CO-TREATMENT OF LANFILL LEACHATE FROM RIO DE JANEIRO – BRAZIL WITH DOMESTIC WASTEWATER

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SUMMARY: The present research was developed in CETE – Experimental Center of Sewage Treatment located in the Federal University of Rio de Janeiro (UFRJ), together COMLURB – Urban Cleaning Company of Rio de Janeiro. The aim of this study is the combined treatment of landfill leachate and domestic wastewater evaluating. The work was divided in two operation lines. The first one is composed by facultative pond followed by maturation pond and the second one is composed by the system aerated pond and sedimentation pond. Both of them received the same leachate and wastewater dilution, varying from 0,5% to 2,0% (ratio flow/flow). Nevertheless, the line one received leachate from Gramacho landfill and the line two received leachate from Gericinó landfill, both located in metropolitan region of Rio de Janeiro. The line 02 operation presented satisfactory results (ratio varying from 0,2% to 0,5%) when related to the units operated just with wastewater. In this case, media BOD efficiency was achieved between 65% and 78% and the media effluent concentration presented under 60 mg/l. However, COD efficiency achieved low values (between 62% and 68%), lower than the efficiency achieved when the unit operated just with domestic wastewater. The line 01 didn't present good results to BOD and COD removal. This bad performance can be function of the high ammonia concentration, even with leachate dilution reduced. Just can be observed in line 02 operation the ammonia reduction by nitrification, with media efficiency varying from 51% to 89%. The phase one in both line operations didn't present good results, since it was used 2% of dilution. Due to leachate and the domestic wastewater characteristics, this ratio (2% v/v) represented increased of 89% and 100% of ammonia load in operation line 01 and 02 respectively.

1. INTRODUCTION

The treatment of the leachate generated in the sanitary landfills of municipal solid wastes is one of the great concerns of the cities with high demographic densities. This effluent is toxic, recalcitrant and therefore difficult to be treated using biological systems. So, this effluent management needs large technical and economic studies. It's important to evaluate the compatibility of the sewage conventional treatment plant existent with the leachate characteristics.

In lots of countries around the world this process is one of the alternatives adopted in such a way of to reduce operation costs in sanitary landfill. In Brazil, the operation of some sanitary landfills use the combined treatment for final disposal of their leachate.

According BOCCHIGLIERI (2005), operation data of SABESP (Water and Wastewater Company from São Paulo – Brazil) indicate that in the period between 1998s and 2003s, the leachate volume received in WWTP (Wastewater Treatment Plant) of Integrated System of Metropolitan Region of São Paulo increased almost 93%.

In city of Rio de Janeiro – Brazil, two big sanitary landfill are responsible to receive around 10.000 T of solid wastes a day. Gramacho Sanitary Landfill receive 7.200 T/d and produce 1.500 m^3 of leachate a day. Gericinó Sanitary landfill receive 2.600 T/d of solid wastes and produce daily 500 m^3 of leachate.

The objective of this study was to investigate the wastewater treatment capacity composed by stabilization ponds in demonstration scale plant (500 habitants), to receive the landfill leachate form Gramacho and Gericinó to a combined treatment. The research was developed in CETE – Experimental Center of Sewage Treatment located in the Federal University of Rio de Janeiro.

2. EXPERIMENTAL STUDY

3.1 Apparatus

The research was developed in a period from April/2007 to august/2008, in experimental units located in CETE, according Figure 01. The 05 operational phases was conducted in two different treatment lines.

Figure 01 – Experimental facilities

Observations: FP: Facultative Pond, MP: Maturation Pond, AP: Aerated Pond, SP: Sedimentation Pond

3.1.Operational Line 01

The operational configuration proposed in this line is based on a system composed by facultative pond followed by maturation pond, receiving the leachate from Gramacho Sanitary Landfill. (Figure 02). Their characteristics are like from old landfill with COD, BOD and ammonia media concentration of 2.628mg/L, 222mg/L e 1181mg/L, respectively.

3.2.Operational Line 02

The treatment line 02 is composed by aerated pond followed by sedimentation pond. The leachate used in this operation is from Gericinó Landfill (Figure 03), with the followed characteristics: COD: 2.291 mg/L; BOD: 538 mg/L; Ammonia: 877mg/L.

