High-Tech Analysis of Low-Cost, Low-Tech Methods for Sustainable Class A Biosolids Production: Set up and Initial Pilot-Scale Data

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INTRODUCTION

- Water resource recovery facilities (WRRFs) producing Class B biosolids face growing challenges that may limit the sustainable reuse of biosolids.
- Unfortunately, many WRRFs lack the resources to apply conventional energy-intensive Class A treatment processes, or negotiate the PFRP equivalency process.
- Increased use of low-cost, low-tech (LCLT) treatment options (e.g., lagoon storage or air drying) for Class A production may be more appropriate for these WRRFs.
- However, widespread adoption of LCLT methods is currently limited by the lack of information on pathogen and indicator organism (PIO) inactivation under ambient conditions.

PROJECT GOALS AND OBJECTIVES

Project Goal

Develop a rational and universal approach for the design of LCLT Class A biosolids treatment processes in order to:

- Move past a trial-and-error approach to the design of LCLT treatment systems,
- Ultimately establish PFRP equivalency of LCLT processes on a national basis.

Project Objectives

1. Design and set up pilot-scale LCLT Class A biosolids treatment systems at two small WRRFs.

2. Monitor key environmental conditions (ambient environmental conditions, biosolids storage temperature, moisture content (measured as total solids, TS), organic matter content (measured as VS), NH_3 content, volatile fatty acids (VFAs), Alkalinity, and pH) over the course of one or two year(s).

3. Apply culture- and molecular-based methods to quantify the inactivation of PIOs (fecal coliforms (FC), coliphage, enteric viruses, and helminth ova) over time in the pilot-scale systems.

STUDY SITES

- **Gogebic-Iron Wastewater Authority**
  (GIWA, Ironwood, MI)
  - **Design Wastewater flow**: 3.4 mgd
  - **2nd Treatment**: Oxidation ditch activated sludge
- **Portage Lake Water and Sewage Authority**
  (PLWSA, Houghton, MI)
  - **Design Wastewater Flow**: 3.1 mgd
  - **2nd Treatment**: Conventional activated sludge
- **Class B Biosolids Treatment**
  - Mesophilic anaerobic digestion (MAD) of 1˚ and 2˚ solids.
  - Conditioned with cationic polymer.
  - Dewater by belt filter press (GIWA: 25% TS, PLWSA: 16% TS).
  - Stored in closed shed during winter.

OBJECTIVE 1

Pilot Scale Test Beds

Test beds (4' high, 4' wide, and 8' long) designed to:

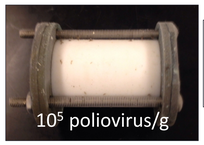
1. Maintain structural integrity through freeze/thaw cycles of the biosolids.
2. Allow drainage water from the biosolids to be collected and disposed of properly.
3. Withstand ambient temperatures.

Seeding Biosolids

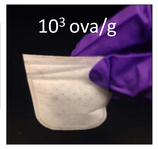
Biosolids typically do not have sufficient levels of helminth ova and enteric viruses to observe:

1. ≥ 3 log reduction of total enteric viruses
2. ≥ 2 log reduction of viable helminth ova
3. ≥ 1 log reduction of fecal coliforms

Therefore, biosolids were spiked and placed in sentinel chambers attached to sampling stacks:



Poliovirus Sentinel Chamber



Helminth Ova Bag Chamber

Poliovirus Chamber Stack

OBJECTIVE 2

Methods

- Three test beds are located indoors (boxes 4, 5, and 6), and three are located outdoors (boxes 1, 2, and 3).

Environmental Conditions

- Davis Vantage Pro2 Plus Weather Stations used to monitor ambient conditions.
- In situ biosolids temperature monitored using iButtons (Embedded Data Systems) in 3 ft. high biosolids pile at depths of 0.5', 1.5' and 2.5' from the top.

Physical/Chemical Parameters

- Pilot test beds sampled monthly via composite cores and analyzed for parameters TS, VS, NH_3, VFAs, Alkalinity, and pH (Aug. '16-Jan. '17).

