DEMONSTRATION OF BIOGASIFICATION OF SUGARBEET TAILINGS

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Biogasification

Biochemical process that mineralizes organic compounds (carbohydrates, proteins and fats) to biogas in the absence of oxygen (O_2) through the concerted action of syntrophic groups of microorganisms.

Biogas: 50 – 70% methane and rest carbon dioxide with traces of contaminants.

Also called **Anaerobic Digestion**

Applications: Waste treatment, biofuel production

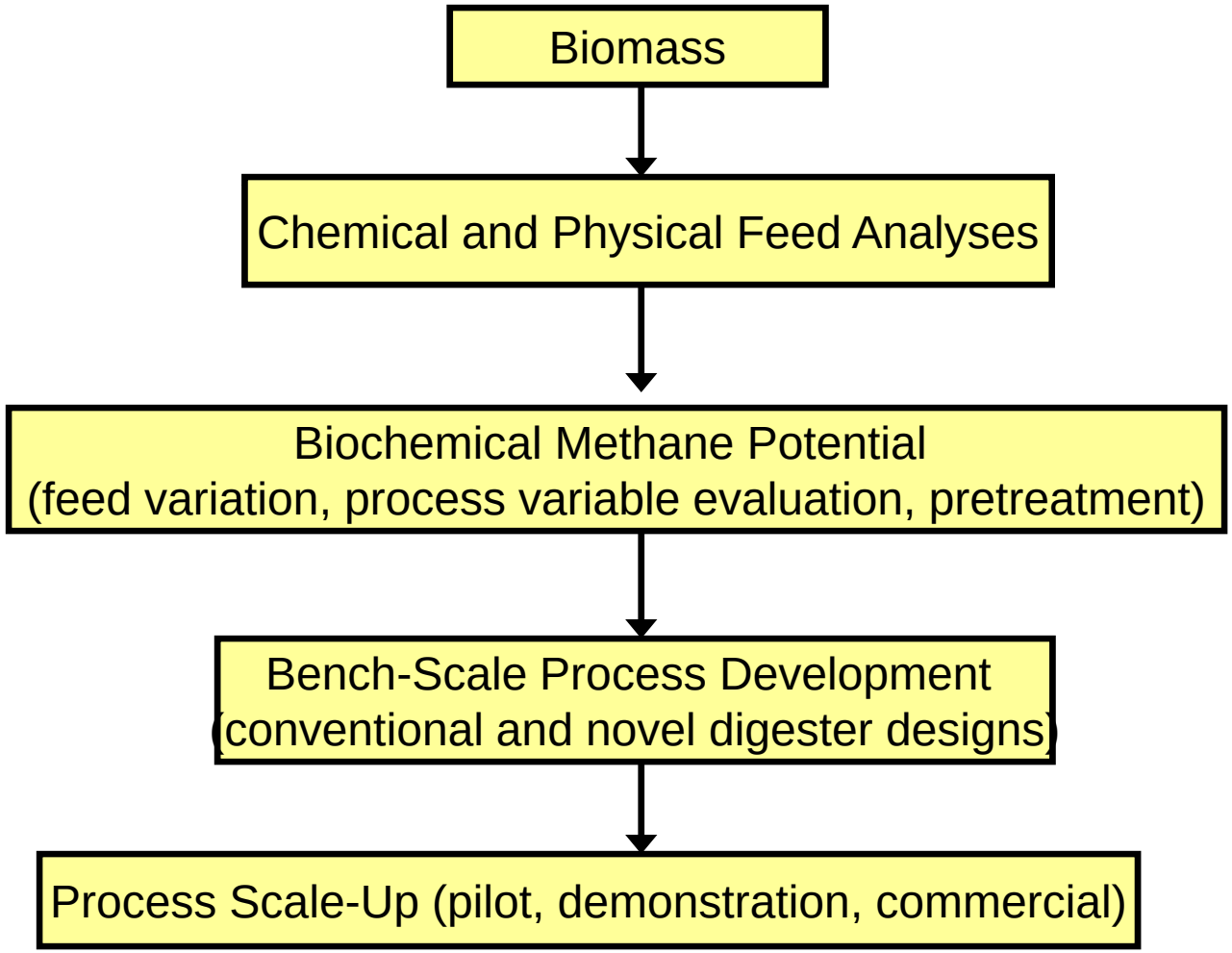
Sugar Beet Tailings
American Crystal Sugar Company