Gramacho Landfill and Gericinó Landfill are located in Metropolitan Region of Rio de Janeiro and can be observed in Figure 02 and Figure 03

Figure 02. Gramacho Landfill

Figure 03. Gericinó Landfill

3.2 Experimental procedure

Both treatment lines were developed considering 05 operational phases characterized by different leachate and wastewater dilutions (varying from 0.5% to 2% v/v) and distinct physical configurations, resulting in diverse hydraulic detention times and superficial organic loads. It can be observed in Table 01.

Table 01 – Operational conditions: hydraulic detention time and superficial organic load applied on ponds in each operational phase

Phases	DT Facultative Pond (days)		DT Aerated Pond (days)		SOL Facultative Pond (kg BOD/ha.day)	
	Applied*	bibliography**	Applied	bibliography	Applied	bibliography
01	6,61	15-45	4,8	2-4	334	100-350
02	6,61		4,8		334	
03	15,2		3,6		134	
04	15,2		7,1		134	
05	15,2		7,1		134	

Obs.: DT → Detention Time
SOL → Superficial Organic Load
* Value applied in period
** Recommended by JORDÃO & PESSOA, 2005

In Phases 01 used dosage 2% of leachate flow in relation to raw sewage and during phases 02, the dosage used was 0,5%. Phases 03, with dosage 0,5% also, was characterized by modification of affluent line 01 and line 02 flow. The aim in this situation was to change detention hydraulic time and superficial organic load, like presented in Table 02. In phases 04, the conditions to line 01 was maintained. To line 02 chased to increase the aerated pond detention time reducing its affluent flow.

Phases 05 was operated in a different way, making the leachate flow fit in function of its ammonia concentration. The frequency of leachate supply was weekly. This adequacy used the ratio between ammonia leachate load and ammonia raw sewage load. The dilution adopted or the leachate flow applied was that one that determined the maxima ratio between loads of 5%.

Table 02 – Leachate flow and sewage flow and respective ratio dilutions

Phases	Operational Line 01			Operational Line 02		
	Affluent flow (l/s)	Gramacho flow (l/h)	Dilution (%)	Affluent flow (l/s)	Gericinó flow (l/h)	Dilution (%)
01	0,10	7,20	2,0	0,15	10,8	2,0
02	0,10	1,80	0,5	0,15	2,70	0,5
03	0,04	0,72	0,5	0,20	3,60	0,5
04	0,04	0,72	0,5	0,10	1,80	0,5
05	0,04	Variable	± 0,2	0,10	Variable	± 0,2

During the operation time, it was collected weekly samples of affluent and effluent of each one of operational lines, raw sewage and raw leachate. The samples were analyzed by COD, BOD and ammonia parameters.

4. RESULTS AND DISCUSSION

The Line 01 operation presented results not as good as the domestic wastewater conventional treatment, independent of the operational conditions adopted in each one of the phases. So, consider that this technology (facultative pond + maturating pond) didn't answer well to the combined treatment. Still about Line 01, the optimum performance of BOD removal was reached in phase 03, operating with 0,5% of leachate dilution, 15 days of hydraulic detention time and superficial organic load of 134 kg BOD/ ha.d. But the same results haven't observed for COD, solids and ammonia.

In Line 02 operation, observed better performance than in Line 01 operation. phase 01, with 2% leachate dilution, presented the worst results, probably due to the high ammonia load of leachate in relation with the ammonia load of wastewater. With the dilution reduction from 2% to 0,5%, the system performance presented results like the expected (COD and BOD removal between 62% to 80%), although lower than that presented in wastewater treatment plant, treating just domestic sewage. The dilution defined by the increase of ammonia load, proposed in Phase 05 presented the best performance results of BOD and COD removal.

4.1. Operational Line 01

In Table 03 can observed the affluent and effluent concentration of BOD, COD and ammonia parameters to line 01. In Table 04 are presented the medium efficiency of the same parameters removal.

