Track (AM/SM/AF/AI/BD/DM/HR/ID/MT/PR/SD/SE/EG/TD/TL/RD): SE

Bioconversion of carbon dioxide to ethanol and other value-added products using anaerobic sludge biomass

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Rapid depletion of fossil fuel sources has led to the search for alternative and sustainable energy resources. Syngas, which consists of carbon monoxide, carbon dioxide, and hydrogen as the major components can be converted to biofuels and other industrial compounds of high value. However, syngas conversion requires high temperature and pressure conditions along with a transition metal catalyst that is easily poisoned due to impurities present in the syngas mixture. This study therefore examined conversion of CO_2, CO, and H_2 present in syngas to ethanol and other value-added products by using anaerobic sludge biomass under ambient temperature and pressure conditions in batch system using serum bottles. Anaerobic sludge biomass composed of acetogens and methanogens capable to utilizing these gases and convert them to volatile fatty acids (acetic acid, butyric acid, propionic acid, *etc.*) and alcohols (ethanol, butanol, propanol, *etc.*) via the Wood-Ljungdahl Pathway. Moreover, mixed consortium of bacteria in the biomass are not easily poisoned due to impurities present in the gas. In addition, contamination problem is minimized and scalability of the process is straightforward. The anaerobic biomass used in this study was collected from a large scale upflow anaerobic sludge blanket reactor (UASBR) treating common effluent from industries. Results showed initial conversion of CO_2 to acetic acid, which is then converted into other VFAs and ethanol along with complete utilization of H_2. The highest acetic acid and ethanol production from H_2/CO_2 were 0.76 g/L and 1.43 g/L, respectively. Further optimization of process conditions and intensification of the CO_2 conversion process is currently underway. This study demonstrated that anaerobic sludge biomass can be used to potentially produce ethanol and other value-added products from CO_2.

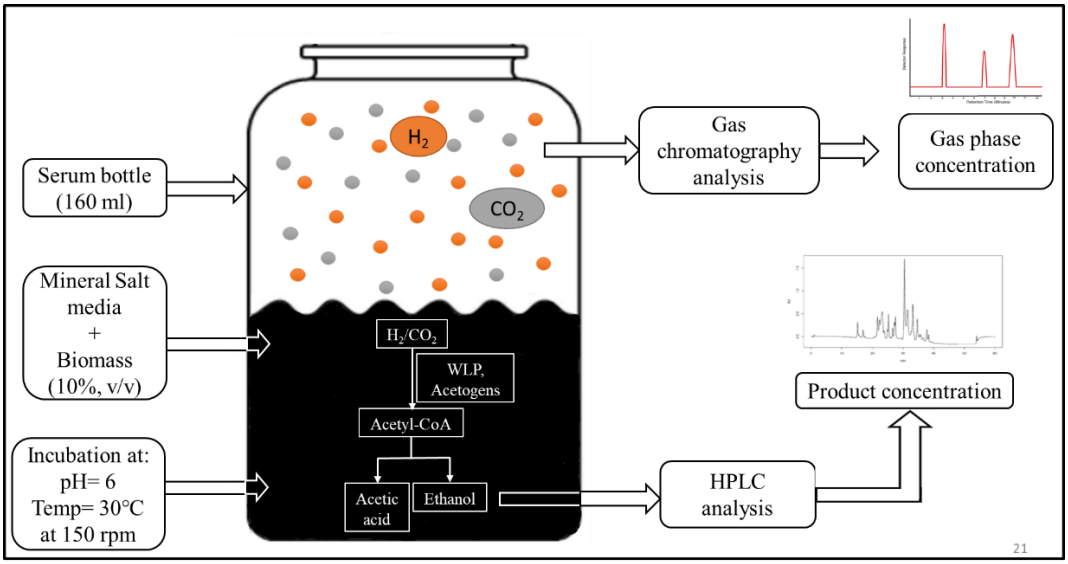
Keywords: Anaerobic sludge, H_2/CO_2, biofuels, Ethanol, Fatty acid.

