BIOLOGICAL HYDROGEN PRODUCTION VIA SELF-IMMOBILIZED BACTERIA

Abstract

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This dissertation explored a creative bacteria immobilization method for hydrogen fermentation. The low growth rate of hydrogen producing bacteria limits the productivity of a suspended-growth reactor due to the requirement for long hydraulic resident time (HRT) to maintain adequate bacteria population. Microbial immobilization is an effective way for bacteria retention, however, traditional calcium alginate entrapment has many limitations for applications in hydrogen fermentation. Anaerobic granular sludge was proposed as the immobilized hydrogen producing bacteria to be used in hydrogen fermentation after methanogenic activity of the granules was eliminated in the pretreatment process. Chloroform treatment of methanogenic granules was compared against acid and heat treatments for the effectiveness to eliminate methanogenic activity. The results showed that chloroform treatment was the most effective among the three methods tested. Chloroform caused elimination of methanogenic activity while allowing normal hydrogen production. Chloroform treated anaerobic granular sludge was proposed as immobilized hydrogen producing bacteria to be used in the hydrogen fermentation. Chloroform treated granules could be re-used for over four fed-batch cultures with pH adjustment, and could be repeatedly cultured for eight times without noticeable damage. Continuous culture with chloroform treated granules showed that the granule structure

could be kept for over 15 days and new granules started to form after 10 days of operation. The hydrogen productivity reached 11.6 L/L/day at HRT of 5.3 hours. The optimum initial pH of the culture medium was neutral and the optimum glucose concentration was below 20 g COD/L.

This study also investigated the possibility of integrating both the immobilized hydrogen fermentation with chloroform treated granules and the immobilized methane production with untreated granular sludge. The results showed that the integrated batch cultures provided 1.01 mol hydrogen and 2 mol methane per mol glucose.

16s rRNA microbial analysis was used to investigate the community change during the chloroform treatment. Most of the *Methanogenic sp.* was eliminated by chloroform treatment, explaining the switching of methane production system to hydrogen production system. However, *Methanosaeta concilii*, the key organism in anaerobic granulation, was not eliminated from the hydrogen producing system, unexpectedly, which might help explain the granulation of hydrogen producing granules.