Effects of low-pressure conditions on degradation of organic matter by methane fermentation

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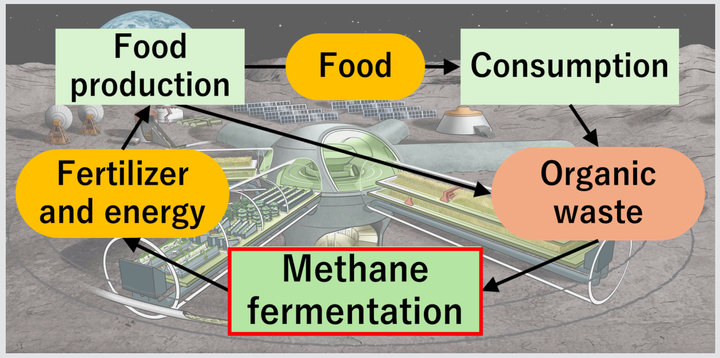
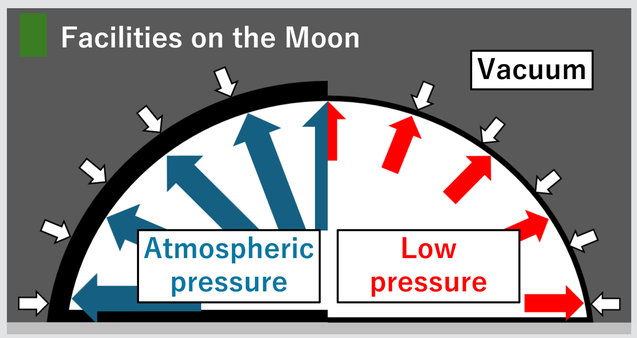
Introduction

The establishment of resource recycling system is necessary to maximize the limited resources utilization on the moon. As the resource recovering technology on the moon, Methane fermentation (MF) that convert waste into biogas and fertilizer has been gathering attentions.



Novelty of research

Every facility must have tolerant structure against pressure gap between inside and outside of building. Low-pressure condition inside of the facility achieves simplify the structure of building. But these studies have investigated for MF only down to about 70 kPa.

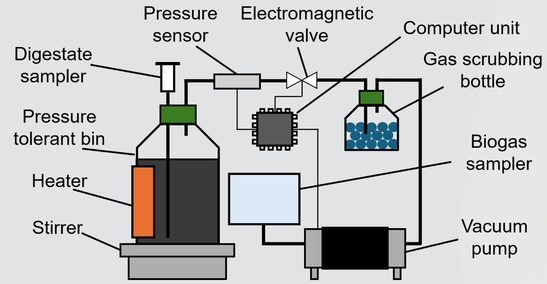


Objective

Determine the efficiency of biodegradation of organic mater by MF and operational strategy under wide range of pressure: from 10 kPa to 100 kPa.

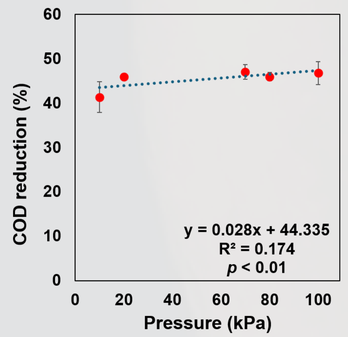
Material & Method

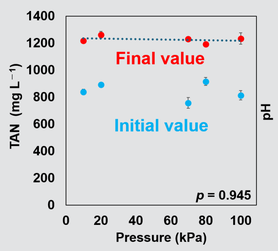
The batch tests were conducted using the systems below under 10, 20, 70, 80, 101 kPa and mesophilic condition. Model raw waste was used as the substrate.

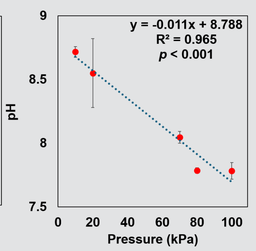


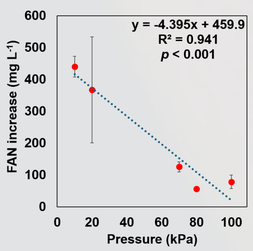
Results

Organic degradation were shown under all condition including 10 kPa.
FAN concentration and pH were increased with decrease of pressure.





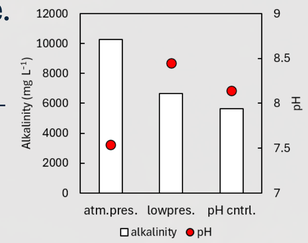




Discussion

- The result supports the feasibility of the operation of MF under low-pressure conditions.
- The increase of pH consumes alkalinity stabilizes pH would make system vulnerable.

$$CO_2(g) \Leftrightarrow CO_2(aq)$$
$$CO_2(aq) + H_2O \Leftrightarrow H^+ + HCO_3^-$$
$$HCO_3^- \Leftrightarrow H^+ + {CO_2}^{2-}$$



- There were inconsistency with previous study about inhibition of high pH and FAN.
- Ammonia and other gaseous materials potentially were stripped to outside of system.
- The continues system may exhibit deferent behavior.

Additional Work

- Determine the mechanism of the tolerance toward high pH and high FAN for the strategical operations.
- Quantifying and preventing volatile gas emission especially ammonia to valorize digestate more.
- Evaluation of the digestate as fertilizer for cultivation: e.g., phosphorus precipitation at high pH condition.
- Verification with continues system and upscaled system for the application.

Acknowledgments

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