited in the landfill, hydrological factors of the soils in the region and mainly the age of the landfill (Ehrig, 1984; Crowford and Smith, 1985).

Studies on the ways of treating industrial leachate are scarce, or practically non existent, justifying the conducting of this research on leachate from the landfill of a textile industry, located in Joinville. The company has an effluent treatment station (ETS), into which the effluents from the productive process, wastewater effluents and leachate from the landfill are poured. At the end of the ETS process the liquid fraction is separated from the solid, which is pressed into cakes and added to the industrial landfill. The cakes are added into ditches of about 3,000m² with a depth of 20m, with waterproofed bottom and sides, and drains from the bottom to take the leachate to the storage ponds. This liquid is transported daily to the STE, about 5Km away, as there is no electricity supply at the landfill for the building a treatment system.

This is the challenge of this study, based on projects that use stabilization ponds in the treatment of wastewater leachate, aimed at analyzing the performance of ponds in the treatment of industrial leachate. The system to be used does not require electrical power, as it simulates the running of natural ponds, and the use of stabilization ponds has been efficient in the removal of potential pollutant, in addition to its inexpensive installation and easy operationalization.

The need for a treatment system in an industrial landfill is due to the proliferation of disease transmitting vectors, such as mosquitoes, flies, rats and buzzards and bad odors, not to mention the environmental risks involved in transporting the leachate to the STE and transport expenses. The objective of this study is to evaluate the performance of the stabilization ponds in the removal of potential pollution caused by the leachate that forms in the textile industrial landfill.

Methods

An effluent treatment system was built with 3 ponds in series, consisting on one 2 meter deep round pond and two rectangular ponds (Figure 1). The sample collection points are: P1: system inflow; P2: Anaerobic pond (L1) outflow and Facultative pond (L2) inflow; P3: Facultative pond (L2) outflow and Maturation pond (L3) inflow; P4: Maturation pond (L3).

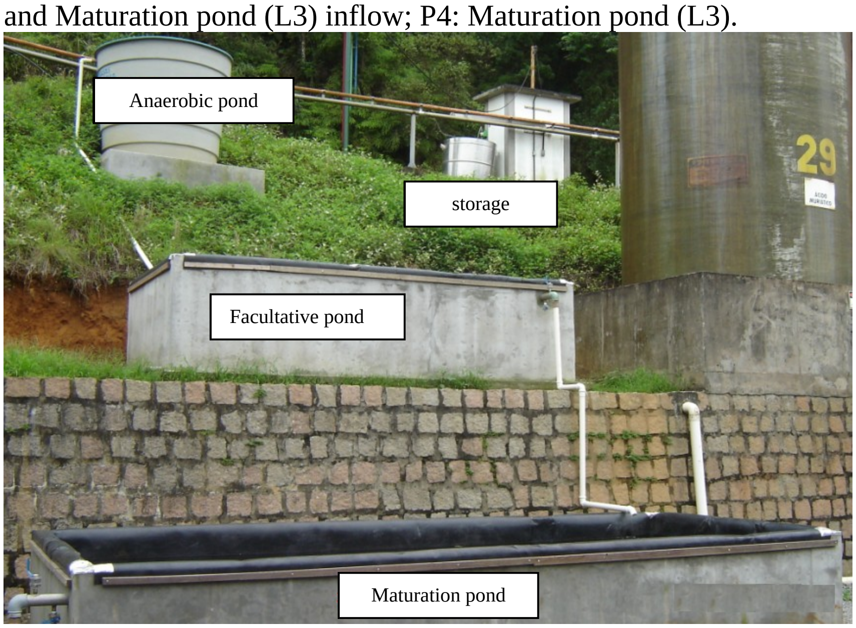

Figure 1. Photo of experimental system profile.

Pond dimensions can be seen in Table 1. The ponds are filled daily with 200 liters of leachate.

Table 1. Pond dimensions

Dimensions	Anaerobic pond (L1)	Facultative pond (L2)	Maturation pond (L3)
Length (m)	-	3.5	3.5
Width (m)	-	2.14	2.86
Height (m)	2.10	1	0.8
Water layer (m)	2	0.8	0.6
Volume (m³)	5	6	6
HDT (days)	25	30	30

Sample collection parameters and frequency:

Analyses conducted in the environmental laboratory at Univille were: Total Nitrogen (TN), Ammoniacal Nitrogen (Am N), Nitrite, Nitrate, Total Phosphorus (TP), COD, Color, Turbidity, Total Solids (TS) and Chlorophyll *a*; and conducted *in loco:* pH, Dissolved Oxygen (DO), Temperature (T) and conductivity. All followed the Standard Methods methodology (APHA, 1998).

To verify if each pond was reaching the desired performance, a chemical, physical and biological parameter behavior analysis was conducted in each pond of the treatment system through Factorial Analysis – Principal Components analysis, with the help of STATISTICA 7.0 software.

