Combination of Biofiltration and Electrocoagulation processes for the treatment of sanitary landfill leachate

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DIA Oumar [a], DROGUI Patrick [a], BUELNA Gerardo [b], DUBÉ Rino [b]

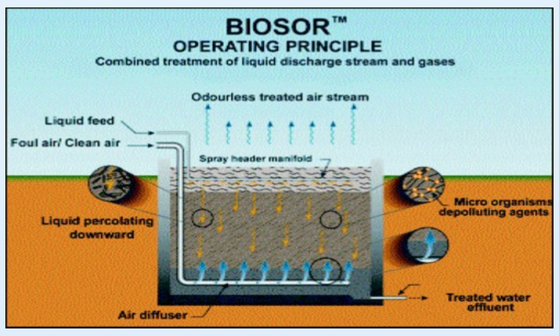
[a] Institut National de la Recherche Scientifique (INRS), Centre-Eau Terre Environnement, 490 Rue de la Couronne, Québec (QC) G1K 9A9, Canada.
[b] Centre de Recherche Industrielle du Québec (CRIQ), 333 rue Franquet, Québec (QC) G1P 4C7, Canada.

OBJECTIVES

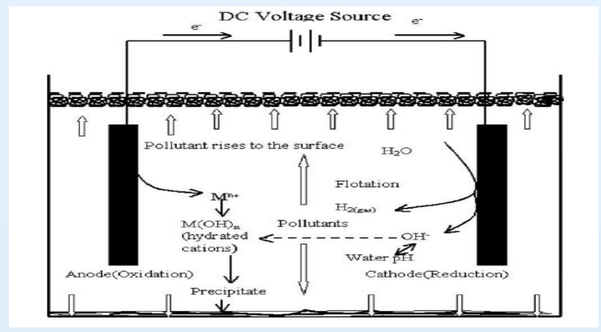
- Development and optimization of a hybrid process capable of treating efficiently different types of landfill leachates
- Investigate the interactions between the biofiltration and the electrocoagulation process in order to overcome the technological uncertainties related to this combination

PRINCIPLES

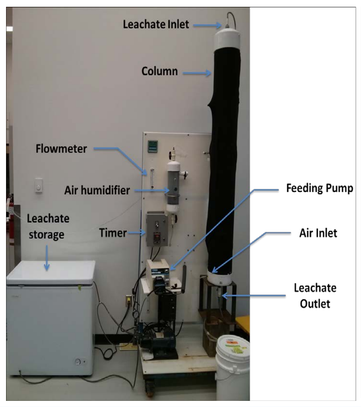
BIOFILTRATION



ELECTROCOAGULATION[1]

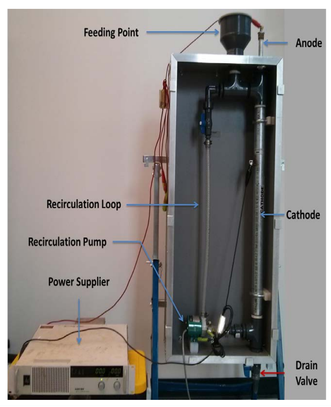


METHODOLOGY



Biofiltration Pilot

- Height = 2m
- Diameter = 20 cm
- Organic media : Peat + wood chips
- Air Flow = 5 LPM
- HRT : 5 – 6 days
- Countercurrent feeding



Electrocoagulation Cell

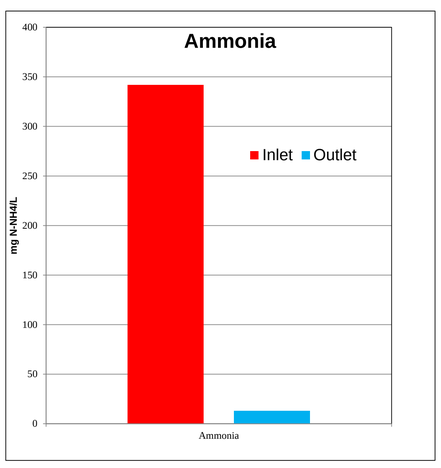
- Capacity : 1.5 L
- Cylindrical stainless steel cathode
- Cathode surface ≈ 900 cm^2
- Anode surface = 476 cm^2
- Power supplier (40V – 70A)

