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ACTIVATE SLUDGE TREATMENT OF LEACHATES FROM VÄÄTSA LANDFILL, ESTONIA

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ABSTRACT

Väätsa Landfill is the first sanitary landfill in Estonia that meets the requirements of the EU landfill directive. The landfill is dimensioned to serve about 130 000 inhabitants.

The first stage of landfill (out of seven) was accomplished in 2000. Disposal of wastes was started in November 2000. By now, the landfill contains: one hectare large disposal site for domestic waste, composting area for organic waste and storage site for construction wastes. In Estonia, the collection of recyclables has not jet developed. In Väätsa landfill, however, waste paper, glass and plastic are sorted. Organic waste is not separated on-site, and this is the reason why the organic content (nutritive waste) of garbage is high. Currently, the landfill serves approximately 40 000 inhabitants.

According to the requirements of the client, Veemaailm INC designed and built a two-phase activated sludge leachate treatment plant. First phase of the treatment, extended aeration, takes place in a container. In order to adjust the concentrations of biogenesis, Ortho Phosphorus Acid is added to the leachate. During the first phase, concentrations of pollutants are decreased approximately by 1/3. The second phase of purification takes place in oxidation lagoon.

The leachate treatment plant worked effectively throughout the first year, both during the summer with high temperatures, and winter with low temperatures. During the first operating year, the main expenses were: energy for blowers, phosphorus acid for nutrient adjustment, and exchange oil for blowers. The analysis of the first operating year shows that BOD has decreased more than 95%, COD approximately 90% and N on an average 60 %. The activated sludge process also reduced the concentrations of some heavy metals.

KEY WORDS: Technical solution, treatment efficiency

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1 INTRODUCTION

Väätsa Landfill was designed by the drafting department of PIC EESTI in 1998. Supervision of design was implemented by COWI, DENMARK. The constructor of the landfill was the MERKO construction company.

The first stage of the landfill construction (1 ha) was completed at the end of the year 2000. The landfill started storing waste in November 2000.

PIC Eesti did not design a leachates treatment plant for Väätsa Landfill. According to the design solution, leachates from the disposal site was collected by an underground drainage system to a pumping station. From the pumping station leachates was pumped to a collection lagoon with the volume of 2,500 m^3. From the tank, trucks periodically freighted the leachates for treatment to Paide WTP. The distance between the landfill and Paide WTP is 15 km.

In April 2002, a design and construction tender for Väätsa Landfill Leachate Treatment Plant was launched. Veemaailm INC was selected as the winning tenderer.

2 BASIC DATA AND TERMS OF REFERENCE FOR DESIGN

Table 1 Data of leachates from disposal area

Constituent	Unit	Contsentration	Daily total
Flowrate			30 m^3/d
pH		7....9	
BOD	mgO_2/l	3,000	90 kg/d
COD	mgO_2/l	4,000	120 kg/d
SS	mg/l	200	6 kg/d
P_{TOT}	mg/l	1	0,3 kg/d
N_{TOT}	mg/l	300	9 kg/d

Pollution load 90 kg BOD_7/d responding to 1,500 population equivalents (PD).

2.1 Requirements on LTP effluent

In compliance with the Estonian legislation [1], an effluent of a landfill with the pollution load less than 2,000 population equivalents, must correspond to the following requirements

Table 2 Effluent requirements

Constituent	Marginal value of pollution parameter mg/l	Or degree of purification %
BOD_7	15	major/equal 90%
COD	125	major/equal 90%
SS	25,0	major/equal 80%
P_{TOT} in landfill effluent	2,0	major/equal 60%
N_{TOT} in landfill effluent	Not applicable	Not applicable

2.2 Additional requirements

Additional requirements and conditions from the client were:

1. To select for leachates treatment a two-step activated sludge treatment where the first step is an activated sludge treatment in a prefabricated container plant and the second step in an oxidation lagoon.
2. The existing collection lagoon was to be utilised for constructing the oxidation lagoon.
3. Total cost of the turn key project had to be less than 1 million EEK (64,000 EUR)
4. For pumping stations, the existing pumping stations were to be utilised (except for the new underground pumping station, which pumps the partly treated leachates into the oxidation lagoon)
5. No expenditures and efforts were to be made to design and construct a nitrogen removal system.
6. The landfill is situated in a relatively cold climate zone. In the wintertime, the temperature of the leachates remains between +4 to +7ºC for a long period. For technical calculations, the lowest air temperature was recommended -35°C.