Results and Discussion

The mean concentration values, standard deviations and removal efficiency of each pond are presented in Table 2.

Table 2: Mean values, standard deviation and removal from system efficiency.

Parameters	Point				Efficiency (%)
	P1	P2	P3	P4	
T (ºC)	20.87 ±4.89	21.47 ±4.15	21.41 ±4.37	21.54 ±4.24	-
DO (mg/L)	4.40 ±1.88	3.65 ±1.88	7.87 ±1.33	7.59 ±0.8	-
pH	7.98 ±0.28	8.01 ±0.23	8.29 ±0.25	8.51 ±0.25	-
Conductivity (us/cm)	4075.57 ±633.5	3050.29 ±533.51	1154.21 ±359.47	430.13 ±222.56	89.45
TN (mg/L)	265.29 ±13.71	226.86 ±31.11	85.86 ±66.18	35.4 ±20.5	86.66
Am N(mg/L)	242.29 ±52.98	181 ±28.79	56.29 ±19.85	18.67 ±9.71	92.30
Nitrite (mg/L)	35.29 ±19.27	64.43 ±20.56	22.14 ±7.41	8.57 ±4.81	75.71
Nitrate (mg/L)	56.43 ±33.66	62.86 ±41.01	94.86 ±49.6	51.14 ±35.26	9.37
TP (mg/L)	2.99 ±0.42	2.27 ±0.29	1.16 ±0.26	0.91 ±0.22	69.38
COD	534.43 ±73.28	441.14 ±75.39	148.14 ±54.41	60.71 ±24.59	88.64
Color (ADMI)	591.43 ±277.82	394.29 ±169.95	160.57 ±96	74.71 ±37.3	87.37
Chlorophyll *a*	25.86± 35.46	33.89± 63.73	150.26± 114.97	58.5± 67.11	-
Turbidity (NTU)	43.01± 28.81	21.49 ±6.13	12.91 ±5.45	4.58 ±2.49	78.67
TS (mg/L)	5415.43 ±3195	4662.14 ±4063	3806.43 ±2388	3130 ±3114	42.20

The removal results for 88% COD are in accordance with Conder (2003) who obtained 95% removal for domestic effluents.

Comparing the results of Alves (2000) conducted for domestic affluent, which were 123.40 mg/L for COD and 113.53 for total solids, while with this experiment, the results were 53,67 mg/L for COD and 3.23 mg/L for total solids, it can be verified that the results obtained by the team were significantly lower.

By correlating the results of the total solids and turbidity, it can be verified that they are in accordance, as the lower the quantity of solids, the lower effluent turbidity will be. On verification of color analysis, a significant decrease was observed, giving the final effluent a better appearance.

Principal components analysis showed the preliminary performance of ponds (Figures 2 and 4).

