Improved Anaerobic Digestion by Athermal Chemical Pretreatment the Kinetic of Biogas Production Rate from Sewage Sludge in Batch Mode

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***Abstract*—**Treatment of waste-water in sewage treatment plants consists of eliminating most of the pollution by generating waste called mud. Sewage sludge is the result of a chemical or biological process aimed at separating solid matter from water from effluents resulting from human activities. The management of sewage sludge is a real economic and environmental matter The owing from the increase in their quantity and regulatory constraints. However, their valorization in the form of biogas, renewable energy, meets sustainable development criteria.

The purpose of this study is to study the effect of chemical treatment coupled with a heat treatment on the physicochemical behavior of activated sludge from the Oued El Atmania waste water treatment plant. This type of pretreatment makes it possible to hydrolyze the organic matter of the sludge in order to ensure its accessibility by the microorganisms and to increase the biodegradability kinetics of the sewage sludge and thus to improve the methane yield. The modified Gompertz, reaction curve, logistic model equations are used to analyze the cumulative biogas yields obtained for each experiment, which allows to represent curves of sigmoidal shape using three parameters Pot∞ , Rm and λ. According to some authors, the RC kinetic model gives a better approach with the experimental study and this was confirmed by our results.

The kinetic of methane production was calculated by performing a series laboratory the chemical agents used were NaOH with five arrangements (1 g/ l, 4 g/ l, 5.5 g/ l, 7 g /l and 20 g/ l) at a temperature of 100 ° C for a period of thirty minutes.

These equations make it possible to adjust the daily outputs of methane cumulative resulting from the values of R2 higher than 0.92 in the case of treatment with NaOH and 0.96. The speed of maximum production is important for the thermochemical amount n1= 4g/l in the case of treatment with NaOH for a better production out of biogas According to certain authors, kinetic model RC gives a better approach with the experimental study and that was confirmed by our results.

***Keywords*—S**ludge, methane, hydrolysis, anaerobic digestion.

I. Introduction

This experimental study was conducted to evaluate the impact of pretreatment by the NaOH. [1] suggested that

Anaerobic digestion consists of three stages Hydrolysis, Acidogenesis and Methanogenesis [2]. The biological hydrolysis step represents the Anaerobic digestion rate limiting step of the process.The chemical treatments can be implemented in order to compensate for the limits of anaerobic digestion particularly if the effluent to be treated contains bio-resistant or toxic molecules or in the case of a substrate which is slowly biodegradable such as purification sludge [3] . Indeed the active stage of methanization is hydrolysis [4]. In fact, pre-treatment has been found to improve the bioavailability of the sludge, and thus make the compost und more susceptible for the further biodegradation [5]. The methods of treatment with powerful oxidants Ozone [6]. Can achieve disintegration rates important at ambient pressure and temperature. The use of hydrogen peroxide and the alcalins makes it possible to solubilize some of the material , but can also lead to the mineralization of matter [6]. It also allows anaerobic biodegradability of the material, Effluent can thus be improved [7], [8]. Studied biogas production by batch tests of anaerobic digestion showed an increase in biogas production of up to 60% [7].

II. Materials And Methods

For better degradation of the substrate, thus promoting the hydrolysis step. The inoculum underwent a chemical treatment. the kinetic of methane production was calculated by performing a series laboratory the chemical agents used were NaOH with five arrangements (1 g/ l, 4 g/ l, 5.5 g/ l, 7 g /l and 20 g/ l) at a temperature of 100 ° C for a period of thirty minutes. The methanogenic potential test is based on the measurement of biogas production in a closed batch bottle. Thus, an amount of a mixture of the substrate, inoculum and nutrient solution is introduced into a 250 ml serum vial.For the same sample, the test includes a series of batch. Each batch is doubled and the results are averaged over the two experimental measurements.

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III. Results And Discussions Of Modeling

The production curves of biogas are modelled by using the equations of Gompertz modified (GM), Reaction curve (RC) and Logistic model (LM) to follow the sigmoid curves. These equations are expressed as follows:

A. Equation of Gompertz modified

$$\mathrm{V}e\left(-e\left(\frac{Rmax\ e}{Vmax}\right)((t) = Vmax\ \lambda - t) + 1\right)$$

