Enhanced Biomethanation from Municipal Solid Waste (MSW): Concentration and Mesh Size Effects of Zero Valent Iron (ZVI)-mediated Hydrogen Production

Center for Bio-mediated & Bio-inspired Geotechnics (CBBG)

Colleen A. Adams; University of New Haven

Mark Reynolds, Dr. Rosa Krajmalnik-Brown, & Dr. Hinsby Cadillo-Quiroz ; Arizona State University

Project Overview

Municipal Solid Waste (MSW) landfills produces biogas as a result of polymer degradation and fermentation of available organic matter. Efforts to capture this methane (CH_4) rich biogas for downstream transformations are actively employed in landfilling operations, however unfavorable concentrations of CH_4 are a problem. The goal of this project is to stimulate biomethanation *in –vitro* within MSW microcosms while addressing the following research questions:

- Does the exogenous addition of different mesh sizes of ZVI alter rates of CH_4 production or total CH_4 volume generated?
- Are certain concentrations of ZVI favored, such as 0.1 g/L, 1 g/L, and 5g/L, accordingly to a ZVI mesh size's varying reactivity?
- Can evidence of the ZVI oxidation be observed in common MSW leachate metrics, such as pH and conductivity?

Background

Municipal Solid Waste (MSW) is the collection of everyday items that are discarded by a local community. The waste contains various organic and inorganic items such as food scraps, paper, plastic, and wood. Due to rapid population increases and vast development; MSW is becoming an issue. Many waste management operations are looking into ways to minimize overhead costs, increase the capacity of landfills, and/or enhance biodegradation of the MSW at a faster rate[1].

Methanogens are microorganisms from the domain *Archaea* that produce CH_4 in anoxic conditions such as landfills. Certain methanogens can use H_2, including H_2 produced by cathodic depolarization-mediated oxidation ZVI to produce methane[2]. In this project, enhancing methanogensesis by utilizing ZVI as an exogenous H_2 source was looked to as a possible solution to this problem.

