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*Research Article*

# IMPROVEMENT OF ANAEROBIC DIGESTION BY MECHANICAL PRETREATMENT " GRINDING "

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**ABSTRACT**
Thanks to the anaerobic digestion of sewage sludge, it is possible to produce a high-energy fuel called biogas. Methanation is an anaerobic fermentation or more precisely a biochemical process where the organic matter is degraded by the microorganisms in the absence of oxygen to be transformed in the end in to bio methane. The purpose of this work is to study the effect of mechanical pretreatment by grinding for grinding times varying from 1min to 15min. The parameters that indicate the solubilization were treated in this work: MES, MVS, soluble and total DCO the Ratio of the soluble DCO on total DCO, yield in biogas and inmethane. This study allowed us to deduce:
- An improvement in methane production (3.8- 5.8) times greater than that of untreated sludge for a time equal to 14 days. A degree of solubility equal to 50% which corresponds to the test C1 = 5min.

***Keywords:*** *Anaerobic digestion, Biogas, pretreatment, Renewable energy.*

## 1. INTRODUCTION

Biodegradability of sewage sludge is a key factor for process efficiency biological treatment, it facilitates the use of sludge as a substrate in the bioconversion (Thi Thanh Ha Pham,2010). The degree of solubilization can be evaluated with the increase of the chemical soluble oxygen demand (DCOS) which represents the increase of the release of organic substances or with the increase of the concentration of certain components (proteins, polysaccharides and lipids) sludge liquid phase (Bougrier and al 2006), (Moller *and al* 2004) ], (Bemal-Martinez , 2007).In addition, physico-chemical and biological pretreatment processes can reduce the size of organic compounds and transform refractory and hard-to-biodegrade compounds into more easily biodegradable compounds. (Chen *and al*, 2009), (Perez *and al*, 2005).The pretreatment also makes it possible to improve the biodegradability of the sludge by modifying their physicochemical properties to be favorable to the microbial use in the subsequent bioconversion (Camacho *and al* (2002a).According to the bibliographic results of the pretreatment by mechanic grinding of the second sludge makes it possible to increase the protein ratio soluble 35, 55, 75,80 and 86% ( Aquino *et al.*,2008).

On the other hand, study of mechanical pretreatment by millennial ball milling, high pressure homogenization and ultrasonic homogenization, shear-gap homogenization 27% increase in digestion of VSS at TRS of 4d ] (Carrère Dumas 2010).

The main objective of this study is to quantify, and measure the effects on the anaerobic biodegradability of sludge in order to determine to optimize mechanical durability tested (grinding and homogenization).

## 2. MATERIAL AND METHODS

The volume of samples to be ground is 500 ml The milling treatment times are selected as follows; C1 = 5min, C2 = 10min, C3 = 15min considering time = 0 for untreated sludge C0.For the same sample, the test includes a series of batches containing 50ml of sludge and 5ml of milk rejection. Each batch is doubled and the results are averaged over the two experimental measurements considering the non-pre-treated sludge corresponding to the grinding time equal to zero. The remaining volume will make it possible to determine the physicochemical parameters such as soluble and total COD, MS, MES ,MVS, and alkalinity (partial and total), TA ,TAC , are analyzed according to standard methods (APHA PHYSICOCHEMICAL ANALYSIS. The pH is measured manually using pH-meter.

Volume of Biogas production was measured daily for all the incubation period by the liquid displacement method. The used liquid is acidified at pH=2. The composition of the biogas was liquid is acidified at pH=2. Throughout the period of digestion, the quantity of biogas and methane production was determined every day. The experiment continues until observation of a production of biogas and methane zero.

The content of $CH_4$ in biogas was determined as follows ( Erguder, 2000) . A known volume of the headspace gas (V1) produced in a serum bottle from Experiment 1 was syringed out and injected into another serum bottle which contained 20 g l1 of KOH solution. This serum bottle was shaken manually for 3–4 min so that all the $CO_2$ and $H_2S$ was absorbed in the concentrated KOH solution. The volume of the remaining gas (V2) which was 99.9% $CH_4$ in the serum bottle was determined by means of a syringe. The ratio of V2:V1 provided the content of $CH_4$ in the headspace gas. The

results of five different determinations indicated that the average methane content of the biogas.

## 3. RESULTS AND DISCUSSION

### 3.1. Effect of grinding treatment on the physicochemical parameters of sludge before incubation

Table 1. Effect of grinding treatment on the physicochemical parameters of sludge before incubation

| | Sludge treated by grinding | | | |
|---|---|---|---|---|
| *Parameters* | $C_0$( t=0) | $C_1$( t=5min) | $C_2$(at t=10 min) | $C_3$(t=15 min) |
| MS (g/l) | 68.78 | 69.90 | 69.18 | 69.36 |
| MVS(g/l) | 29.38 | 29.09 | 28.98 | 28.78 |
| $COD_S$ (g $O_2$/l) | 51.72 | 227.58 | 196.55 | 248.27 |
| $COD_T$ (g $O_2$/l) | 413.79 | 620.68 | 403.44 | 527.58 |
| pH | 7,1 | 7,06 | 7,04 | 7,20 |
| MES(g/l) | 58.53 | 38.62 | 34.10 | 44.67 |

*3.1.1Effect of mechanical pretreatment by grinding on pH*

Tableau 1 shows that the During the pretreatment pH remains in near neutral (pH = 7).

