Optimization of bio-hydrogen production through two-phase anaerobic digestion for reducing carbon dioxide emission

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Abstract

It is generally known that carbon dioxide is the most critical cause of climate change. There are have been many attempt to reduce carbon dioxide, including anaerobic digestion, which generating energy from organic waste. But anaerobic digestion is carbon neutral process, since carbon dioxide in biogas (40 ± 10%) still emit to environment. Biological methane upgrading via hydrogenotrophic methanogen ~~requires~~ convert the supply of hydrogen and carbon dioxide of 4:1 to methane. So this process is the carbon negative technology, owing that carbon dioxide change to other compound. Since biogas does not contain much hydrogen, it is unavoidable supplying hydrogen from an external source to system. Therefore, if hydrogen is supplied from an internal source, it will be beneficial from a view of operational cost. In this study, a lab-scale two-phase anaerobic digester has been run with different operational conditions (hydraulic retention times (HRT), organic loading rates (OLR)) to determine the optimized operation conditions for bio-hydrogen production in the acidogenic reactor. Foodwaste powder with a different target total solids (TS) was used as substrate. In short, the highest hydrogen yield of 40 mL H_2 g^{-1} VS_{add} was obtained with the maximum H_2 content of 25% under the HRT of 4 d, and an ORL of 22 g VS $L^{-1}d^{-1}$. In addition, through the microbial community analysis, proliferation of hydrogen producing archaeal and bacteia (*Clostridium*,*Lactobacillus*, *Lachnospira*, *Bifidobacterium*) was observed when the high hydrogen yield was achieved. The result of the current study demonstrated that a high bio-hydrogen yield can be achieved under the condition of a relatively low pH (5.0-5.5), a short HRT (within 4 d), and a high OLR (20 g VS $l^{-1}d^{-1}$).