3 TECHNICAL SOLUTION

From the existing wastewater pumping station, sewage pumps pump landfill leachates into a prefabricated container plant for an activated sludge treatment. An electromagnetic flowmeter MAGFLO® has been installed on the inlet pipe. For the optimisation of N:P ratio, a dosing pump adds Ortho Phosphoric Acid (1 l contains 273 g P) to the container inlet.

The volume of the aeration tank (AT) is 70 m^3. O_2 concentration is retained at 0,8 –1,5 mg/l. On the bottom of AT, there are 42 PU diffusers AFD270 (from Stamford Scientific International, USA).

From AT the mixed liquid flows to a lamella separator (LS).

A dry installation pump pumps the return sludge back to AT. The same pump pumps excess sludge to an excess sludge container. The excess sludge container is periodically depleted to disposal area.

From AT the partly treated leachates flows to the underground pumping station which pumps the partly treated leachates into the oxidation lagoon.

The existing collection tank were separated by bulkhead into two parts: oxidation lagoon and anoxic lagoon.

On the bottom of the oxidation lagoon there are 128 pcs Airflex PU tube diffusers 62*610 mm.

From the oxidation lagoon the mixed liquid flows into the anoxic lagoon and from the anoxic lagoon trough decanting overflow into a recipient stream.

The pressure pipeline from the pumping station to the oxidation lagoon inlet is supplied with electrical heating. Decanting overflow of the anoxic lagoon is also supplied with electrical heating.

In case of necessity, it is also possible to lead the treated effluent of anoxic tank for diluting raw leachates from the disposal site as a respective system has been built.

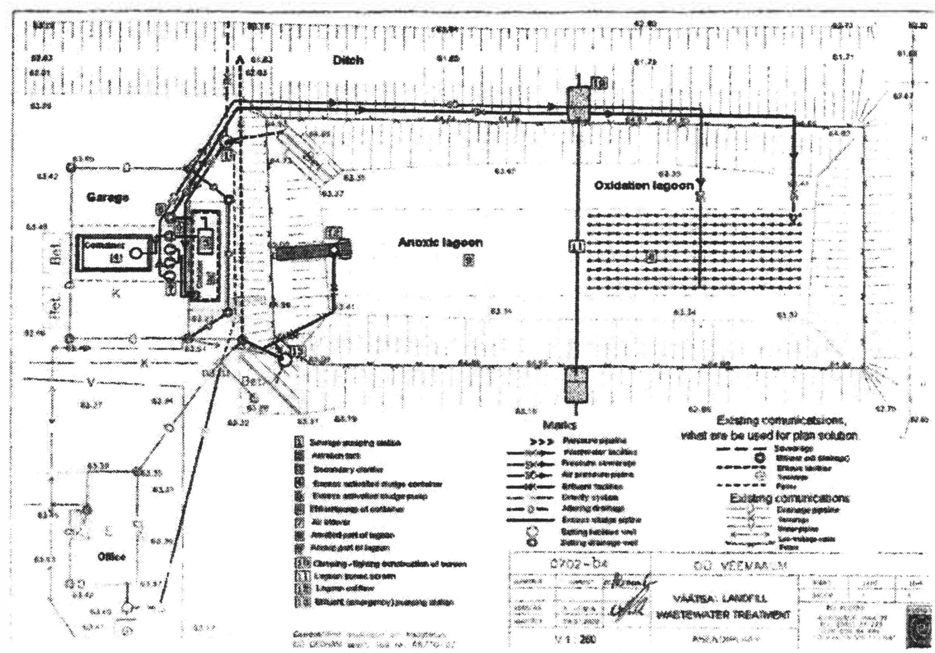

Figure 1 Situation plan of Väätsa Landfill Leachates Treatment Plant

4 ACTUAL FLOWRATE AND TREATMENT EFFICIENCY

Plant started under operation in October 2002.