- Five processing plants along Red River Valley, MN and ND
- 440 tons per day of tailings in each plant
- Currently land applied/ landfilled (East Grand Forks)
- Natural gas for drying spent pulp

Project Objective

To build, operate and evaluate a biogasification plant that will process 10 tons per week of tailings.

Approach to Biogasification Process Development



Characteristics of Sugarbeet Tailings

Dry Matter	13 - 16 % wet weight
Volatile solids	82 - 85 % dry matter
Methane potential	275 L/kg VS (1320 cu ft/ton wet weight)

Solid feedstock digester designs

- One stage systems
  - Wet
  - Dry
- Two stage systems
  - Wet
  - Dry
- Batch
  - Single stage dry
  - Two stage dry
  - Two stage hybrid

Advantages of Dry Process

Does not require

- fine shredding of feedstock or other pretreatment
- mixing or agitation
- conveying solids during digestion

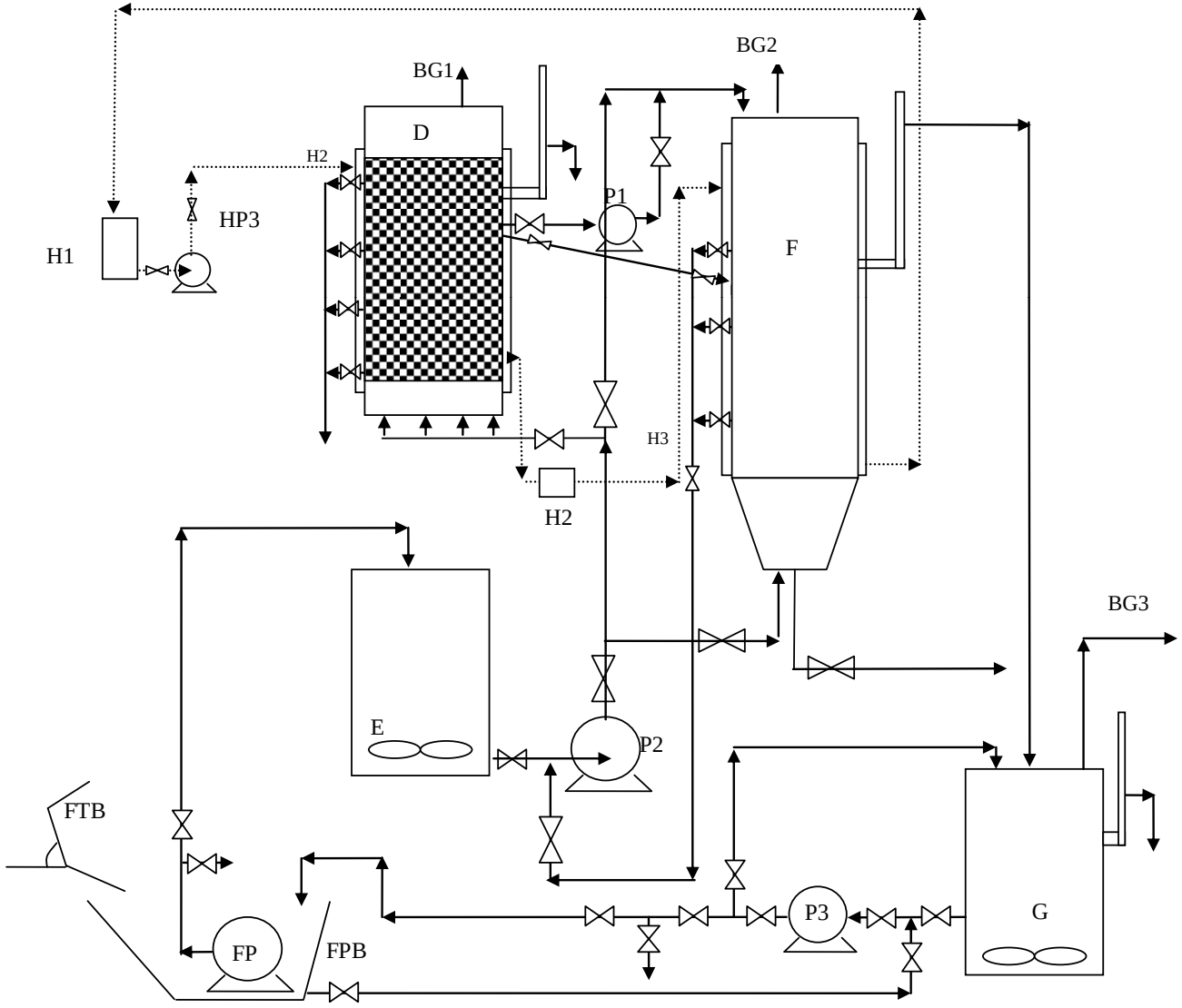
Need for Improvement of Existing Designs