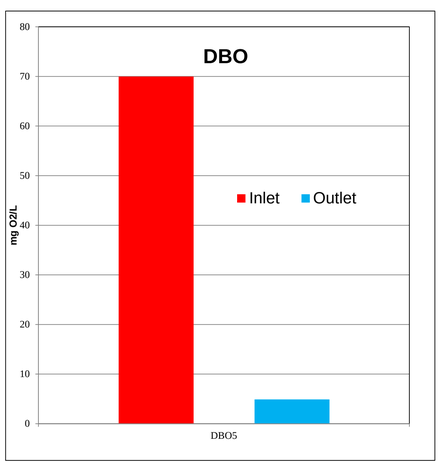
Landfill leachate characteristics

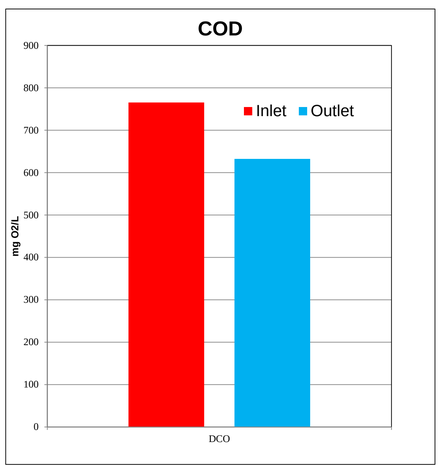
Parameters	Units	Average values	Min Values	Max values	N
Total COD	mg/L	765	534	1332	74
BOD_5	mg/L	70	12	110	11
BOD/COD	-	0.09	0.02	0.13	11
TSS	mg/L	30	30	30	1
Turbidity	NTU	106.9	17.1	319	74
pH	-	8.21	7.48	8.8	69
Alkalinity	mg $CaCO_3$/L	2750	2418	3198	6
$N\text{-}NH_4$	mg/L	342	221	444	72
$P\text{-}PO_4$	mg/L	2.33	0.24	9.8	67
Zn	mg/L	0.07	0.04	0.10	2
Fe	mg/L	2.6	1.9	3.31	2

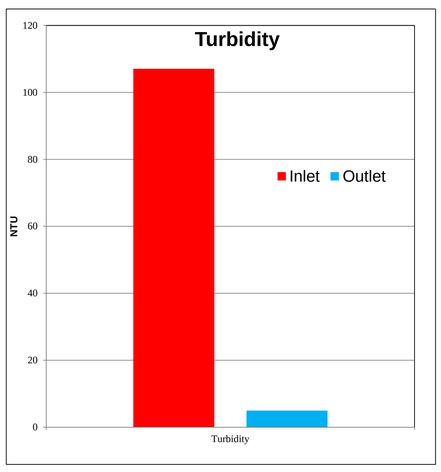
RESULTS

BIOFILTRATION







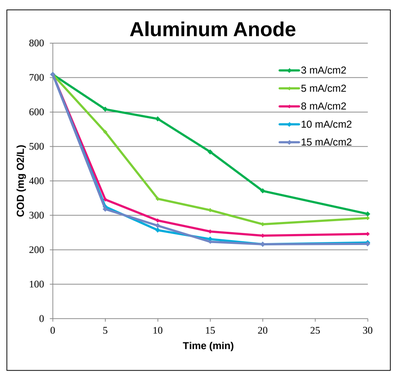


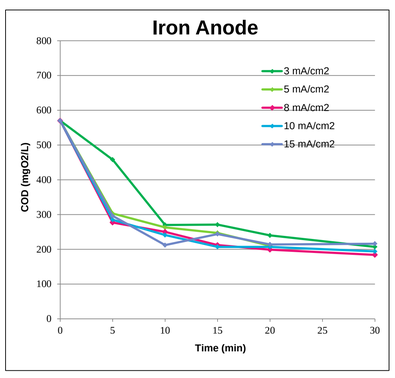
Biofilter efficiency

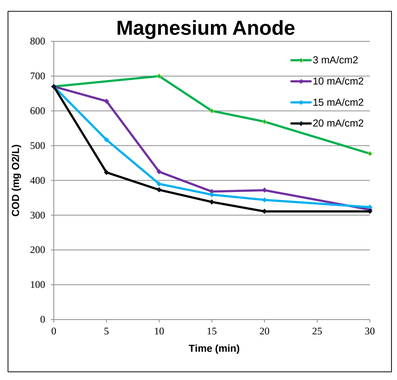
- 325 days of operation without any sign of clogging
- Hydraulic load = 0.175 $m^3/m^2/j$
- Pollutants Removal on average:
  - 96 % of BOD_5
  - 96 % of NH_4
  - 98 % of PO_4
  - 95 % of turbidity
- 20 % removal of COD du to the high presence pf humic substances in the landfill leachate