Table 3 Actual flow rate of leachates

Month, year	Overage daily flow rate m^3/d	Minimum day flow rate m^3/d	Maximum day flow rate m^3/d
November 2002	17,2	12,4	24,7
December 2002	8,5	2	27,0
January 2003	10,7	5	30,6
February 2003	3,2	1	7,0
March 2003	17,8	2	84,0
April 2003	12,7	5	35,0
May 2003	12,0	7	29,0
June 2003	5,9	4	11,0
July 2003	11,3	3	80,0
August 2003	10,5	5	23,0
September 2003	6,8	1	16,0
October 2003	10,7	6	19,0
Year	10,25	1	84,0

4.1 Constituent concentrations of leachates from disposal area

Table 4. Leachates constituent concentrations

Month / Constituent	BOD_7 mgO_2/l	COD mgO_2/l	pH	P_{TOT} mg/l	N_{TOT} mg/l	NO_3^- mgN/l	SO_4^{2-} mg/l	SS mg/l
November	371	111	8,0	3,8	236,2			708
December	3,576	8,130	7,19	1,64	410,8		205	253
March	1,650	2,700	7,0	0,76	171	8,0	210	
May	2,000	6,000	7,05	1,8	397	0,05	51	
June	5,300	6,900	7,25	2,7	518	0,03	2,4	
13.August	2,645	4,240	7,56	1,4	445	7,5		
15.August	2,385	4,340	7,52	1,4	468	7,5		
17.August	1,760	3,900	7,44	1,1	416	7,5		
19.August	1,530	3,740	7,48	1,4	434	2		
26.August	1,850	3,475	7,48	1,08	482	5		
02.September	1,550	3,157	7,49	1,5	436	5		
11.September	1,700	2,900	7,55	2,0	400	0,05		