*3.1.2 Effect of mechanical pretreatment by grinding on MES etMVS*

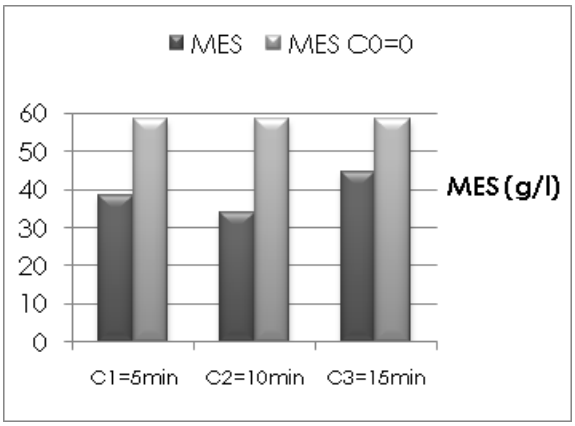


Fig 1. Effect of mechanical pretreatment by grinding on MES

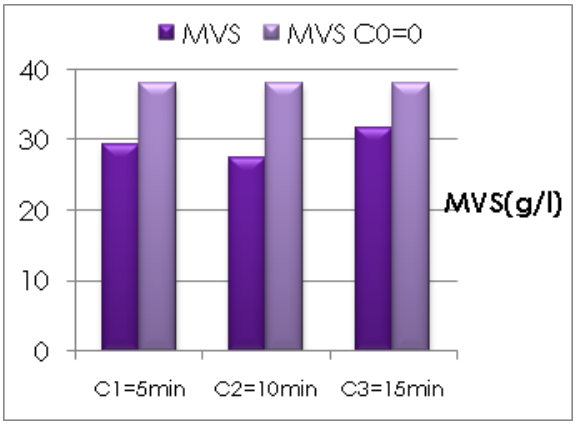


Fig 2. Effect of mechanical pretreatment by grinding on MVS

In all cases mechanical pretreatment by grinding treatment causes an important solubilization of matter. The

concentration of soluble matter increases significantly. Figure 1. shows that the concentration of soluble matter increases, while that of particulate matter decreases (decrease of the MES during the treatment) This solubilization phenomenon applies to organic and mineral matter. See Figure 2.

*3.1.3 Effect of mechanical pretreatment by grinding on COD*

In order to compare the results, it is also possible to use the solubilisation rate or the ratio CDOS/ CDOT which reflects the transfer of particulate phase to the soluble one.The rate of solubilisation (Bougrier and al 2006).

$$\mathbf{SDCO} = \frac{(\mathbf{DCOs} - \mathbf{DCOS0})}{\mathbf{DCOP0}} \times \mathbf{100}$$

CDOs : soluble CDO of the treated sample (g O2/L)

DCOS0 : soluble CDO of the untreated sample (g O2/L)

DCOtotal : particulate CDO of the untreated sample (g O2/L)

(CDOP0 = CDOto –CDO so)

Table 1. Evolution of the degree of solubility and the ratio DCOS / CODt for each treatment time

| Sludge treated by grinding | | | | |
|---|---|---|---|---|
| *Parameters* | C0( t=0) | C1( t=5min) | C2(at t=10 min) | C3(t=15 min) |
| DCOs (g o2/l) | 51.72 | 227.58 | 196.55 | 248.27 |
| CDOT (g o2/l) | 413.79 | 620.68 | 403.44 | 527.58 |
| Degree of solubility(%) | _ | 48.50 | 40.00 | 54.58 |
| Ratio CDOS/ CDOT | 12.52 | 36.71 | 48.77 | 47.11 |

Pretreatment by grinding results in solubilization of the COD (see tableau.2). Figure 3 shows that the soluble COD increases with the pretreatment time. However, it would appear that the soluble COD will continue to increase if we would have increased the duration of pretreatment something we could not achieve as the mill used can not withstand more than 15min.

Figure 3 shows the evolution of the solubilization as a function of the grinding treatment time. The solubilization ratio varies between 40% and 54.58%. A better solubilization corresponds to the treatment time C3 = 15min, thus resulting in a solubilization ratio of 54.58%.

