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Cod removal efficiency from leachate using combined process –electrocoagulation and anaerobic digestion

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***Abstract*— The objective of the present study is to investigate the removal of chemical oxygen demand from Landfill Leachate effluent Using an electrocoagulation process such as preprocessing before anaerobic digestion. A Landfill Leachate effluent which has a COD amount to 11199 mg of O2/L was treated used an aluminum electrode with a current density of 200 A/m2 without buffering solutions for three residence time 60min, 120 min and 240 min who showed a removal capacity of 17%, 29.7 % and 49 % consecutively the results of the sample characterization analyzes show the effectiveness of anaerobic digestion, in the mesophilic when the COD removal efficiency reached is 76.9% , 77% and 82.9% for substrate electrocoagulation time of 60min, 120 min and 240 min successively**

***Keywords*— A Landfill Leachate effluent, electrocoagulation, COD removal, aluminum electrode, combined processes**

I. INTRODUCTION

Water percolating through the waste interacts with organic and inorganic components to generate aleachate.
many treatment methods have been examined in the literature to treat leachate, such as biological treatment methods [1], membrane processes[2], advanced oxidation techniques [3], coagulation–flocculation methods [4].
as it's known Leachate is difficult to treat, to meet with the discharge standards for its variable composition and proportion of refractory materials, generally only one method will not be sufficient as efficiently process, that's why a combine process was realize to see their effectiveness to treat lechate. The aim of this study was to investigate the efficiency of combined process - electrocoagulation and anaerobic digestion, because It is shown that the treatment of leachates by EC can be used as conjoint treatment [5] and generally, anaerobic digestion usually applied in leachate treatment for treating high-strength organic compounds, with methane production and utilization as an alternative energy resource [6,7].
The electrocoagulation (EC) is one of a technique for treating polluted water that has shown its effectiveness in the treatment of certain soluble or colloidal pollutants, such as encountered in Liquid waste containing heavy metals, emulsions, suspensions... [8].
This technique based on the electrochemical dissolution of sacrificial aluminum or iron electrodes, the cations produced participate to reduce the stability of suspended contained by reduction of their zeta potential.
olso the production of hydroxides ions at the cathode, metal ions combined to hydroxides which are known as an efficient coagulants. forthwith a flotation process was engendered from The hydrogen bubbles formed at the cathode who adsorb the flocs formed and facilitate the separation from the treated water.
Anérobic digestion (AD) or the methanization of the wastes constitutes a treatment and a technical valorization with several advantages :
biological process that can convert organic substrates to biogas in the absence of oxygen [9], reduction of environmental harmful effects and obtaining an organic fertilizer matter.
A mesophilic range of temperature, a neutral acidity value, convenient stiring, a well balanced ratio are the major parameters to be controlled.

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The test of anaerobic digestion consists to incubating an amount of waste with an anaerobic inoculum and measuring the production of methane by measuring the volume of biogas and analyzing its composition.
The electrochemical oxidation process was performed at different times that leads to the decrease of COD intended to know how much we can earn of COD removal from anaerobic digestion.
leachate was obtained from Constantine landfill site in Algeria , and were analyzed before treatment and average values were given in Table 1.

TABLE1

THE PROPERTIES OF RAW LEACHATE FROM CONSTANTINE LANDFILL

LEACHATE CHARACTERISTICS	VALUE	LEACHATE CHARACTERISTICS	VALUE
COLOR	BROWNISH	SMELL	FECALOIDE
PH	7.80-8.26	PHENOL (MG/L)	4221
COD (MG/O_2/ L)	11199	TURBIDITY (NTU)	1096
SUSPENDED SOLIDS (MG/L)	277	CHLORIDE (MG/L)	3517
ORTHOPHOSPHATES (PO_4^{3-}) (MG/L)	39.8	ALKALINITY (MG CACO3/L)	1149
TOC (MG/L)	2022	CONDUCTIVITY (MS/CM)	29.3 (AT 28.8 ◦C)
TC (MG/L)	4800	SALINITY(MS/CM)	18.2 (AT 28.8 ◦C)
TN (MG/L)	2354	NITRATE (MG/L)	641

II. MATERIALS AND METHODS

The first part of the study is based on treatment of leachate by electrocoagulation. The second is based on quantitative analyses (biogas generation) after that a qualitative analyses (physico-chemical characterization of samples before and after incubation)

A. Analytical procedures

Chemical oxygen demand (COD) was colorimetrically determined following dichromate digestion heated in a COD reactor (Model WTW termoreactor CR 3000) for 120 min after which the absorbance was measured using a spectrophotometer (Model Jasco V-730). The pH was electrochemically measured (pH-meter model Jenway 3505).
All other parameters, such as and solid concentrations (TSS and VSS), were analyzed according to standard methods [10].