B. Equation of Transference Model (RC)

$$V(t) = Vmax(1 - exp\left(\frac{Rmax(\lambda - t)}{Vmax}\right)$$

C. Equation of LM (LM)

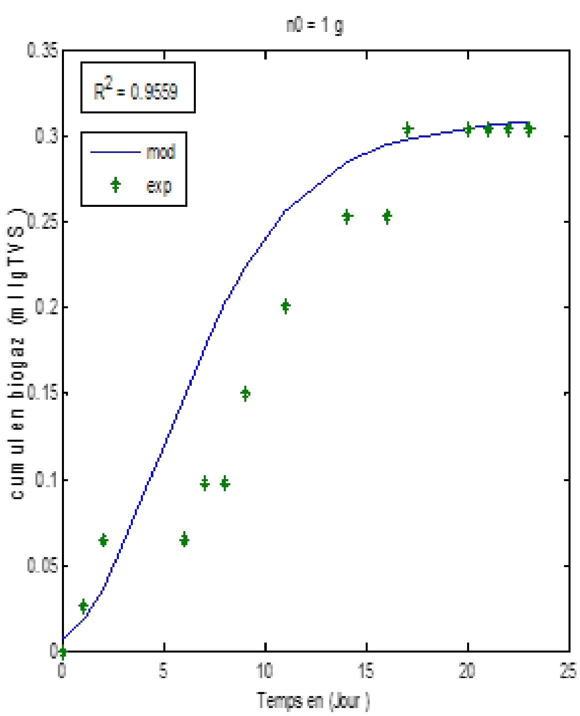
$$V(t)\,\frac{Vmax}{1+exp\ (4\ Rmax\ (\frac{\lambda - t}{Vmax})+2)}$$

The production of biogas was compared according to three characteristic parameters: latency (λ), the maximum speed of production of biogas (Rmax), and the final volume of produced biogas (Vmax). These parameters were calculated using an adjustment with the equations of GM, RC and LM by using a nonlinear regression, of the effect NaOH on the production of biogas in phase mésophile: The experimental data and the simulation of the equations of GM, RC and LM in phase mésophile are represented on the following Figures:

III.1 The Effect NaOH on the Production of Biogas

- **The Experimental Data and the Simulation of the Equations of Gm**

The experimental data and the simulation of the equations of GM, in phase mésophile are represented on the following Figures:



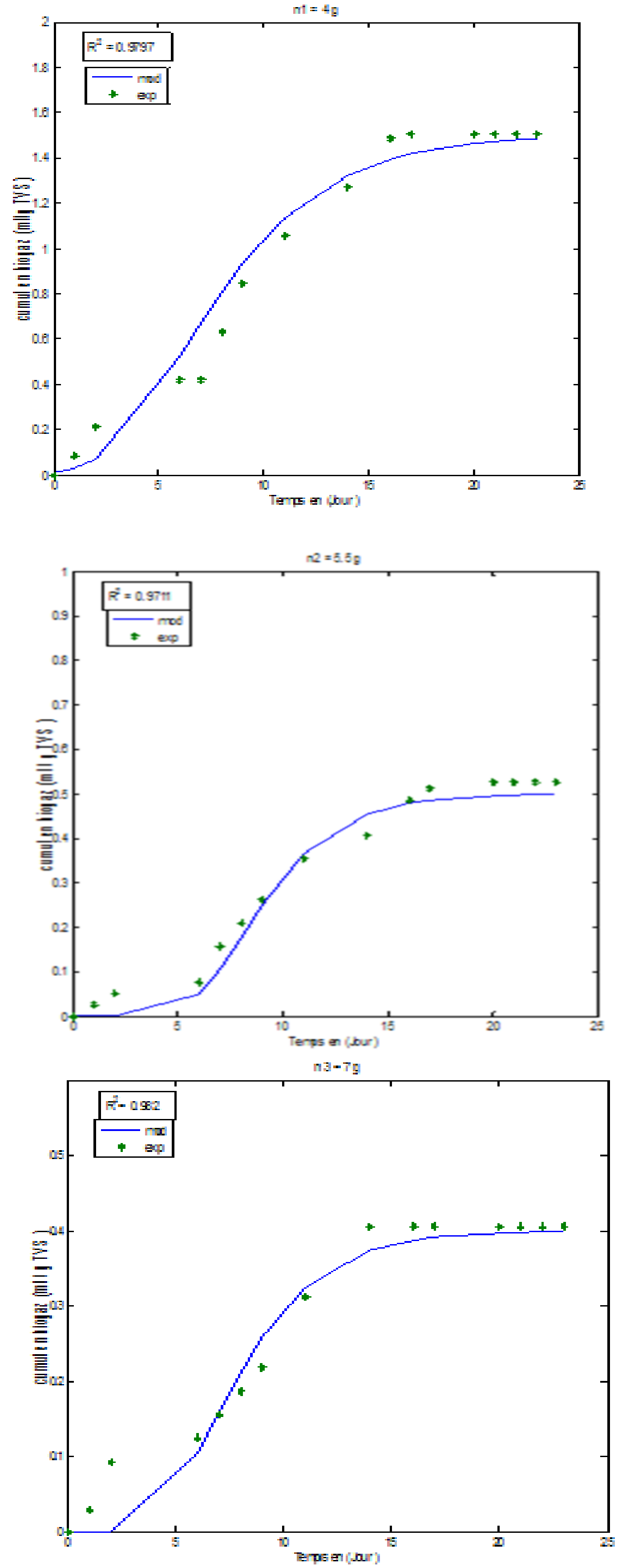
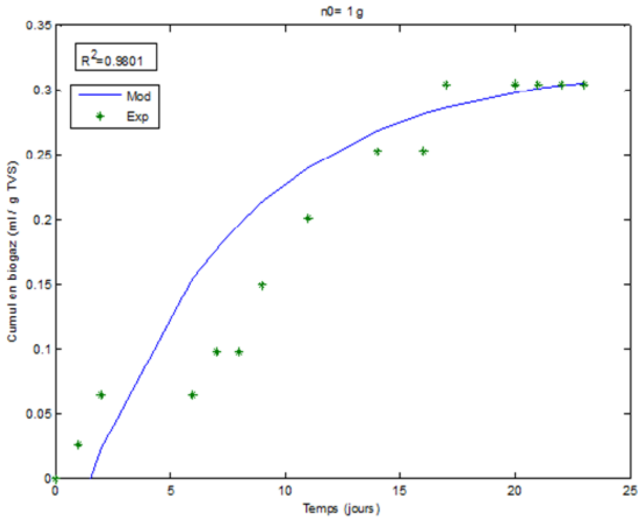
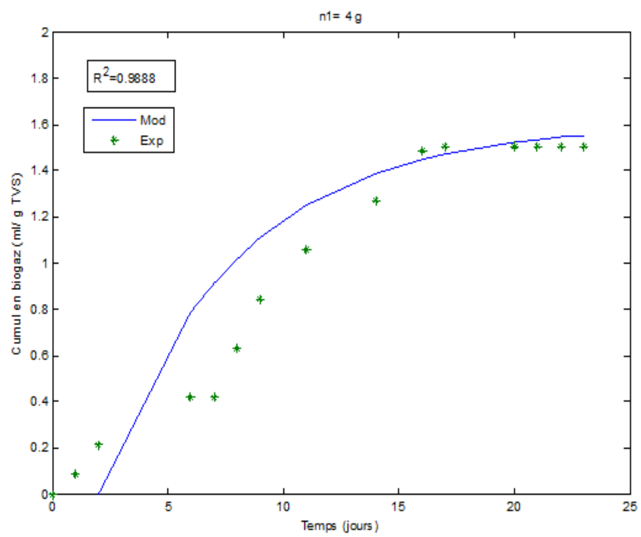


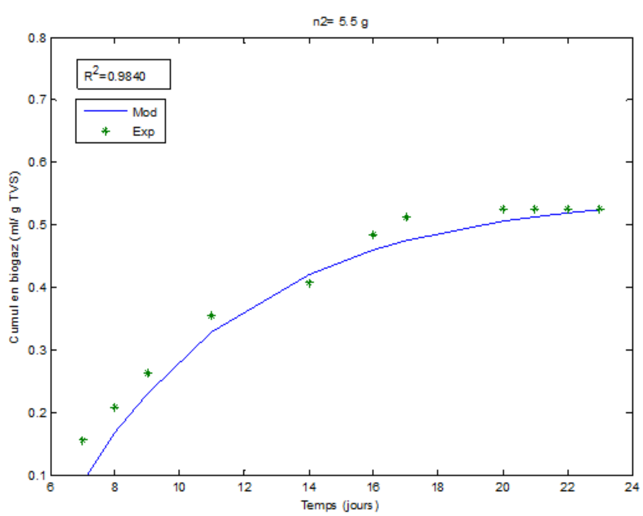
Fig. 1: Cumulative biogas production (ml / g TVS) and regression of GM as a function of time for different concentrations of NaOH

- **The Experimental Data and the Simulation of the Equations of (Rc).**

The Experimental Data And The Simulation Of The Equations Of (Rc), In Phase Mésophile Are Represented On The Following Figures:







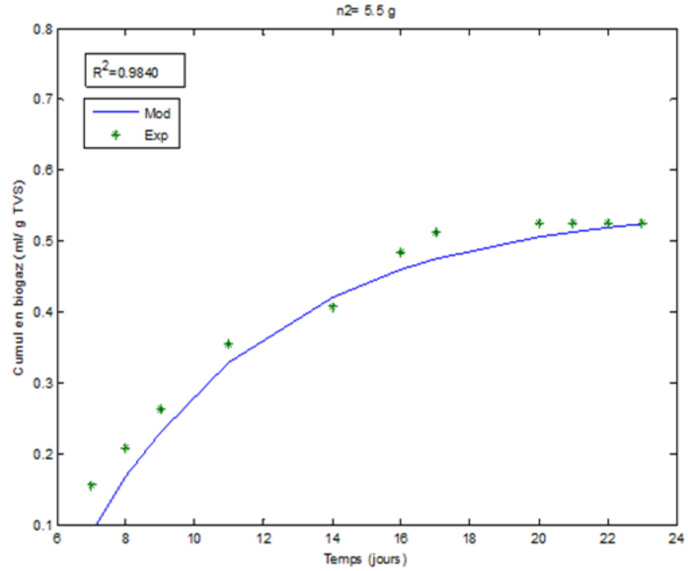
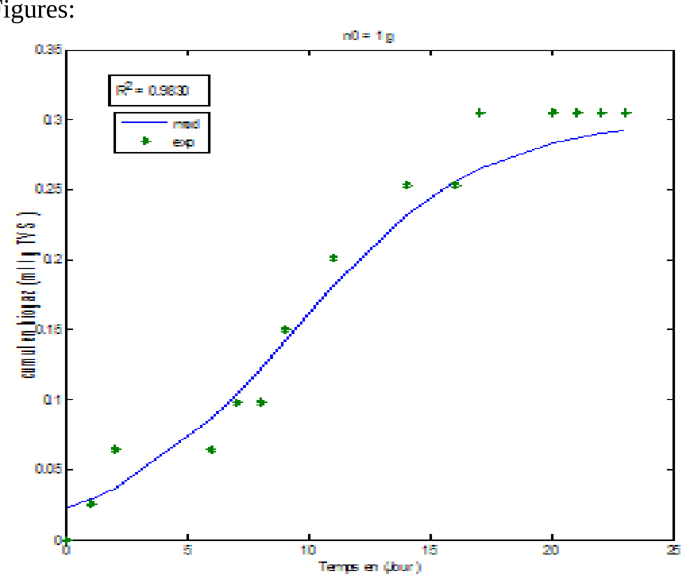


Fig. 2: Cumulative biogas production (ml / g TVS) and regression of (RC) as a function of time for different concentrations of NaOH

- **The Experimental Data and the Simulation of the Equations of Lc**

The experimental data and the simulation of the equations of GM, in phase mésophile are represented on the following Figures:



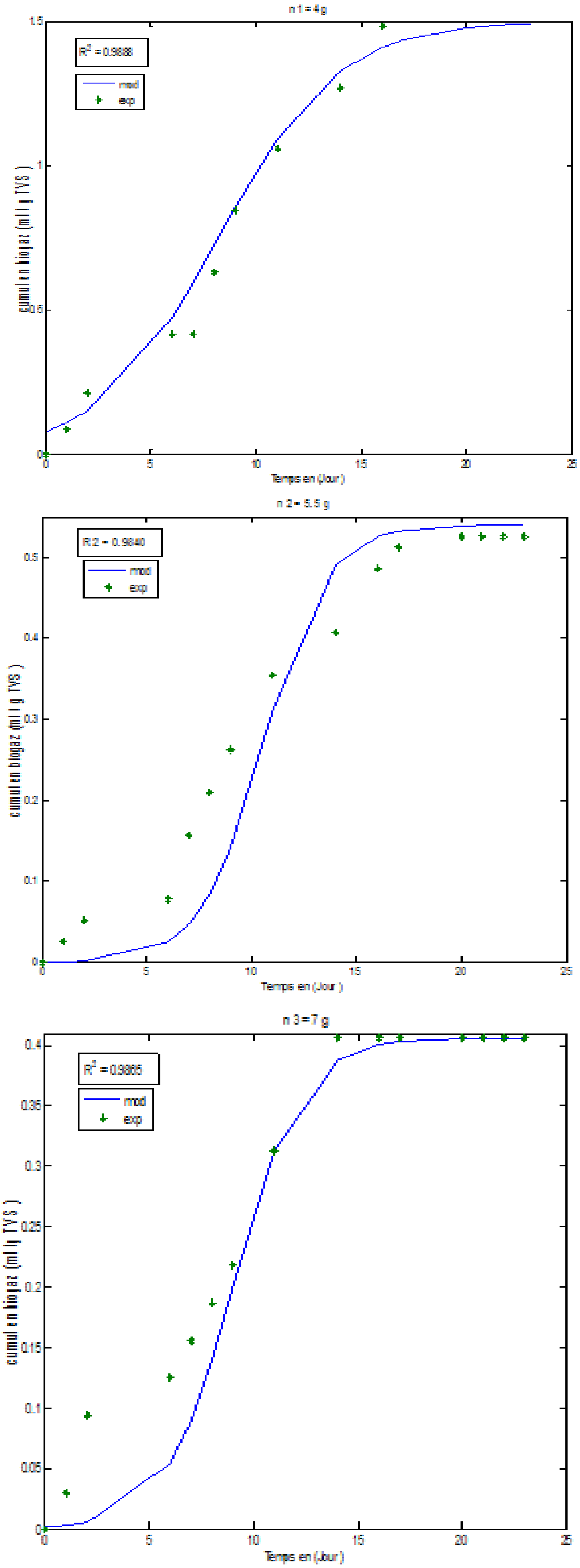


Fig. 3: Cumulative biogas production (ml / g TVS) and regression of (LC) as a function of time for different concentrations of NaOH

The production curves cumulated of biogas according to the regression of GM, RC and LM of the test of N0=1g/l, N1=4g/l, N2=5.5g/l and N3=7g/l, follow curves sigmoïdales correspond exactly to the experimental values. On the other hand for the amount of N4=20g/l the curve does not follow sigmoid what gave values which do not correspond to the experimental values.

III.2 The kinetic parameters of various models

The kinetic parameters of various models obtained are presented in the tables which follow:

TABLE I :
ESTIMATE OF THE KINETIC PARAMETERS OF THE MODEL OF (GM)

Cumulated volume		Estimate of the parameters of GM			
	ml/gTVS	ml/gTVS	ml/gTVS.d^{-1}	day	
reactor	**$V_{max\ exp}$**	**Vmax**	**Rmax**	**λ**	**R^2**
N_0=1g/l	0.30	0.30	0.03	1.30	0.96
N_1=4g/l	1.51	1.48	0.40	2.45	0.98
N_2=5.5g/l	0.53	0.50	0.20	5.60	0.97
N_3=7g/l	0.41	0.40	0.15	4.12	0.98
N_4=20g/l	0	0	0	0	/

TABLE II:
ESTIMATE OF THE KINETIC PARAMETERS OF THE MODEL OF RC

Cumulated volume		Estimate of the parameters of GM			
	ml/gTVS	ml/gTVS	ml/gTVS.d^{-1}	day	
reactor	**$V_{max\ exp}$**	**Vmax**	**Rmax**	**λ**	**R^2**
N_0=1g/l	0.3049	0.32	0.047	1.5	0.9801
N_1=4g/l	1.506	1.5538	0.27	2	0.9888
N_2=5.5g/l	0.526	0.525	0.1	6	0.9840
N_3=7g/l	0.406	0.40	0.25	6	0.9865
N_4=20g/l	0	0	0	0	/

TABLE III:
ESTIMATE OF THE KINETIC PARAMETERS OF THE MODEL OF (LM)

Cumulated volume		Estimate of the parameters of GM			
	ml/gTVS	ml/gTVS	ml/gTVS.d^{-1}	day	
Reactor	**$V_{max\ exp}$**	**Vmax**	**Rmax**	**λ**	**R^2**
N_0=1g/l	0.3049	0.3	0.08	1.9	0.9830
N_1=4g/l	1.506	1.5	0.53	2.53	0.9888
N_2=5.5g/l	0.526	0.54	0.35	7.55	0.9840
N_3=7g/l	0.406	0.4060	0.25	5.8	0.9865
N_4=20g/l	0	0	0	/	/

It is noticed that the production out of biogas is negligible for the amount N4= 20 g, it is important for the amount N1=4 g (1,506 mL.gTVS-1) with a speed of 0.4 mL.gTVS-1.j-1, 0.27 mL.gTVS-1.j-1 and 0.53 mL.gTVS-1.j-1 respectively for GM, RC and LM. Speeds and the production out of biogas are almost similar.

IV. CONCLUSION

The daily cumulative biogas outputs were adjusted by using the equations of GM, RC and LM resulting from the values of R2 higher than 0.96. The speed of maximum production is important for the amount thermochemical N1= 4g/l in the case of treatment with NaOH for a better production out of biogas Helpful Hints.

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