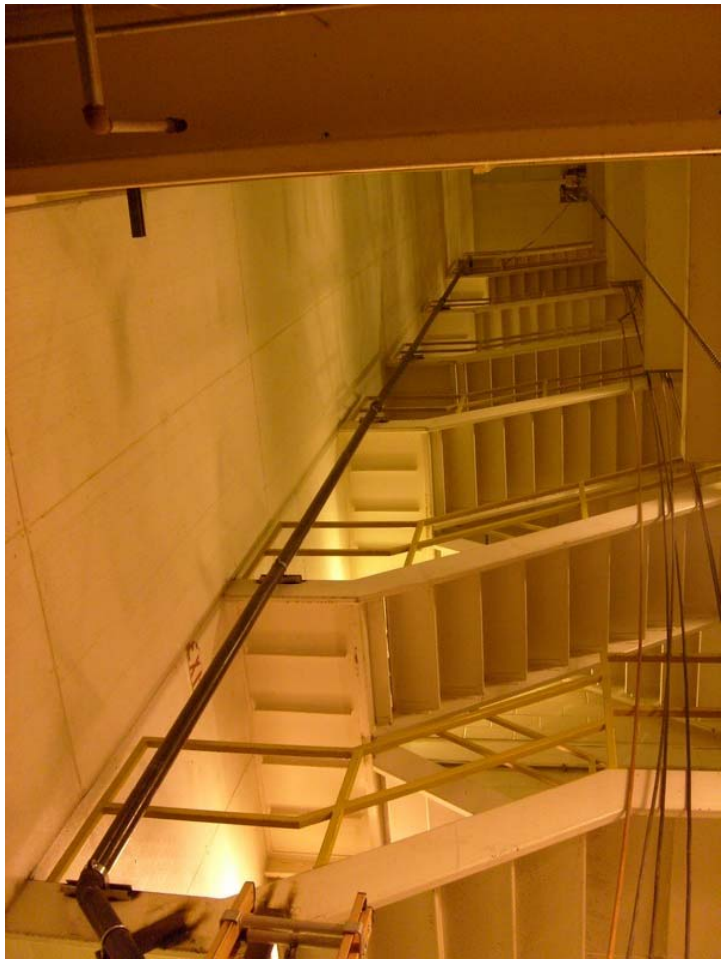
- Large fraction of readily soluble organic matter (~ 50 g COD/L) in tailings.
  - Rapidly ferments, pH < 4, Inhibits process
  - Solution: Separate the soluble organics
- Ensure inactivation of plant pathogens and weed seeds
  - Solution: thermophilic temperatures

Performance of two stage batch hybrid system

- Over 275 L of methane/kg VS within 10 days.
- Soluble COD less than 5 g/L at the end of digestion.
- Low concentrations of volatile organic acids at the end of digestion.
- TS reduction = 82% and VS reduction = 88%.
- Successfully digested 5 kg of tailings loaded in the high solids digester. OLR = 7.5 kg VS/m^3/d
- 45-50% of methane yield from high solids digester.