B. Electrocoagulation

A batch system in laboratory scale was performed to treat leachate by electrocoagulation , two aluminum plates (size 150×45×2 mm) were used as electrodes, they were immersed in a beaker containing 500ml of leachate.
The immersed surface of each electrode was 30 cm^2 and the distance between them is 2 cm, a stirring using a magnetic bar and a distance.
a digital dc (Electrophoresis power supply,EV 202, 0–220V, 0.0–2.0 A) was used to give an adjusted electricity current to the electrochemical cell.
a current density of 200 A/m2 was applied without buffering solution for three residence time 60min, 120 min and 240 min.
% Removal were calculated as :

$$R\,\% = {}^{(C0 - C)}/_{C0} \times 100$$

Where: C0 is the initial concentration and C the final concentration.

C. Anaerobic digestion

For anaerobic digestion we used solutions obtained from electrocoagulation treatment with anaerobic inoculum collected from the waste water treatment plant « IBN ZIAD» of Constantine in Algeria.
This inoculum was stored into the laboratory for predigestion of organic compounds contained in the sludge by incubation at the temperature 37 ° C, where the tests were carried out.
Reactors of 500 ml hermetically closed (contain 150 mL of inoculum and substrate), a mesophilic range of temperature (An oven heated with an adjustable resistance Allowing to maintain a constant temperature at 37 ° C) , a neutral acidity value, convenient stirring, the gas phase was purged with N_2.
To exhaust the residual organic charge, we used a suitable inoculum, fresh and pre-incubated under test conditions where a bottle as a control who containing only the inoculum was prepared to measure residual activity. All experiments were carried out in duplicate and the results expressed as a mean.

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The production of biogas was controlled, where a gasometer include a vial containing a NaOH solution 1.5% (w/v) to capture the CO2 [11], and a graduated burette receiving the displaced liquid, this system was used to measure the volume of methane produced by the displacement of an equivalent volume of the liquid.

III. RESULTS AND DISCUSSIONS

The purpose of this study is to indicate the effects of electrocoagulation on pollutant removal efficiency and to evaluate the electrocoagulation and digestion of leachate.

A. First Part

previous by electrocoagulation where a direct current is applied to the electrodes to induce the electrochemical reactions necessary to achieve coagulation (Figure 1), also it has the advantage, of removing the smallest colloidal particles [12].

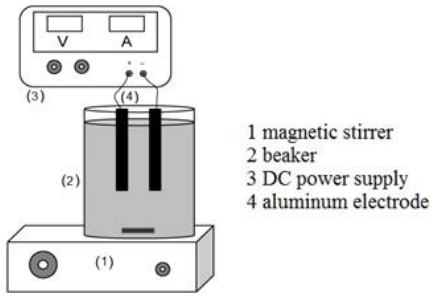

Fig. 1 Electocoagulation (EC) experimental set-up.

The evolution of chemical oxygen demand (COD) efficiency in the electrocoagulation process according to the time at a current density of 200 A/m2 and without buffering solutions is represented in Figure 2 , for three residence time 60min, 120 min and 240 min who showed a removal capacity of 17%, 29.7 % and 49 % consecutively.

it shows that an increase in time causes an increase in efficiency, we deduce that the electrolysis time determine the rate of dissolution of the anode [13].