Table 03 – Affluent and effluent concentrations – Line 01

Phases	**BOD (mg/l)**		**COD (mg/l)**		**Ammonia (mg/l)**	
	Affluent	**Effluent**	**Affluent**	**Effluent**	**Affluent**	**Effluent**
01	181 (11)	75 (9)	315 (12)	173 (12)	40 (8)	45 (8)
02	128 (12)	58 (11)	236 (13)	141 (13)	56 (6)	58 (6)
03	142 (10)	42 (12)	238 (14)	119 (15)	46 (7)	22 (7)
04	137 (8)	51 (9)	248 (8)	132 (9)	37 (8)	29 (9)
05	138 (6)	52 (6)	296 (7)	258 (7)	37 (7)	24 (7)
Sewage *	163 (30)	45 (30)	469 (43)	130 (43)	-	-

Obs.: Values between parenthesis mean number of data
* Results of treatment when the line operated treating just sewage

Table 04 – Removal Efficiency of COD, BOD and ammonia -Line01

Phase	BOD (%)	COD (%)	Ammonia (%)
01	54	44	33
02	51	44	37
03	68	50	41
04	59	42	43
05	53	47	54
Sewage *	70	71	-

Obs.: * Results of treatment when the line operated treating just sewage

4.2. Operational Line 02

To line 02, the affluent and effluent concentrations of COD, BOD and ammonia are presented in Table 05. And the the media removal efficiency to the same parameters are presented in Table 06.

Table 05 – Affluent and effluent concentrations – Line 02

Phase	BOD (mg/l)		COD (mg/l)		Ammonia (mg/l)	
	Affluent	Effluent	Affluent	Effluent	Affluent	Effluent
01	165 (13)	49 (11)	258 (13)	110 (13)	115 (7)	15 (7)
02	170 (10)	32 (9)	337 (12)	84 (12)	66 (5)	28 (5)
03	165 (13)	27 (12)	275 (15)	92 (15)	35 (8)	15 (7)
04	135 (10)	33 (9)	222 (11)	72 (11)	42 (11)	13 (11)
05	127 (6)	33 (5)	295 (6)	90 (6)	40 (6)	10 (6)
Sewage *	156 (35)	27 (35)	442 (45)	72 (45)	-	-

Obs.: Values between parnethesis mean number of data
* Results of treatment when the line operated treating just sewage

Table 06 – Removal Efficiency of COD, BOD and ammonia -Line02

Phase	BOD(%)	COD (%)	Ammonia (%)
01	65	56	84
02	78	66	51
03	78	62	60
04	95	62	89
05	71	68	77
Sewage *	81	82	-

Obs.: * Results of treatment when the line operated treating just sewage

5. CONCLUSIONS

The operation of Line 01 (facultative pond + maturation pond) showed a effective increase of BOD removal in phase 03 (68%) only. For COD removal, no increase in the efficiency removal was observed, even in phase 03. This line, when operated with sewage only, showed a BOD efficieny removal of 70%. It can be concluded that the facultative pond did not work well with the combined treatment, even with a reduction of ammonia affluent load, reducing the leachate dilution.

It should be pointed out that the detention time increase did not lead to a significant enhance in COD removal. When the parameter under evaluation is BOD, the hidraulic adequacy of the treatment line (proposed on phase 03) promotes a better performance, but still under the expectations.

The system composed by aerated pond followed by sedimentation pond reached better results, this way considered a feasible alternative for the combined treatment. BOD removal efficiencies over 65%, till 78%, resulted in medium effluent concentration bellow 60 mg/L. The COD removal efficiency was worst, but still between 62% and 68%, except in Phase 01, with a high ammonia load.

The graphics boxplot showed a higher stability of the aerated pond and sedimentaion pond system related to the facultative pond and maturation pond system. The facultive pond, the most natural process for sewage treatment, did not operate well with the high organic matter concentration, mostly little degradable, as well as with the toxicity of the affluent ammonia concentration.

Only the aerated pond showed a good ammonia reduction in some operational phases, varying from 51% to 89%. For the aerated ponds, the process of ammonia reduction occurs by nitrification. This way, it is observed a nitrate concentration in all phases and the consequent ammonia concentration reduction.

A melhoria de desempenho nas fases subseqüentes podem ser avaliadas também em função da sensível redução na relação entre as cargas de amônia dos dois resíduos. It is considered that that the performance for Phase 01 (2% dilution) was not satisfactory due mainly to the the high ammonia load of the leachate related to the non treated domestic sewage load (around 100%). The better performance in the subsequent phases can be evaluated considering the sensible reduction in the ammonia load relation for the two residues.

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