# Evaluation of pH Control Performance of Oyster Shell in Anaerobic Digestion

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## OBJECTIVES

Oyster shells have the potential to be able to control the pH. Few studies conducted to investigation of the effect as alkali source containing $CO_3^{2-}$ for the two-stage anaerobic digestion system (TSAD). Thus, we aim to investigate and evaluate oyster shells' performance as alkali material in controlling the pH of TSAD.

## METHODOLOGY

Kitchen waste, agriculture waste, and horse dung were collected in Tsushima Campus, Okayama University. TSAD consisted of CSTR (2 L, TS 3%, HRT 5 days, 35°C) for hydrolysis and UASBR (6 L, 35 °C) for methanogenesis. pH control conducted in hydrolysis stage by adding NaOH 10M or oyster shell powder 7.5 g/L. GHG emission of NaOH chemical production was calculated by using SimaPro 9.0.0, and for the oyster shell powder, GHG emission from milling machine studied was calculated based on Boicko (2005, in de Alvarenga et al., 2012).

## RESULTS AND DISCUSSIONS

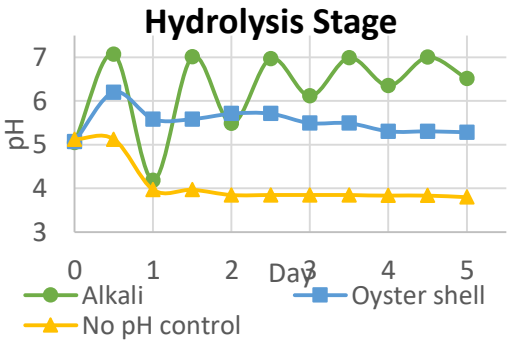


*Figure 1. Hydrolysis pH*

*Table 1. Liquid hydrolysate VS and COD*

| Treatment | VS % | COD (g/L) |
|---|---|---|
| Alkali | 1.18 | 27.97 |
| Oyster shell | 1.14 | 23.88 |
| no pH control | 1.12 | 20.83 |

An addition of oyster shell powder at the beginning maintains reactor pH above 5. Meanwhile alkali needs daily application but can raise the pH to 6.5 at the end. Using alkali for the pH control resulted in the highest VS% and COD value in liquid phase from hydrolysis process, that is high in organic matter.

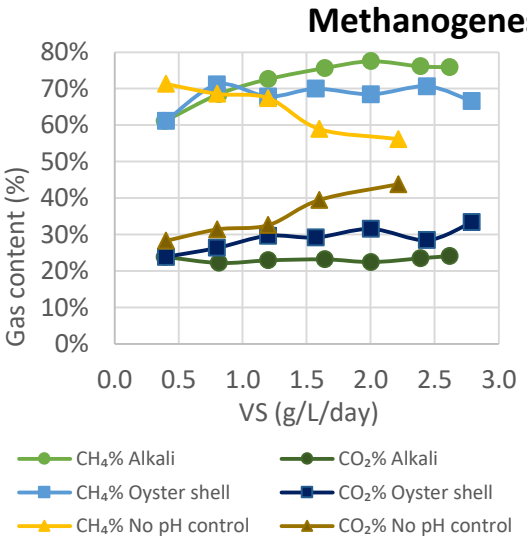


*Figure 2. Biogas content*

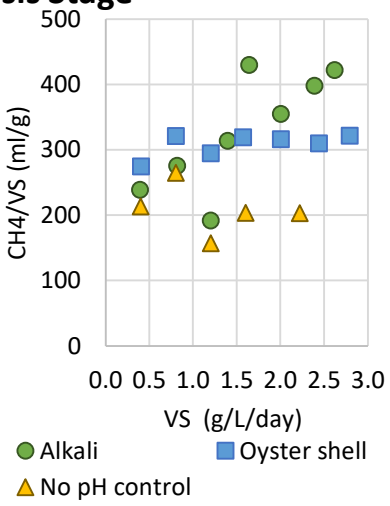


*Figure 3. Methane gas yield*

Methane production yield by alkali treatment increased proportionally with OLR and produces biogas with the highest methane percentage. Contrarily, that by oyster shell treatment produced stable methane yield. Combination of mildly acidic pH inhibits methanogen (Ye et al., 2012) and high OLR shifting the process to syntrophic acetate oxidizing pathway (Bi et al., 2020) resulted in accumulation of the intermediate product ($CO_2$). The inhibition and shifting pathway could affect the decreasing methane and increasing $CO_2$ percentage.

### Greenhouse Gas Emission Analysis

*Table 2. Usage and GHG emission*

| pH conditioner | Alkali (NaOH) | Oyster shells powder ($CaCO_3$) |
|---|---|---|
| pH conditioner per experimental material (kg/kg) | 0.0463 | 0.0864 |
| GHG emission per pH conditioner ($kgCO_2eq/kg$) | 1.26 | 0.102 |
| GHG emission per experimental material ($kgCO_2eq/kg$) | 0.0583 | 0.0088 |

## CONCLUSIONS

Utilizing NaOH for pH control resulted in better result in hydrolysis and methanogenesis by the VS%, CODcr level, methane yield and methane concentration in high OLR condition. Nevertheless, oyster shell produced lower GHG emission and stable methane yield across different OLR. Further investigation on microbiological consortium and stability of the system in long operation is still needed.

REFERENCES
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Bi, S., Westerholm, M., Qiao, W., Xiong, L., Mahdy, A., Yin, D., Song, Y. and Dong, R., 2020. Metabolic performance of anaerobic digestion of chicken manure under wet, high solid, and dry conditions. Bioresour. Technol., 296, p.122342.
Ye, R., Jin, Q., Bohannan, B., Keller, J.K., McAllister, S.A. and Bridgham, S.D., 2012. pH controls over anaerobic carbon mineralization, the efficiency of methane production, and methanogenic pathways in peatlands across an ombrotrophic–minerotrophic gradient. Soil Biol. Biochem., 54, pp.36-47.