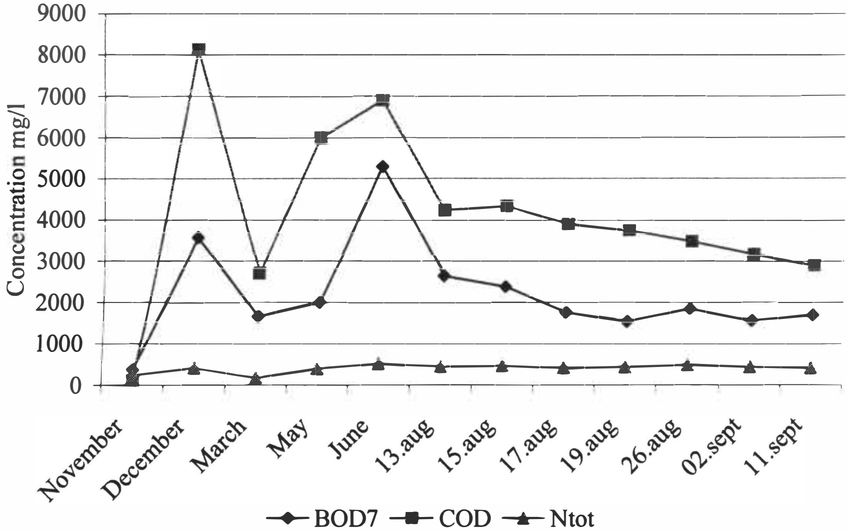

Figure 2. BOD_7, COD and N_{TOT} dependence of date in inlet

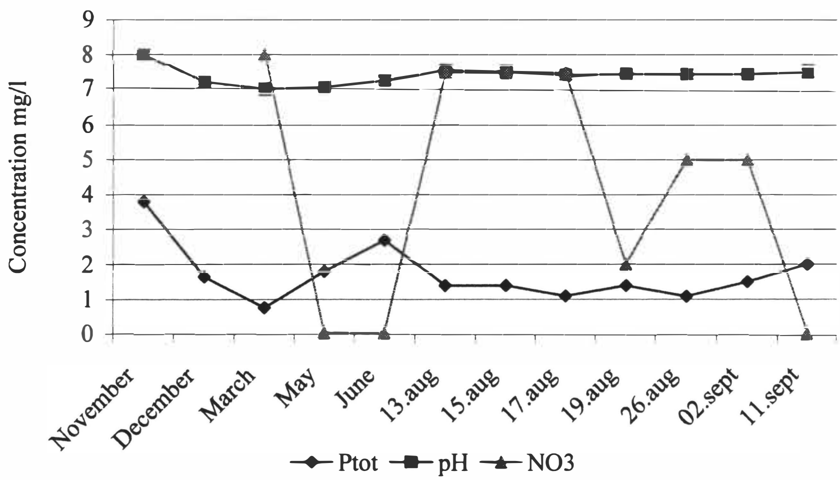

Figure 3. P_{TOT}, pH and NO_3^- dependence of date in leachate

4.2 Efluent constituent concentrations

Table 5. Effluent constituent concentrations

Month / Constituent	BOD_7 mgO_2/l	COD mgO_2/l	pH	P_{TOT} mg/l	N_{TOT} mg/l	NO_3^- mgN/l	SO_4^{2-} mg/l	SS mg/l
November	19,8	111	7,93	22,74	165,8			42
December	58,5	370	8,15	5,62	99	4,9	295	60
March	60	500	8,7	1,3	145	4,1	174	
May	50	420	8,65	1,8	131	<0,02	98	
June	62	430	8,85	2,9	115	0,1	70	
13.August	55	567	8,91	1,4	84	25		
15.August	51	535	8,65	1,0	105	22,5		
17.August	77	547	8,79	1,4	102	22,5		
19.August	36	556	8,85	1,2	105	20		
26.August	30	446	8,76	1,2	147	11		
02.September	75	474	8,78	1,1	130	9		
11.September	52	450	8,9	1,2	75	6,0	51	

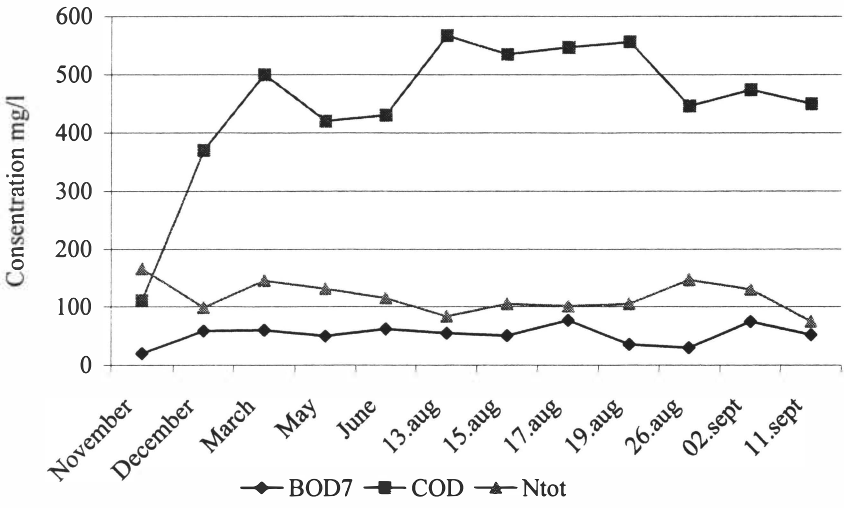

Figure 4. BOD_7, COD and N_{TOT} dependence of date in effluent

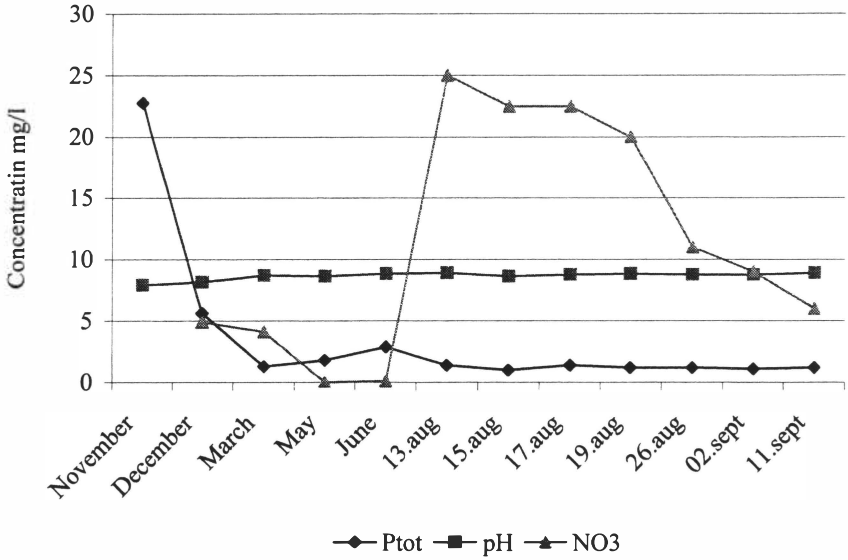

Figure 5. P_{TOT}, pH and NO_3^-dependence of date in effluent.

