

II - 104

嫌気性消化の酸生成相における有用物の最適回収のための微生物の特徴に関する研究

STUDY ON MICROBIAL CHARACTERISTICS IN ACIDOGENESIS PHASE OF ANAEROBIC DIGESTION FOR OPTIMUM RECOVERY OF USEFUL MATERIAL

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Introduction

An acidogenic microbial activities could be acclimated so as to anaerobically convert glucose solution into volatile fatty acid and biogas. It is generally considered that the methanogenesis phase has unstable and delicate features toward environmental changes, and the growth of methanogenic bacteria is very slow compared with that of acidogenic bacteria suggesting that a rate-limiting step in the overall methane fermentation must depend on activities of methanogenic bacteria.

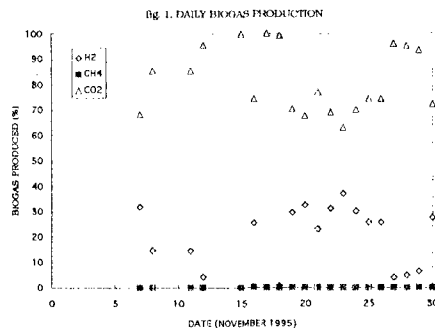
In this context, attempt has been made to separate methanogenic and acidogenic bacterial activities from the fermentation process. This is done by ensuring that methane gas does not exist in the biogas product. And only volatile fatty acid (e.g. acetate, propionate, butyrate, lactate), ethanol, carbon dioxide and hydrogen gas would be observed as the other end products of the fermentation. Batch cultures experiments was also done on the cultured sludge. One of the best result of the experiments is presented here. The kinetics of the microorganisms was formulated and comparisons will be made to those kinetics values from various other researches.

Materials and Methods

To eliminate methanogenesis phase (conditions) from the original digestion sludge, semi-continuous cultures were carried out at relatively high dilution rate, 3.5 day^{-1} .

Seed culture for acclimatization. The seed sludge from a sewerage treatment plant digester (Koriyama City) was inoculated into a glucose solution followed by anaerobic cultivation at 35°C at $\text{pH} < 5.5$. Initially, methane and carbon dioxide gas is allowed to be produced and every time the gas production ceased, a part of the broth was replaced with fresh medium of glucose medium. The glucose concentration was $11,700 \text{ mg/l}$ and the medium solution consists of trace elements (10 ml), yeast extract (0.1 gm/l) and certain amount of NaHCO_3 ($2.0 \sim 3.0 \text{ gm/l}$) as the pH buffer.

After the methane gas production was established, 25% or more sludge was replaced by glucose medium everyday for about 2 months after which the gas evaluation is analyzed more thoroughly. At that time the methane gas production has substantially diminished ($< 0.1\%$), and the sludge is considered to be in an ACIDOGENESIS phase. The daily gas production composition of the tank is presented in figure 1.



Preparation for batch experiments. Some of the sludge solution is then replaced into a cultivation vessel of 1500 ml reaction flask (working volume 1400 ml). A semi-continuous cultures were continued by replacing 500 ml of the culture broth with fresh medium once a day. After a stable production of gas was observed (about constant volume and composition), batch experiments were done for 24 hours.

Results

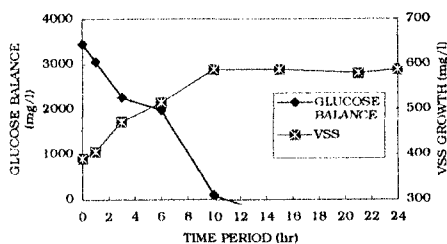
Figure 2 shows results of the batch experiments. From those results, some kinetics variables related to the microbial culture was able to be calculated by using these equations:-

$$\mu = (\ln X_t - \ln X_0) / t$$

$$Y = (X_t - X_0) / (S_0 - S_e)$$

Maximum specific growth rate, μ_{\max} and the saturation constant K_s could be determine by plotting the values of $1/\mu$ and $1/S$ on a graph.

fig. 2. VSS & GLUCOSE CONCENTRATION



Conclusions

1. The kinetics variables of the batch cultures results are comparable to other researches and review literature.
2. The diminishing production of methane gas from a culture could be considered as the turning point on which the microorganisms activities of methanogenesis phase has changed into the acidogenesis phase of activities in the fermentation of glucose.
3. The activities of the microorganisms in a acidogenesis phase would only produced hydrogen and carbon dioxide gas.
4. The HRT calculations of the semi-continuous culture could be accepted as some other research has cited the decaying of methanogenic microorganisms at HRT of 14 hr or below.

The above research and analysis is an attempt to prepare an acidogenesis phase microorganisms which could be used for other conditions in anaerobic process. Further studies on the same microorganisms activities in a chemostat culture system is being carried out. The actual aim of research is to analyze the anaerobic microorganisms activities in various treatment systems, conditions and other kind of substrates such as protein compounds or other actual industrial wastewater.

References

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- 2). Kanbe, H., Nakamura M. and Matsumoto J., Proceedings of 3rd IAWPRC Regional Conference, Shanghai (1991), III-227.