ENERGIC UTILIZATION OF WASTE BIOMASS

C. Pérez, N. Elortegui, F. Jarabo and F. Díaz
Departamento de Química Técnica. Universidad de La Laguna. La Laguna, TENERIFE (Spain)

KEYWORDS
Methane fermentation • Anaerobic digestion • Sewage sludge • Kinetics

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

\[ \gamma = \frac{1 \text{ CH}_4}{1 \text{ dig. day}} = \frac{B_0 S_0}{\mu_m (1 + \frac{K}{\mu_m^{0.4} - 1 + K})} \]  

was used to describe the anaerobic digestion of sewage sludge, and the parameters of this model were calculated, resulting \( B_0 = 260.882 \) l CH\(_4\)/kg VS; \( \mu_m = 0.331 \) 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 \( S_0 \) of approximately 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 agitation glass digesters (Fig. 1). Temperature was maintained 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 chromatography. 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 VSS/l). Three of them were maintained until the gas production had fully stopped, in order to determine the operational parameter \( B_0 \).

RESULTS AND DISCUSSION
The value for the ultimate methane yield, \( y_m \), 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 \( (0 \rightarrow \infty) \).

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 \( S_0 = 12.60 \) 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 \( S_0 \).

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

\[ \gamma = \frac{y_m S_0}{K + S_0} \]  

where \( y_m \) is the methane production rate \( (1 \text{ CH}_4/l \text{ digester day}) \), \( y_m \) is its maximum value, and \( K \), a saturation constant.

The plot of \( I / \gamma_m \) vs. \( I / S_0 \) was used to determine the parameters of the model [Fig. 3]. From the linear regression the values \( y_m = 0.486 \) l CH\(_4\)/l digester day and \( K = 37.368 \) g VSS/l were obtained.

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

\[ S_0^{\text{cont}} = y_m \frac{(1 + \sqrt{K})^2}{B_0 \mu_m} \]

The result \( S_0^{\text{cont}} = 37.812 \) g VSS/l was obtained, and it shows a good agreement with the value determined for the saturation constant, \( K \).

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, \( K \), 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.

REFERENCES