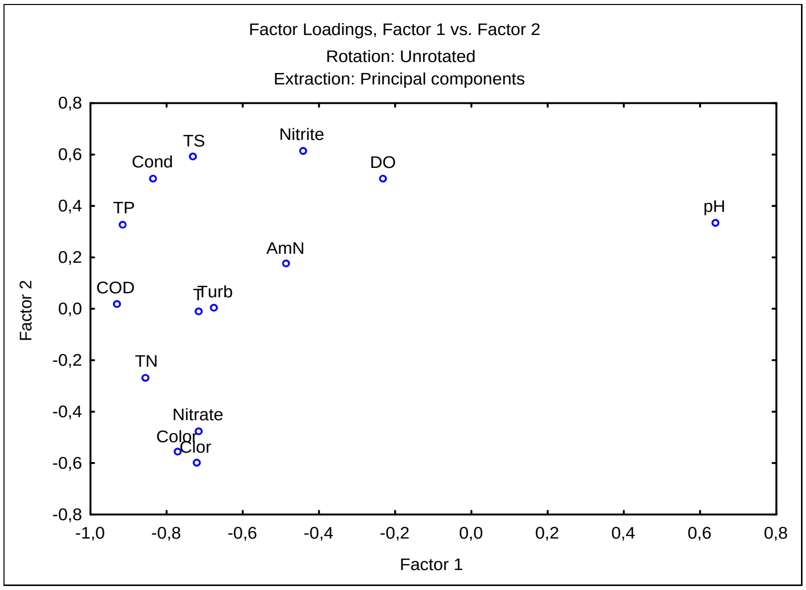

Figure 2- Dispersion Diagram of L1 principal factors

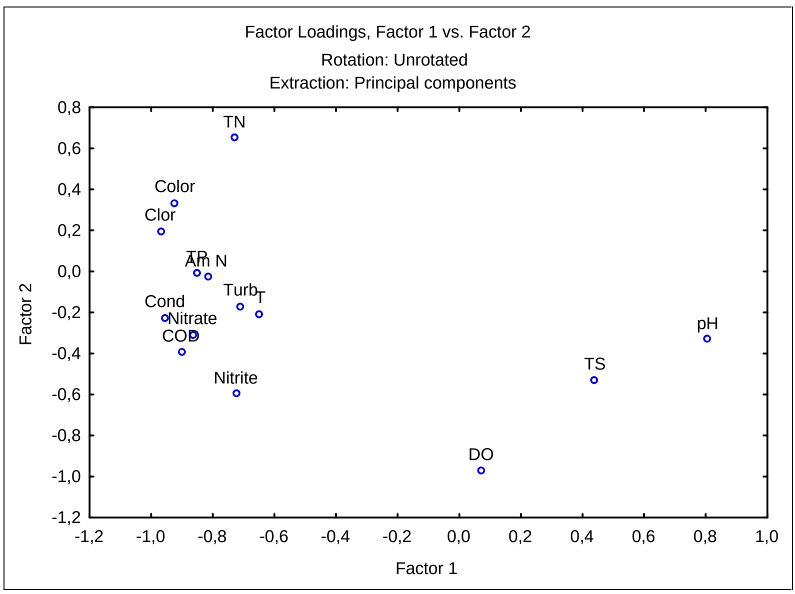

Figure 3- Dispersion Diagram of L2 principal factors

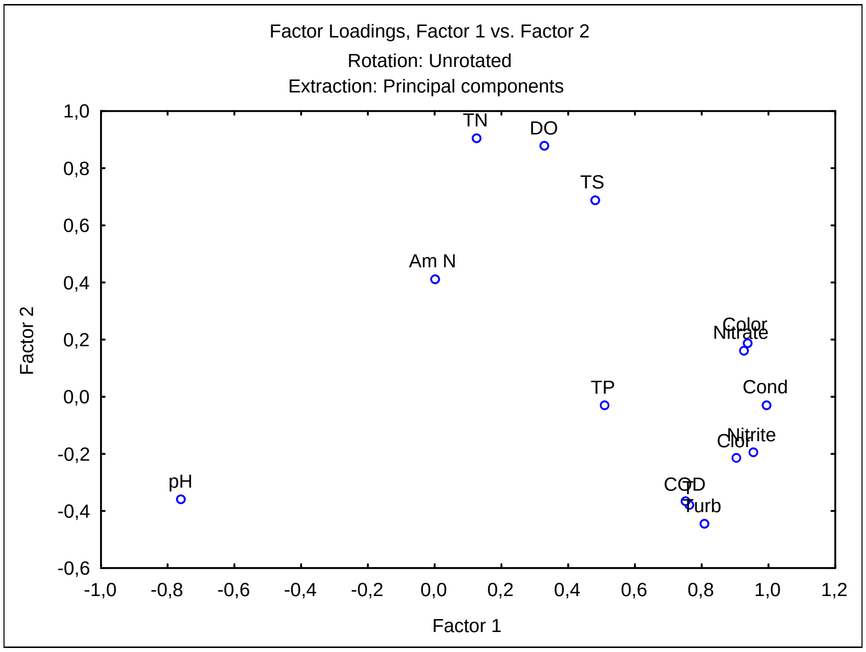

Figure 4- Dispersion Diagram of L3 principal factors

In the anaerobic pond (L1) 3 artificial factors together explain 82% of the system, with the factor 1 (7.15) having strong correlation with COD parameter, factor 2 (2.47) with the nitrite and factor 3 (1.90) with the DO, indicating a predominance of the organic material factor.

The concentration factor of organic material indicates the need for care with the release of effluents into receiving bodies, may be related, for example, an insufficient removal of organic matter or an excess of solid suspended, contributing to the depletion of dissolved oxygen in the body receiver, implying damage to aquatic life and odors (Silva Filho, 2001).

In the facultative pond (L2) there was predominance of the aerobicity factor, correlated to the positive balance of DO with factor 1 (8.47), the TS parameter correlated with factor 2 (2.63) and the pH with factor 3 (1.86), resulting in a surplus of oxygen in the reactor. The three together explained 92% of the system.

In L3 the conductivity factor predominated, associated to factor 1(7.39), the DO related to factor 2 (3.00) and the TP related to factor 3 (1.44), indicating the predominance of artificial factor aerobicity. The prevalence of the factor in aerobic ponds, created an environment with high concentration of DO, which allows good removals of coliforms in the systems analyzed.

Conclusion

The system attained good removal efficiencies, such as: TN (~87%), TP(~69%), TS(~42%), COD (~88%), Color (~87%) and Turbidity (~78%).

The final concentration values of some parameters are not in accordance with the limits demanded by law, making continued studies on the system necessary.

The ACP results showed that the ponds have good removal efficiency, presenting the artificial factors expected in each type of pond.

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