Methods

Salt River Landfill (SRL) MSW ~20 years old

ZVI Mesh Sizes

Vials with 90% Gravimetric Moisture

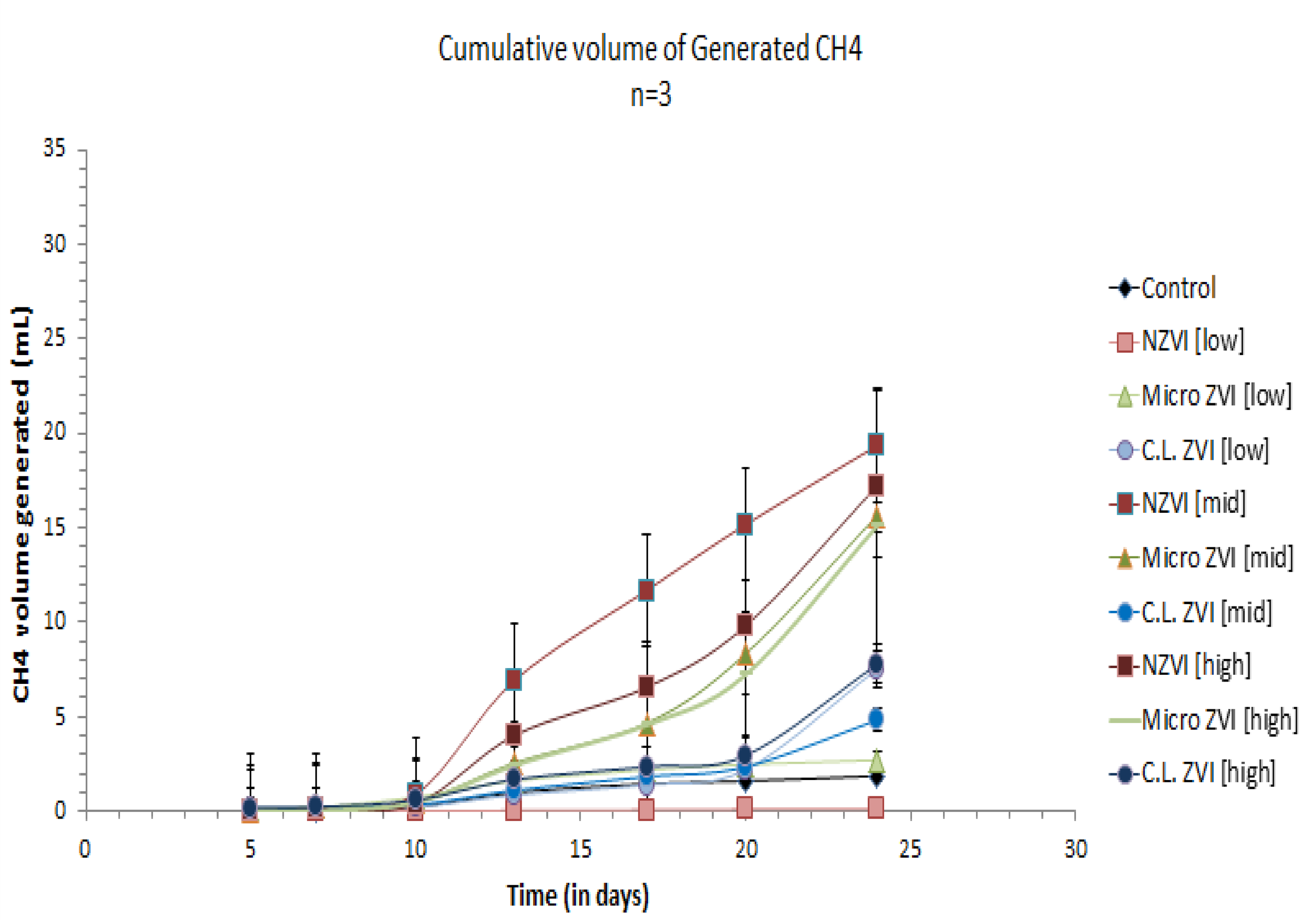
Frictionless Syringe

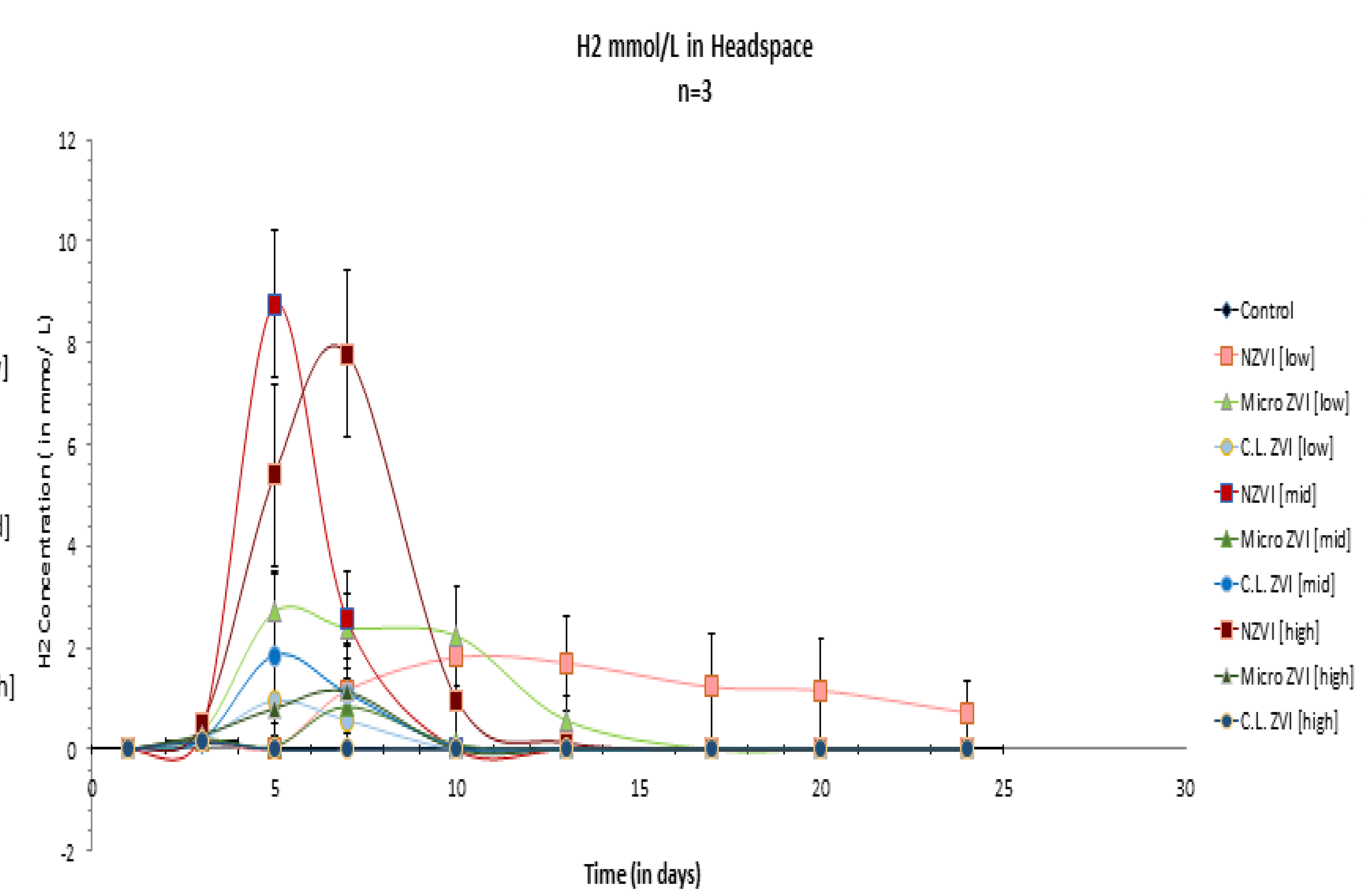
Gas Chromatography Thermal Conductivity Detector (TCD)