Flow diagram for ACSC Demonstration Plant



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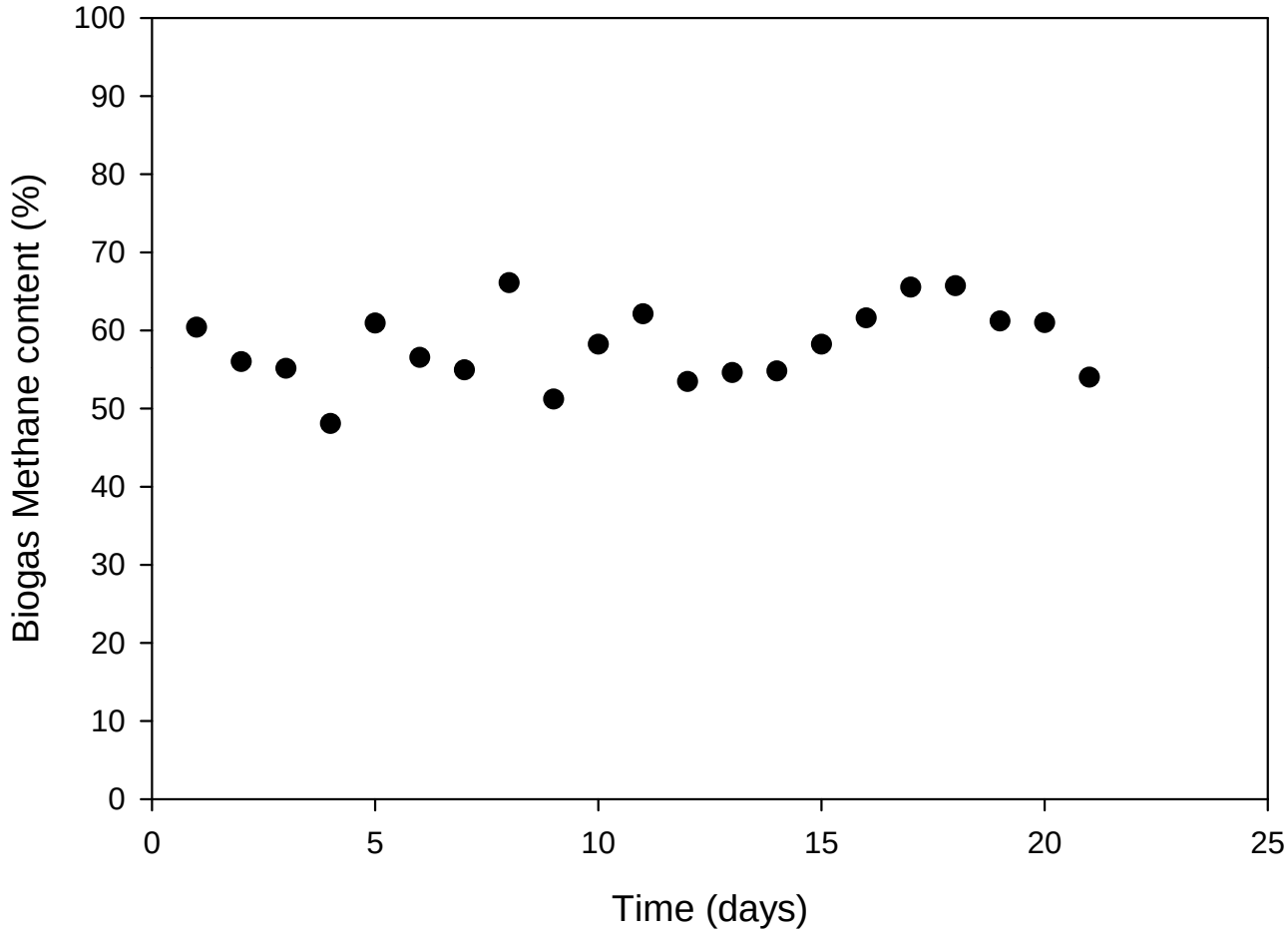