5 BOD, COD AND N EFFICIENCY

Table 6. Treatment efficiency

Month / Constituent	BOD_7 %	COD %	N_{TOT} %
November	94,7	-	29,8
December	98,4	95,4	75,9
March	96,4	81,5	15,2
May	97,5	93,0	67
June	98,8	93,8	77,8
August	97,5	86,5	75,8
September	96,0	84,7	75,4
Average	97,0	90,1	60.0

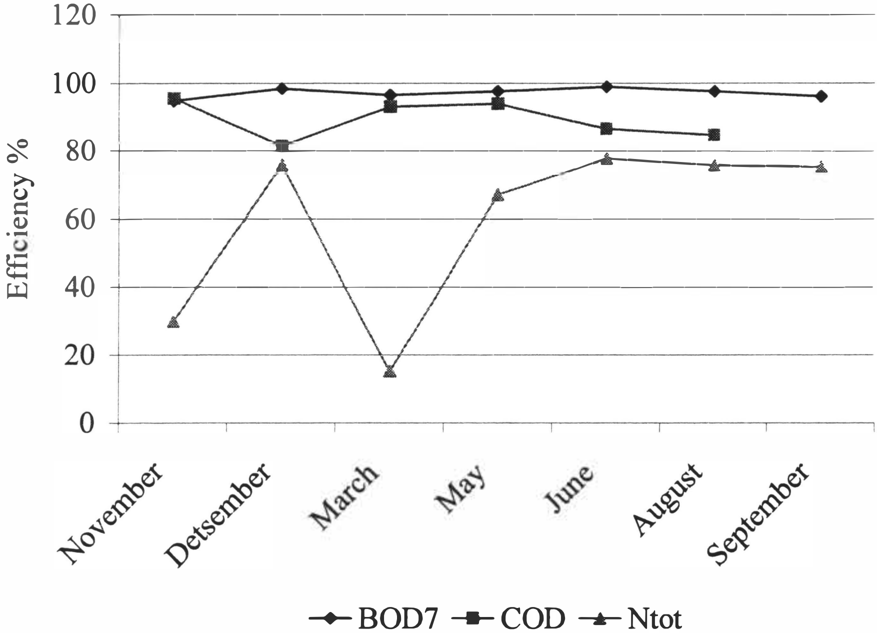

Figure 6. BOD_7, COD and N_{TOT} treatment efficiency dependence of month

5.1 Concentrations of heavy metals in Väätsa Landfill leachates and effluent

Table 7. Concentrations of heavy metals in Väätsa Prügila leachates and effluent

Constituent	Unit	Before plant operation		Before treatment	After treatment plant			Standard
		17.04.02	17.05.02	26.11.02	26.11.02	18.03.03	19.06.03	
Cadmium(Cd)	µg/l	<0,1	0,3	0,4	0.1	<0,1	<0,1	0,2
Chromium(Cr)	mg/l	0,035	0,144	0,099	0,016	0,026	0,026	0,5
Copper (Cu)	mg/l	<0,04	0,047	<0,04	<0,04	<0,05	<0,04	2
Mercury(Hg)	µg/l	<0,05	<0,05	0,1	<0,05	0,022	<0,05	0,05
Nickel (Ni)	mg/l	0,015	0,148	0,096	0,016	0,006	0,024	1
Lead (Pb)	mg/l	0,01	0,01	0,009	0,004	0,022	0,001	0,5
Zinc (Zn)	mg/l	0,03	0,077	0,121	0,012	0,04	0,01	2

NB Storage of wastes started in November of 2000. Leachates treatment started in October of 2002.