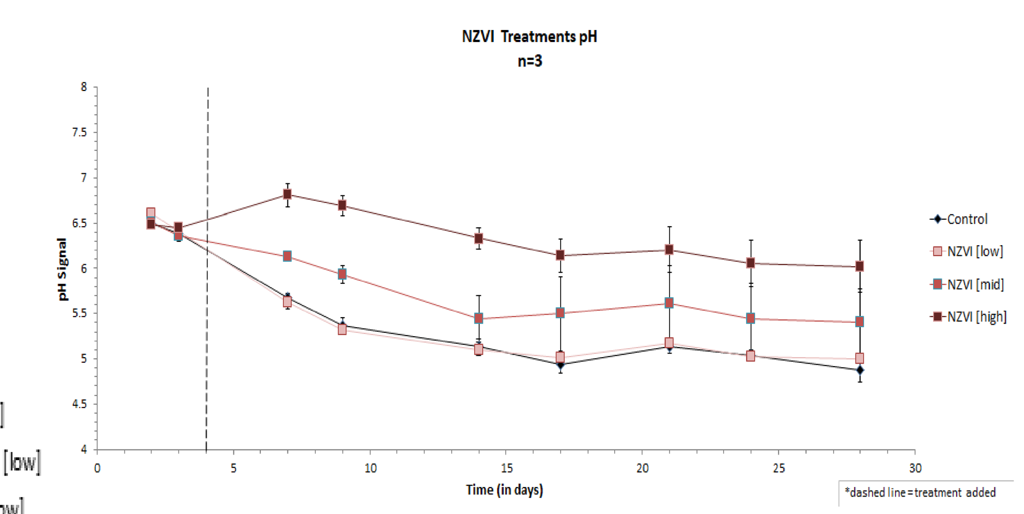
SympHony pH meter

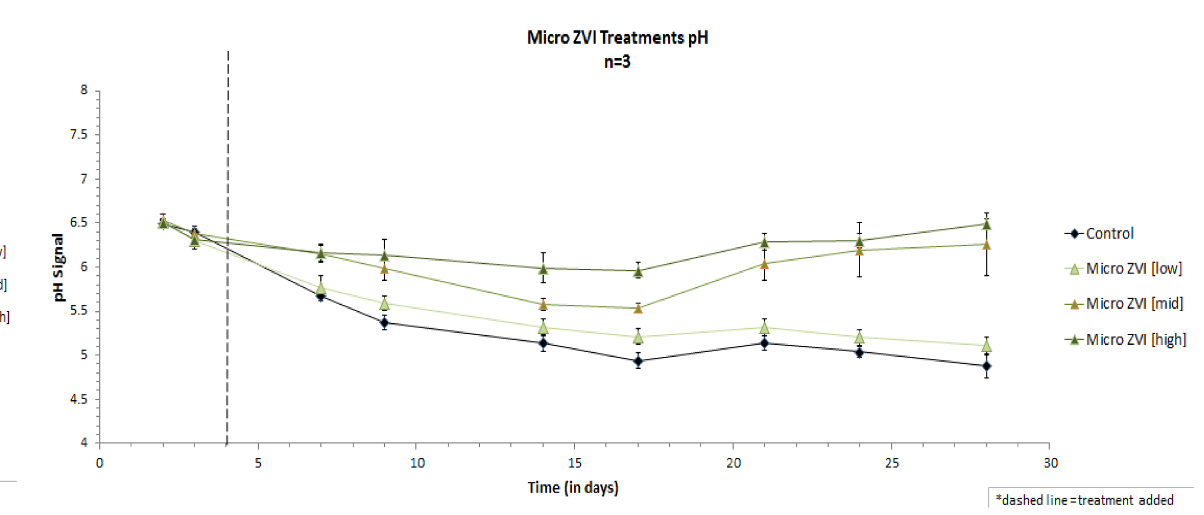
Vernier Conductivity Probe

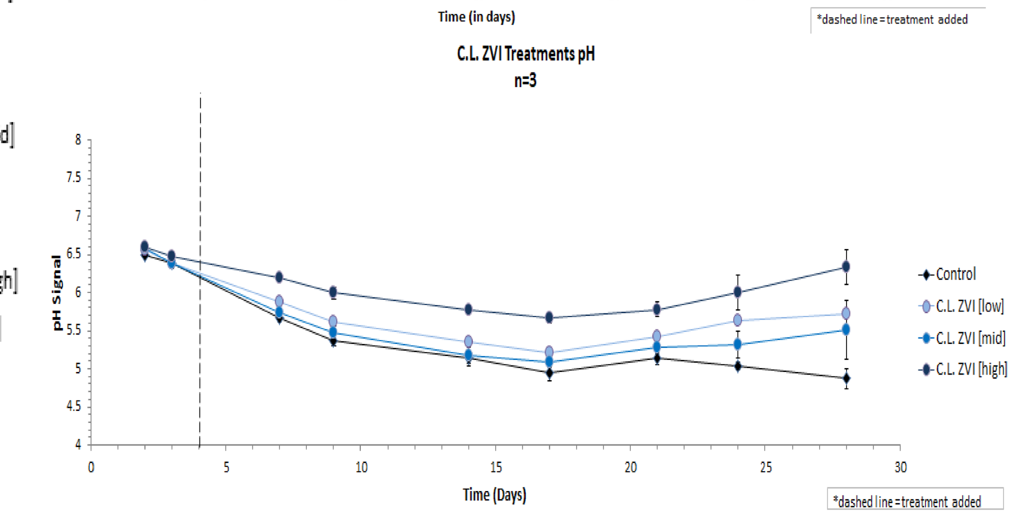
Results

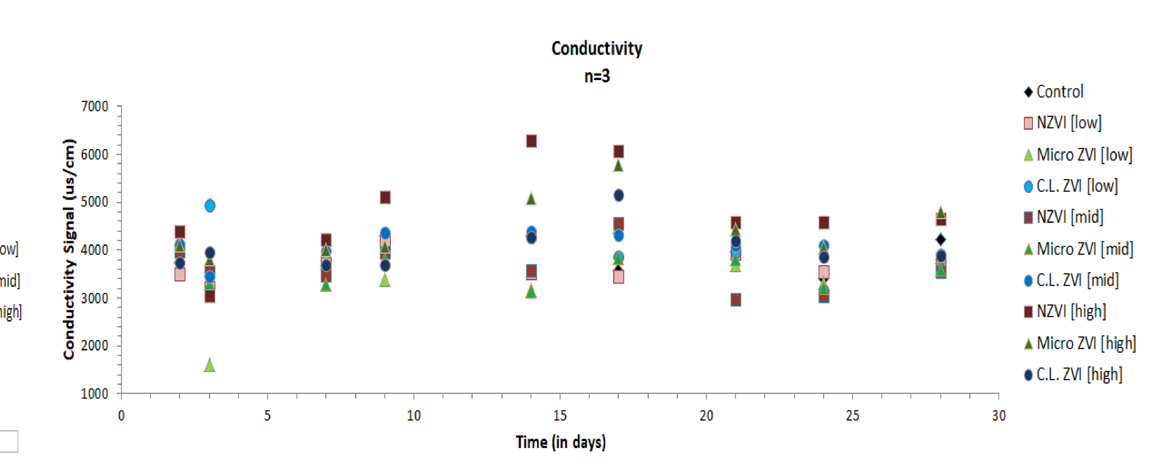












Interpretation

Treatment	CH4 concentration (% by volume)	Cumulative Volume of Generated CH4	Highest [H_2] mmol/L in Headspace Observed	pH Range	Highest Conductivity Value Observed
Control	14.09 %	1.86 mL	0.13 mmol/L	4.8-6.5	4299.82 uS/cm
NZVI [mid]	26.75 %	19.35 mL	8.77 mmol/L	5.4-6.5	4573.74 uS/cm
NZVI [high]	35.18 %	17.23 mL	7.79 mmol/L	6.0-6.8	6301.53 uS/cm
Micro ZVI [high]	33.68 %	15.11 mL	1.14 mmol/L	5.9-6.5	5787.84 uS/cm
C.L. ZVI [mid]	20.56 %	7.78 mL	1.86 mmol/L	5.0-6.6	4397.41 uS/cm

Conclusions & Recommendations

Data suggests that increased surface area of the ZVI among the [high] and [mid] treatments correlate with:

- Greater CH_4 volume generated
- Optimum pH for biomethanation
- Peak H_2 production and conductivity

Recommendation:

Deploying NZVI and Micro ZVI at [mid] & [high] and concentrations in between, should further be explored as possible solutions to enhance biomethanation in bioreactor landfill operations

References

1) Gangopadhyay M. 2013. Effect of Nano Zero Valent Iron on Degradation of Municipal Solid Waste in Bioreactor Landfills 1–106.
2) Boopathy R, Daniels L. Effect of pH on Anaerobic Mild Steel Corrosion by Methanogenic Bacteria. *Applied and Environmental Microbiology*. 1991;57(7):2104-2108.

Acknowledgements

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