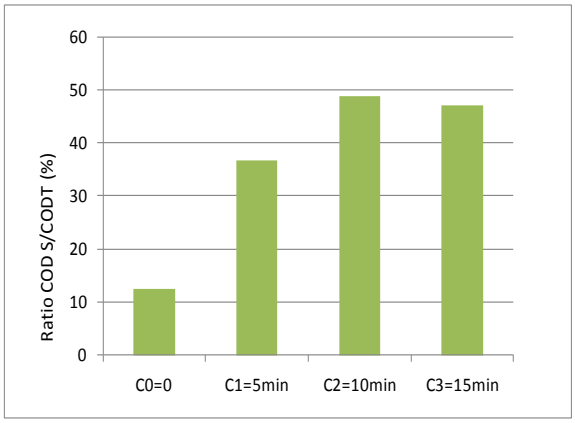


Fig 3. Effect of mechanical pretreatment on ratio CODS/DCOT

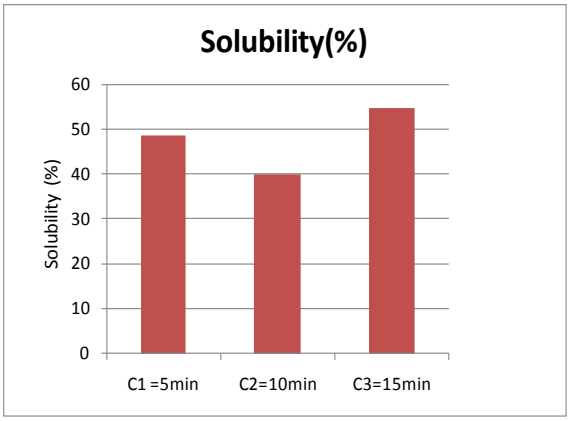


Fig 4. Effect of mechanical Pretreatment on ratio solubility

## 3.2 Influence of grinding on the anaerobic biodegradation of the gaseous phase after incubation

### *3.2.1 Variation of the total cumulative volume to CH4*

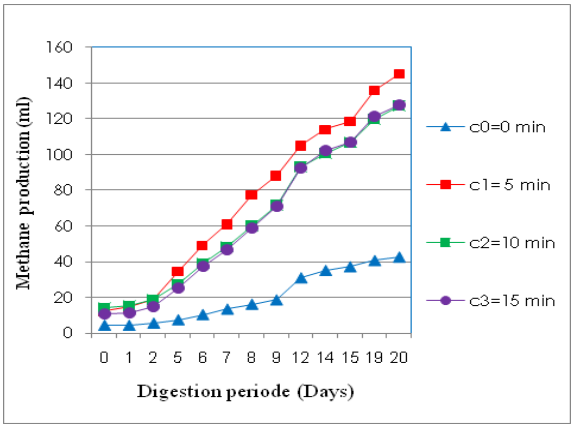


Fig 5.Total cumulative volume as $CH_4$ product in mesophilic phase

Figures 5 the composition of cumulative volume methane produced during the mesophilic phase incubation period for the four tests used. This parameters are very important for the control and monitoring of the digester. Indeed a significant production of methane reflects the proper functioning of the latter. We note that the best cumulated volume productions in CH4 are successively for the test C1 = 145.23 ml, C2 = 127.90 ml and C3 = 127.92 ml . In terms of improvement of the relation between the volumes of biogas produced by the treated and untreated sludge:

$$\boldsymbol{Improvement} = \frac{\textbf{volume of methane produced by treated sludges}}{\textbf{volume of methane produced by untreated sludges}}$$

It was noticed that the best treatments lead to a production of methane 3, 8 – 5,8 times greater than that of untreated sludge for a period of time equal to 9 days. See figure 7.
The methane percentages of the three pretreatments tested are successively 50.7%, 54.5%, 58.3% for C1 = 5min, C2 = 10min, C3 = 15min. From a qualitative and quantitative point of view, the highest percentage of methane is obtained for the pretreatment test equal to C1 = 5min.

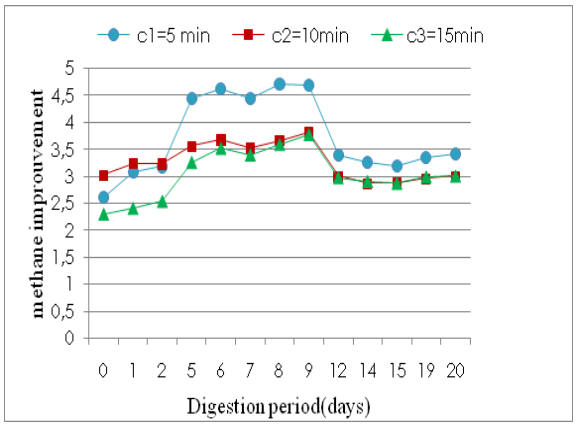


Fig 7: Improvement in methane compared to sludge without treatment.

## 4. CONCLUSION

According to the pretreatment results, the grinding results in a solubilization of the COD with a solubilization rate varying between 40% and 54.58%, the best solubilization corresponds to the treatment time C3 = 15min, thus resulting in a solubilization ratio of 54.58%. With regard to the results with respect to the cumulated volume yield of CH4, it is noted that the best productions are successively for the test C3 = 15min, C2 = 10min, C3 = 5min leading to a production 3.8- 5.8 times higher than that of untreated sludge for a time equal to 9 days.

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