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ENERGIC UTILIZATION OF WASTE BIOMASS

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INTRODUCTION

In a previous report (1) the kinetic model of Chen and Hashimoto (2)

$$\gamma_v \left[\frac{1\ CH_4}{1\ \text{dig. day}}\right] = \frac{B_o S_o}{\theta}\left(1 + \frac{K}{\mu_m \theta - 1 + K}\right) \quad [1]$$

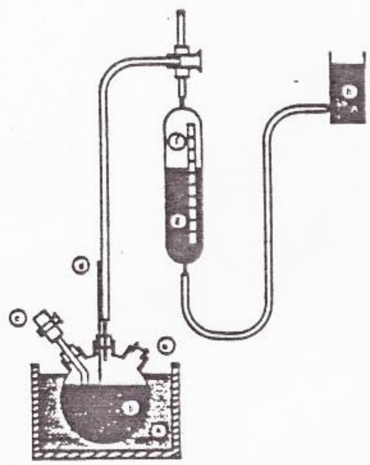
was used to describe the anaerobic digestion of sewage sludge, and the parameters of this model were calculated, resulting B_o = 260.882 l CH_4/kg VS; μ_m = 0.331 $days^{-1}$ and K = 2.776.

Equation (1) makes the description of the behaviour of the system possible when working at steady-state. However, it does not explain the fact, observed before by some authors (3), (4), that the maximum methane production rate is reached at influent VS concentration (S_o) of aproximately 40 g/l for 37 °C.

The purpose of this study is trying to explain that concentration limit using anaerobic digestion results obtained from a batch reactor.

MATERIALS AND METHODS

The methanic batch fermentations of the sludge were started in 1-liter laboratory agitated glass digesters (Fig. 1). Temperature was mantained constant using a water bath at 37 °C. The gas was collected under a water column and its volume was measured daily. The methane content in the gas was determined by gas cromatography. The pH of the system was also measured daily.



Experiments were run at 8 different concentrations of the sludge (between 6.85 and 31.09 g VS/l). Three of them were maintained until the gas prodúction had fully stopped, in order to determine the operational parameter B_o.

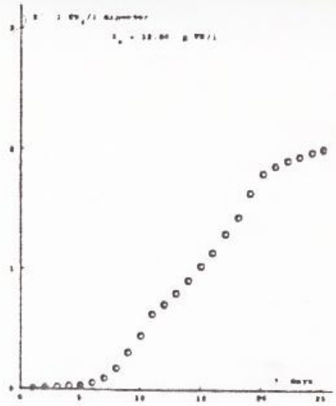
RESULTS AND DISCUSSION

The value for the ultimate methane yield, B_o, obtained by means of the batch digestions was 276.021 ± 1.897 l CH_4/kg VS, slightly higher than the value obtained for the continuous, daily-feed system, but probably more accurate, because continuous values were calculated by extrapolation ($\theta \rightarrow \infty$).

The plot of the volume of methane produced/l digester vs. time showed a fairly good linearity between days 8 and 18 (Fig. 2 shows the case for S_o = 12.60 g VS/l), with different slopes for each initial sludge concentration. The differences between the slopes suggest that the methane production rate was constant and maximum in this interval, but dependent from S_o.

The results obtained suggested the proposal of the Monotype kinetic model:

$$\gamma_v = \frac{\gamma_m S_o}{K_s + S_o} \quad [2]$$

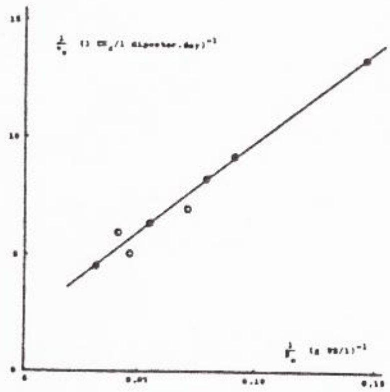


where γ_v is the methane production rate (1 CH_4/l digester. day), γ_m its maximum value, and K_s a saturation constant.

The plot of l/γ_v vs. l/S_o was used to determine the parameters of the model (Fig. 3). From the linear regression the values γ_m = 0.486 l CH_4/l digester day and K_s = 37.368 g VS/l were obtained.

The feed concentration to give the maximum rate of methane production in a continuous system, equivalent to γ_m, was then calculated by means of the equation derivated from (1):

$$(S_o)_{CONT} = \gamma_m \frac{(1 + \sqrt{K})^2}{B_o \mu_m} \quad [3]$$



The result $(S_o)_{CONT}$ = 37.812 g VS/l was obtained, and it shows a good agreement with the value determined for the saturation constant, K_s.

CONCLUSIONS

A model which describes the behaviour of a batch anaerobic digestion of sewage sludge during the period of constant methane production rate was presented (equation [2]) and applied as a starting point in understanding the process.

The comparison of the parameters of this model with the behaviour of a continuous, daily-fed system seems to indicate that the saturation constant, K_s, of the model can be used to determine the maximum influent concentration for the continuous digestion. Working at higher influent concentrations will produce a decrease in the methane production rate.

The concepts presented are preliminary and require extensive, systematic research to test their validity and limits.

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