References

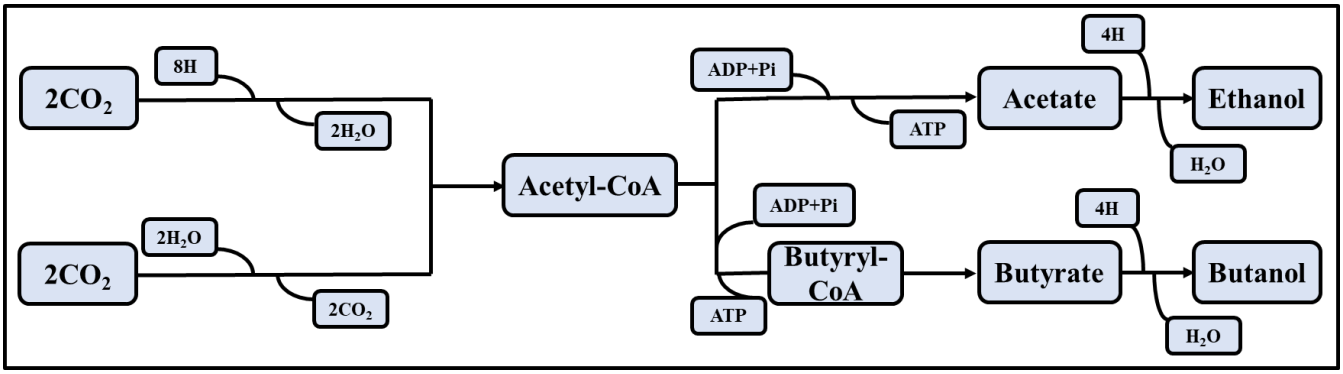
Chakraborty, S., Rene, E. R., Lens, P. N., Rintala, J., Veiga, M. C., & Kennes, C. (2020). Effect of tungsten and selenium on C1 gas bioconversion by an enriched anaerobic sludge and microbial community analysis. Chemosphere, 250, 126105.

Fernández-Naveira, Á., Abubackar, H. N., Veiga, M. C., & Kennes, C. (2017). Production of chemicals from C1 gases (CO, CO2) by Clostridium carboxidivorans. World Journal of Microbiology and Biotechnology, 33(3), 1-11.

He, Y., Cassarini, C., & Lens, P. N. (2021a). Bioethanol production from H2/CO2 by solventogenesis using anaerobic granular sludge: effect of process parameters. Frontiers in microbiology, 12.



(a)



(b)

Figure 1. (a) Schematics showing the batch system used in the study for CO_2 bioconversion **(b)** Wood-Ljungdahl Pathway involved in CO_2 bioconversion

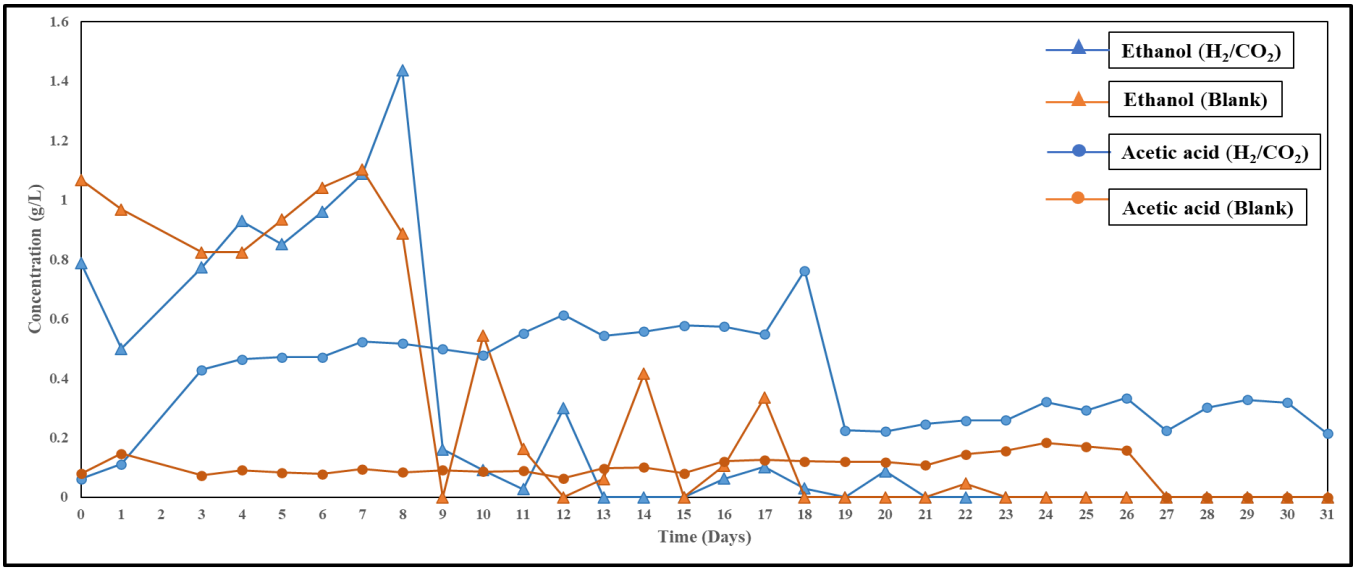


Figure 2. Acetic acid and ethanol production profile from H_2/CO_2 using anaerobic sludge