Example Results

Environmental Conditions

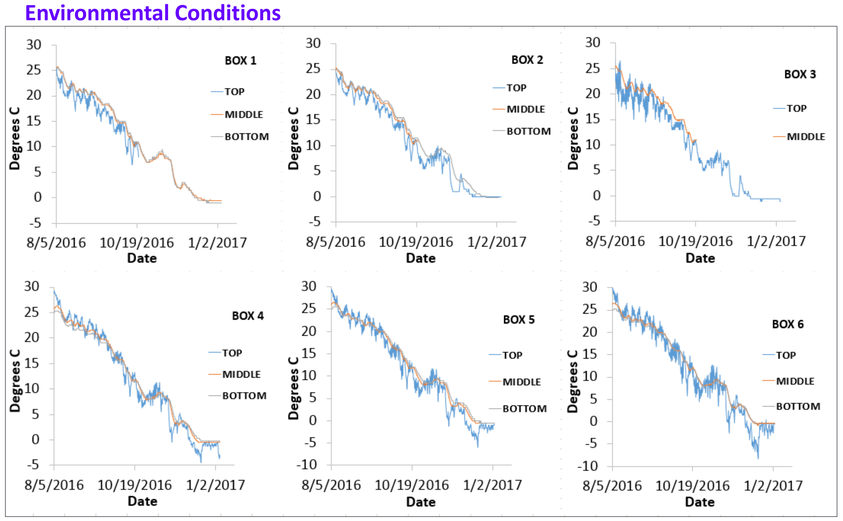


Figure 1: In Situ Biosolids Temperatures at PLWSA. Each data point represents the average of duplicate analyses

Physical/Chemical Parameters

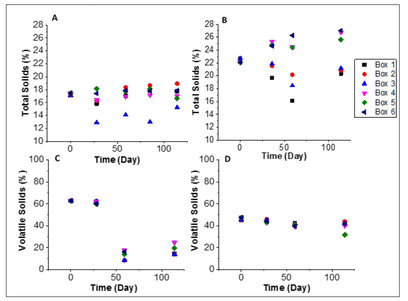


Figure 2: **Total Solids at (A) PLWSA and (B) GIWA, and (C) Volatile Solids at PLWSA and (D) GIWA. Each data point represents the average of duplicate analyses.**

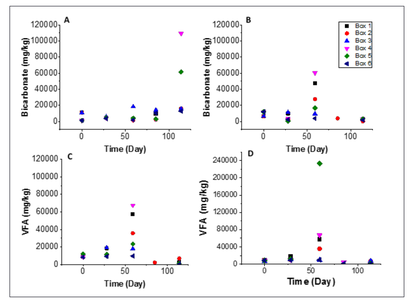


Figure 3: **Bicarbonate at (A) PLWSA and (B) GIWA, and VFA at (C) PLWSA and (D) GIWA. Each data point represents the average of duplicate analyses.**

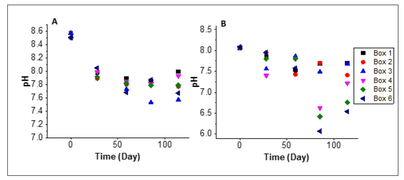


Figure 4: **pH at (A) PLWSA and (B) GIWA. Each data point represents the average of duplicate analyses.**

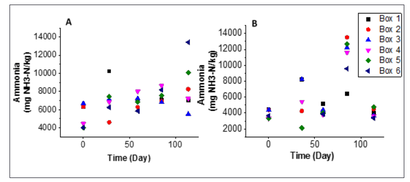


Figure 5: **Ammonia at (A) PLWSA and (B) GIWA. Each data point represents an individual measurement.**

OBJECTIVE 3

Methods

- Pilot test beds sampled monthly via composite cores and analyzed for FC and coliphage; sentinel chambers removed monthly and analyzed for ova and poliovirus (Aug. '16-Jan. '17).

Example Results

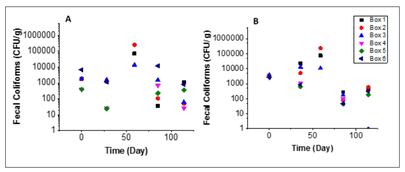


Figure 6: **Fecal Coliforms at (A) PLWSA and (B) GIWA. Each data point represents an individual measurement**

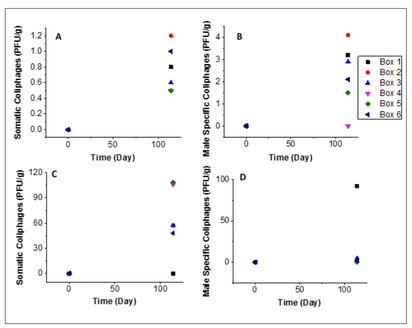


Figure 7: **Somatic Coliphages at (A) PLWSA and (C) GIWA, and Male Specific Coilphages at (B) PLWSA and (D) GIWA. Each data point represents an individual measurement.**

CONCLUSIONS

- **Objective 1**: Pilot scale study set up.
- **Objective 2**: Biosolids temperature decreasing, pH decreasing, ammonia increasing (PLWSA) or no clear trend (GIWA).
- **Objective 3**: FC increased, then decreased; limited coliphage data indicate an increase
- The data demonstrate that changes in environmental conditions, physical-chemical parameters, and microbial populations have occurred over the course of the study; however, additional data are needed to determine the treatment efficacy.

Acknowledgements

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