論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Use of Acclimated Sludge for the Acceleration of Methane production from Glycerol
著者(和文)	Juan Esteban Vásquez Bustamante
Author(English)	Juan Esteban Vásquez Bustamante
出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第10569号, 授与年月日:2017年3月26日, 学位の種別:課程博士, 審査員:中﨑 清彦,日野出 洋文,丹治 保典,吉村 千洋,藤井 学
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第10569号, Conferred date:2017/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

THESIS OUTLINE

Use of acclimated sludge for the acceleration of methane production from glycerol

Department of International Development Engineering, Tokyo Institute of Technology

Vásquez Bustamante Juan Esteban

Since last decade, biodiesel production has increased worldwide. The main byproduct of biodiesel production is glycerol, which cannot be used in chemical industries since it has high concentrations of impurities and has become a waste. Anaerobic digestion is a suitable alternative to treat this waste glycerol. To anaerobically digest a new substrate, sludge that is digesting one substrate must adapt to the new one. This adaptation, called acclimation, involves shifts of the microbial community in the sludge. Considering the high activity of acclimated sludge compare to the unacclimated one, is possible that acclimated sludge can be useful to accelerate the anaerobic digestion. Several problems need to be addressed before effectively using acclimated sludge to accelerate the anaerobic digestion of glycerol. One is the issue of how to conduct the acclimation, other is the possible effects of the mixing ratio of acclimated sludge on the acceleration of the process and third, what is the effect of storage on the microbial activity of acclimated sludge. The objectives of this work were: 1) To acclimate anaerobic sludge for the production of methane from glycerol, comparing two different approaches. 2) To evaluate the effects of the mixing ratio of acclimated sludge on the anaerobic digestion of glycerol. And 3) To evaluate the effects of storage of acclimated sludge on the activity of the microbial community and its ability to accelerate the process.

Firstly, effects of using different acclimation methods were investigated. Two

different acclimation approaches were compared. One was a shock loading of glycerol as the sole carbon source; the other was a stepwise loading involving a gradual increase of the amount of glycerol in a solution containing glycerol, glucose, sodium acetate and lactic acid. Main results showed that acclimation by the different approaches led to the establishment of different bacteria communities, but similar archaea communities. At the end of the experiments, the acclimated sludge obtained by both approaches performed the digestion similarly. At early stages of the shock loading significant accumulation of volatile fatty acids (VFAs) was observed, which did not happen in the stepwise loading. The methane production rate (MPR) was higher for the stepwise experiment during early stages. The steady state MPR at latest stages was similar for both experiments (around 21 mmol/L/d). Dominant bacteria at latest stages were different for both experiments, but the dominant archaea were similar. Results suggest that irrespective of the acclimation method, acclimated sludge with similar archaeal community can be obtained that performs the process with a similar MPR, despite the development of different bacteria communities.

Secondly, effects of the mixing ratio of acclimated sludge were studied. Four experimental runs were performed with varying mixing ratios of acclimated sludge (0, 10, 20, and 33 %) in the seeding material. Glycerol was the only carbon source. Main results showed that higher mixing ratios led to higher initial MPR and shorter lag times. Accumulation of VFAs was lower with higher ratios of acclimated sludge in the seeding material. The initial MPR was proportional to the mixing ratio, and the lag time before attaining stable state of methane production was shorter with higher mixing ratios of acclimated sludge. Steady state MPR for all runs was around 21 mmol/L/d. Dominant microorganisms were similar at the latest stages of all the experiments. These results

confirm a significant effect of the mixing ratio of acclimated sludge on initial stages of the process causing the acceleration of the anaerobic digestion of glycerol.

Lastly, effects of storage on the microbial activity of acclimated sludge were evaluated. Acclimated sludge was stored by refrigeration and by freeze drying. Two new experiments were carried out. In one, the seeding material was a mixture of unacclimated sludge and acclimated sludge previously stored by refrigeration. In the other experiment, the seeding material was a mixture of unacclimated sludge and acclimated sludge previously stored by freeze drying. Glycerol was the only carbon source. Main results showed significantly lower MPR for both experiments than that obtained when fresh acclimated sludge was used in the seeding material. In both experiments, glycerol was rapidly consumed, indicating that bacteria kept a high activity. A significant VFAs accumulation was observed, indicating that the activity of archaea that degrades VFAs was damaged by both storage methods. Results indicate that archaea was selectively damaged by the storage, causing the loss of acceleration ability of the acclimated sludge.

These results allow concluding that archaea community plays a key role in the performance of the acclimated sludge during the process by preventing VFAs accumulation and allowing a high initial MPR, thus accelerating the process. Distributing acclimated sludge to new wastewater treatment plants can make more suitable the anaerobic digestion of glycerol worldwide. Moreover, the significant effect of the mixing ratio of acclimated sludge on the process will allow future users to implement the acclimated sludge according to their needs.