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LANDFILL LEACHATE MULTISTAGE TREATMENT – A CASE STUDY

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Introduction

Old and intermediate Landfill leachates represent highly polluted aqueous systems containing non-biodegradable substrates, but also high concentrations of ammonia – nitrogen and nitrogen containing organic substances.

Salubris SA is operating a leachate treatment plant for the landfill Balteni based on sequencing batch reactors (SBRs) and some chemical treatment facilities. The SBRs were designed for nitrification and denitrification and organics removal, with design data restricted to COD < 2650 mg O₂/L (Chemical Oxygen Demand), BOD/COD ratio between 0.25 and 0.66 (BOD-Biochemical Oxygen Demand), ammonia NH₄⁺ < 800 mg/L without a specified TKN (Total Kjeldahl Nitrogen). The real leachate parameters were COD-Cr = 2900-5000 mg O₂/L, BOD/COD < 0.15, TKN=1000-2500 mg N/L, NH₄⁺ = 1000-1500 mg/L and the quality of the treated leachate became an issue. Treatment tests achieving advanced ammonia, TKN, COD and color removal on laboratory, pilot and industrial scale were done coupling biological oxidation, coagulation and adsorption on activated carbon.

Materials and methods

The treatment of Leachate from Balteni was done mainly using an activated sludge process using two SBRs. The process was modified for alternating, multiple, aerobic and anoxic phases with filling, adapted gradually to the best performance in relation with ammonia oxidation to nitrate but also without nitrite accumulation. With an exchange rate of 5% and a specific ammonia load of 0.07 kg TKN/(m³·day) a concentration of about 4 kg VSS / m³ was maintained. Good or very good ammonia and TKN removal were observed: effluent ammonia is typically 10-20 mg/L (or below, down to 2 mg/L in summer), while TKN is reduced down to 100-150 mg/L. Performance is lower in winter and values of between 30 and 70 mg/L were observed for ammonia-N. Regarding nitrite, the operation was stable, generally the biologically treated effluent having 2-5 mg NO₂/L. However, if the daily load is increased, the system will start to accumulate nitrite (values up to 900 mg NO₂ /L are possible and were recorded during the plant adjustment phase). The pH for the biological effluent was stable for almost one year to values above pH = 7 due to favorable alkalinity of the leachate (pH = 8-8.5, alkalinity 130-160 mEq/L) and some biodegradable COD available for denitrification. The situation evolved in time to an expected state of alkalinity deficiency (both due to a moderate decrease of

the leachate alkalinity and to a sudden and permanent BOD and BOD/COD decrease from 0.25 to 0.1 and below, observed in less than a year), so pH values below 5.5-6.0 were established after biological treatment. COD and the color were not improved by biological treatment and no results could be obtained by leachate pre-treatment (coagulation with Fe^{3+}). A post-treatment of the nitrified biological effluent, using only the existing facilities (dosing capabilities and a contact basin with mixer) was tested on full-scale. The process consisted in coagulation using poly-hydroxyaluminum chloride sulfate (Kempac-14, Kemcristal Fundulea) and adsorption on powdered activated carbon (PAC, Flochem Floerger).

Results and conclusions

Coagulation and adsorption process were tested as two alternatives: A. coagulation, solids separation followed by adsorption, pH adjustment with NaOH and settling (*two contact phases process*) and B. coagulation, PAC addition and contacting, pH adjustment, flocculation and settling (*one contact phase process*). Results for the alternative B., using Al^{3+} dosage - 0.400 kg/m³, PAC dosage – 5 kg/m³, anionic polymer 5 g/m³ and contact time of 120 min are presented in Table 1. These were the optimized dosage values, according to preliminary laboratory and pilot scale test work.

Table1. Post-treatment of the biological effluent full scale, one contact phase process

Parameter	Unit	Leachate	Biological effluent	Post-treat	Removal
COD	mg O ₂ /L	3608	2948	616	79%
TKN	mg N/L	1060	126	39.5	69%
Total P	mg P/L	14.5	23.9	<0.1	99%
pH		7.98	5.56	6.59	-
UV-VIS Absorbance					
254 nm	cm ⁻¹	24.5	20.2	2.20	89%
436 nm	cm ⁻¹	2.25	1.65	0.060	96%
525 nm	cm ⁻¹	0.850	0.625	0.020	97%
620 nm	cm ⁻¹	0.500	0.325	0.015	95%

Significant improvements were obtained for the post-treated biological effluent, such as 79% removal of COD and >95% reduction of color (from glossy black to yellow). TKN resisting biological oxidation could be lowered by 69%, down to 40 mg N/L. However, the regulated limit for COD (125 mg O₂/L) was exceeded by a factor of five. From laboratory-scale tests resulted that a lower value for COD can be obtained, 450 mg O₂/L, or even lower for a type A. process (but it will anyway exceed 250-300 mg O₂/L and the process complexity is higher, being difficult to be implemented using the existing leachate treatment plant). By coagulation alone it is possible to reduce the COD value down to 1100-1500 mg O₂/L, but also TKN (down to 50-70 mg/L) and Total P (below 1 mg/L). The cost estimation was 3.5 Euro/m³ for the coagulation step alone and 14.1 Euro/m³ for the complete process, the activated carbon being the major cost item. Better efficiencies could be obtained for higher PAC doses, but were not cost-effective.

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