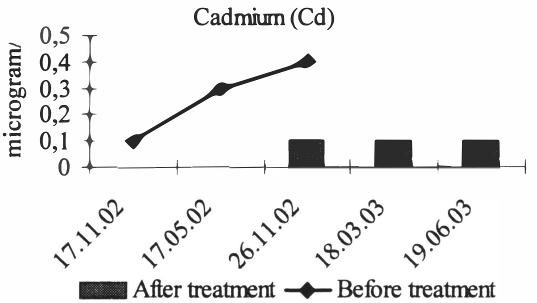

Figure 7.1. Cadmium (Cd)

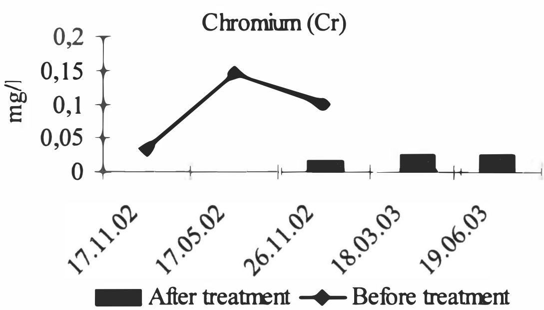

Figure 7.2. Chromium (Cr)

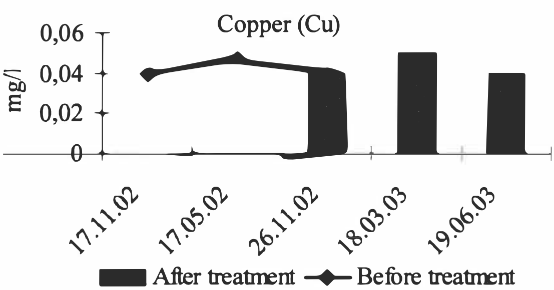

Figure 7.3. Copper (Cu)

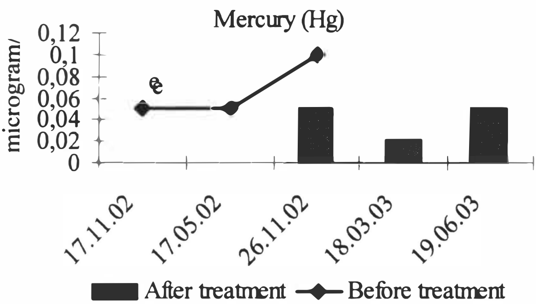

Figure 7.4. Mercury (Hg)

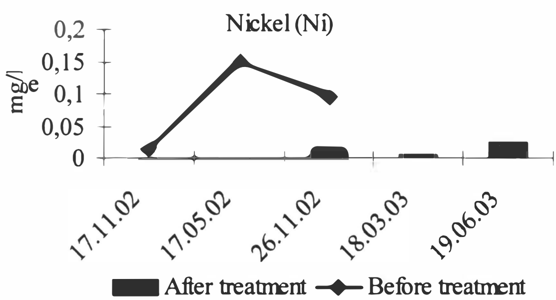

Figure 7.5 Nickel (Ni)

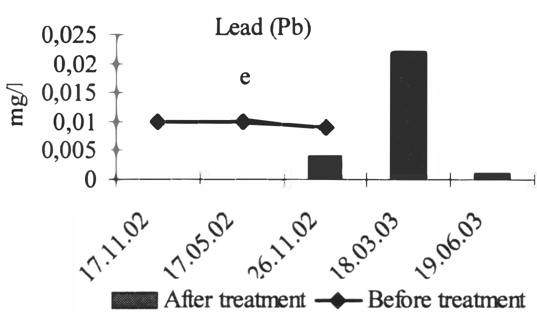

Figure 7.6. Lead *(Pb)*

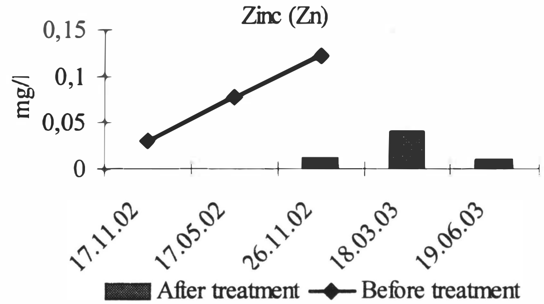

Figure 7.7. Zinc (Zn)

6 REFERENCES

[1] Vabariigi Valitsuse 31.juuli 2001a. määrus nr 269 "Heitvee veekogusse või pinnasesse juhtimise kord" RTI 2001, 69, 424