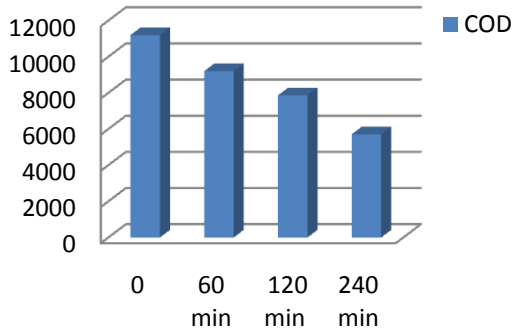

Fig. 2 Influence of electrolysis time on chemical oxygen demand (COD) removal in Electocoagulation (EC) process

B. Second part

When evaluating the anaerobic digestion process of wastewaters, parameters such as the pH, volatile fatty acids (VFAs), biogas, and chemical oxygen demand (COD) have generally been used as indicators of treatment performance. Quantitative tests were performed in the liquid phase and under anaerobic conditions during a period of 94 days.

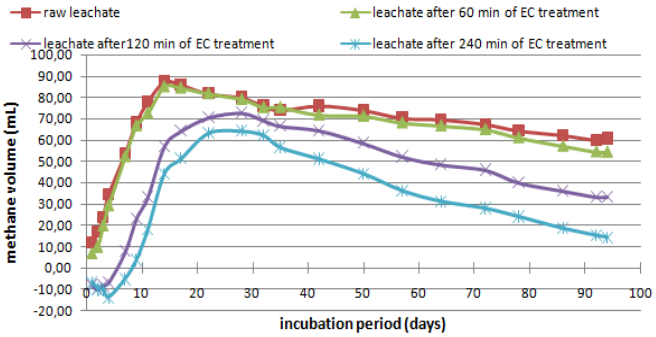

Fig. 3 Total methane production over time at a mesophilic temperature range.

In the mesophilic rang, after the operation, biogas production from the digester was very low as it shown in figure 3, after 14 days ,only about 87ml of methane for raw leachate and 85 ml for leachate after 60min of electrocoagulation treatment, with COD removal efficiency of 80.3% and 76.9% successively.

And after 28 days, about 72 ml of methane for leachate after 120min of EC treatment, and 64 ml for leachate after 240min EC treatment, with 77% and 82.9% of COD removal efficiency respectively,then stopped altogether, this indicated the gradual inhibition of the inoculum as it's showen in figure 4.

After 94 days of anaerobic fermentation, we noticed a little biogas production (figure 3), the reason it's a Small volume of substrate (50 mL in each reactor), when we can stop the anaerobic process after 1 month , but we Continued for 3 months to notice the Decline phase, it's the end of stationary phase where the colony count declines, death of cells is due to nutrient exhaustion and accumulation of detrimental end products.

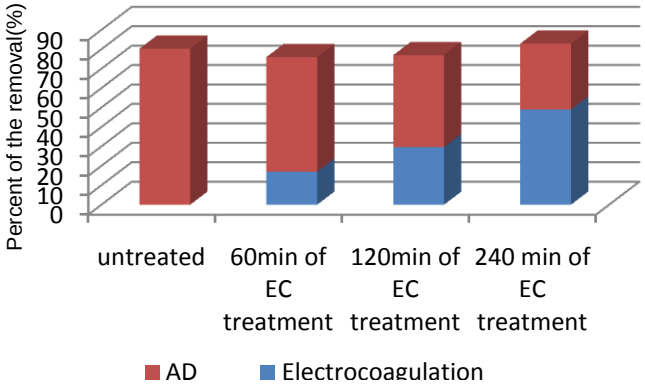

Fig. 4 COD removal efficiency.

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IV. CONCLUSIONS

According to this study, it is shown that :
electrocoagulation decrease the organic matter that's result a decrease of organic matter able to be treating in anaerobic digestion process and it' prouved in the volume of methane produce in eatch case during AD treatment
Comparing the COD removal efficiency reached 76.9% , 77% and 82.9% for substrate electrocoagulation time of 60min, 120 min and 240 min successively indicated that electrocoagulation considerably reduced the concentration of COD and improved the anaerobic treatability with approximate percentages, the cause it can be that the electrocoagulation is widely used to remove the unwanted substances, which consist largely of clay minerals and proteinous matter in widely varying particle sizes,So to be effective in removing these inhibitors.
In case of raw leachate (untreated), we noticed a clear decrease in DOC content 80% and biogas production whitch is close to other percentages, maybe we can cancel the electrocoagulation treatment , but we need more analysis than COD to prove the efficiency of each treatment to eliminate other Pollutants.
Furthermore, it can be concluded that for the treatment of Leachate the electrocoagulation technique and anaerobic digestion allow a good results as combined processes.

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