ELECTROCOAGULATION

Effect of current density and treatment time on COD removal





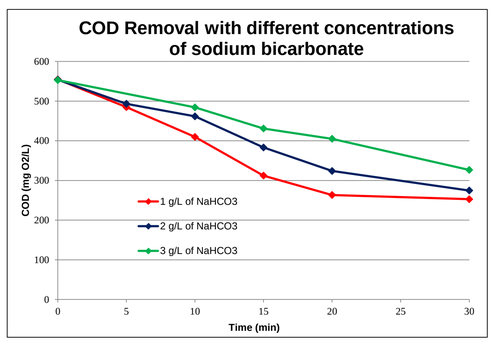


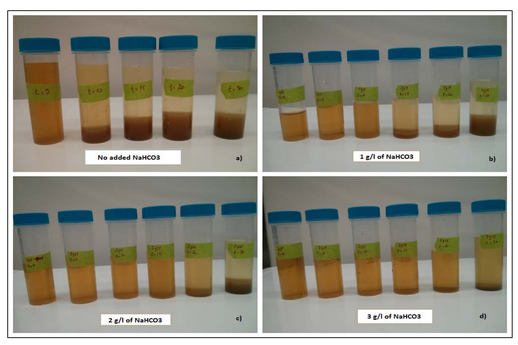
- The Increase of current and treatment time promotes the COD removal in all anodes
- Aluminum and iron are more efficient for residual COD removal
- The use of magnesium anode leads to a high increase in pH after the treatment

Optimum parameters

Anodes	Current (mA/cm^2)	Time (min)	COD initial (ppm)	COD Removal (%)	Color removal (%)	pH final
Aluminum	10	20	709	70%	90%	9,41
Iron	8	20	570	65 %	85%	9,09
Magnesium	10	30	670	53%	85%	10,63

Magnesium anode: Influence of alkalinity



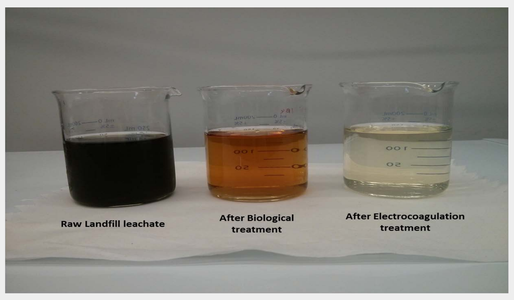


- The increase of alkalinity has a negative impact on COD removal
- The alkalinity resists to the increase of pH and delays the magnesium ions precipitation
- This phenomena leads to the formation of magnesium and calcium carbonates and induces the fouling of the electrodes

$$HCO_3^- + OH^- \rightarrow CO_3^{2-} + H_2O$$
$$CO_3^{2-} + Mg^{2+} \rightarrow MgCO_3\,(s)$$
$$CO_3^{2-} + Ca^{2+} \rightarrow CaCO_3\,(s)$$

CONCLUSIONS

- The biological treatment has allowed removing **96% of ammonia nitrogen**, **95 % of turbidity** and **96 % biodegradable carbon** by applied a hydraulic load of **0.175 $m^3/m^2/j$**
- The subsequent electrocoagulation treatment has enabled to reduce **70% of residual COD and 90% of residual color using aluminum anode with 10 mA/cm^2 and 20 minutes of treatment time**
- By comparison with aluminum and iron, magnesium anode is less suitable for the electrocoagulation of bio-treated landfill leachate. Magnesium anode greatly increases the pH so that electrodes fouling is observed
- The combination of biofiltration and electrocoagulation processes is technically feasible and economical viable to treat efficiently sanitary landfill leachate.



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[1]. M. Y. Mollah, P. Morkovsky, J. A. Gomes, M. Kesmez, J. Parga, and D. L. Cocke. (2004) Fundamentals, present and future perspectives of electrocoagulation. *J Hazard Mater* 114 (1-3): 199-210

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