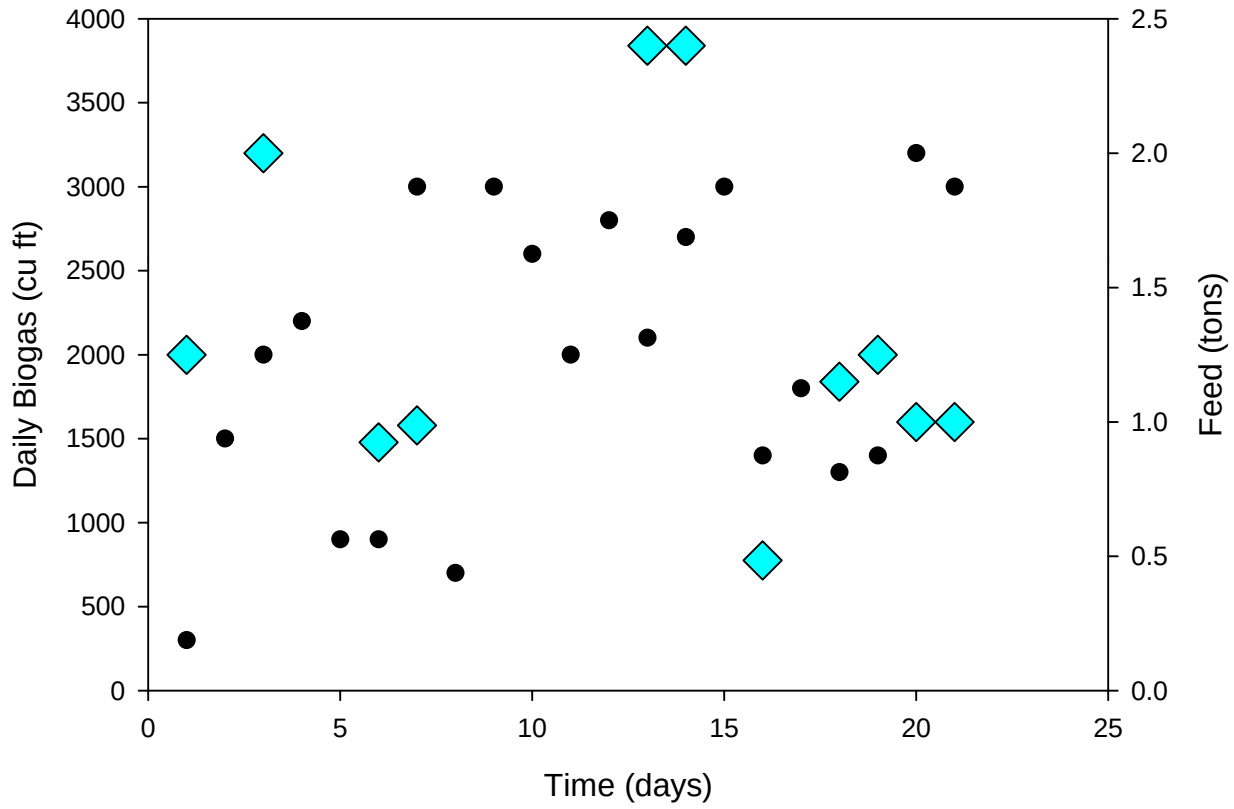
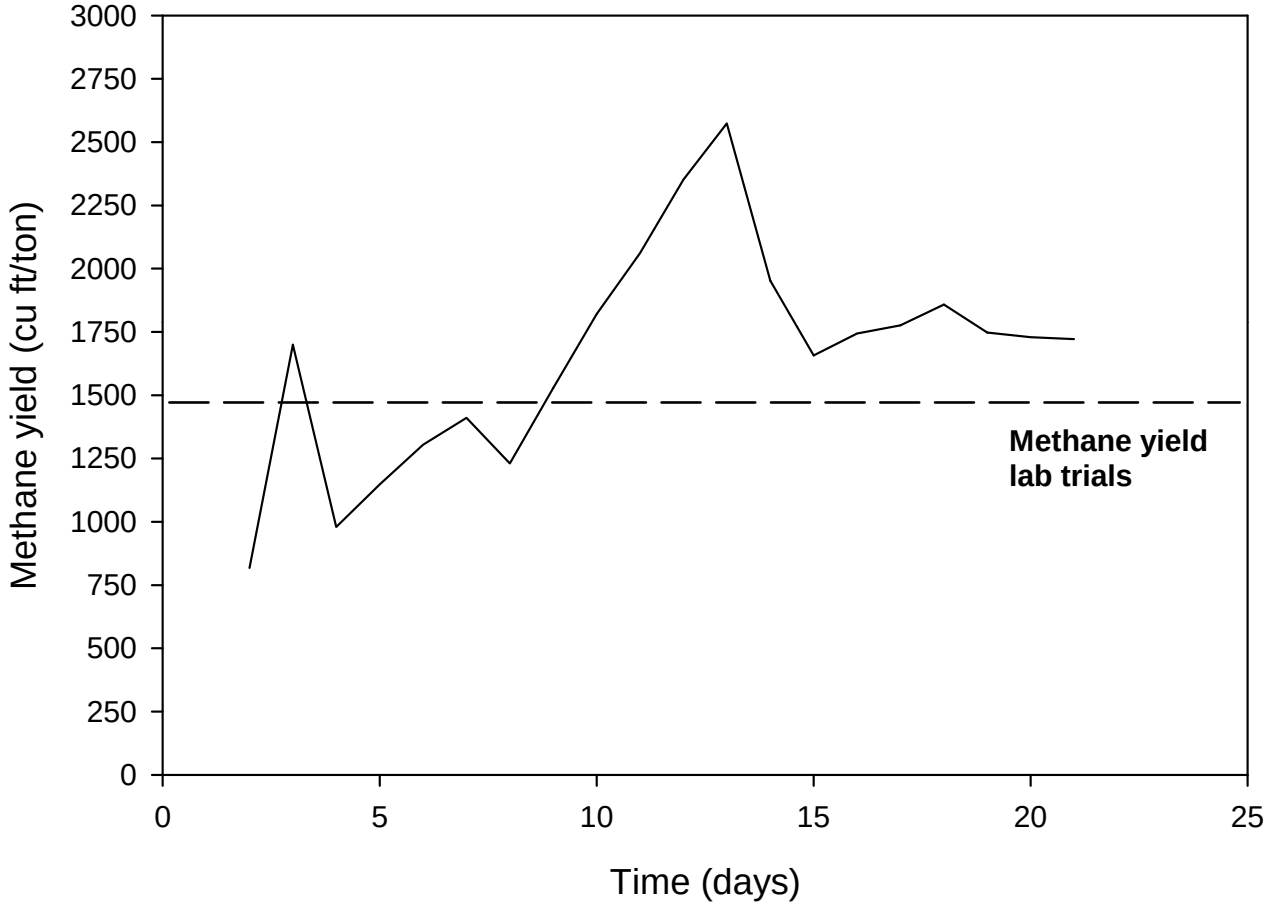
P2

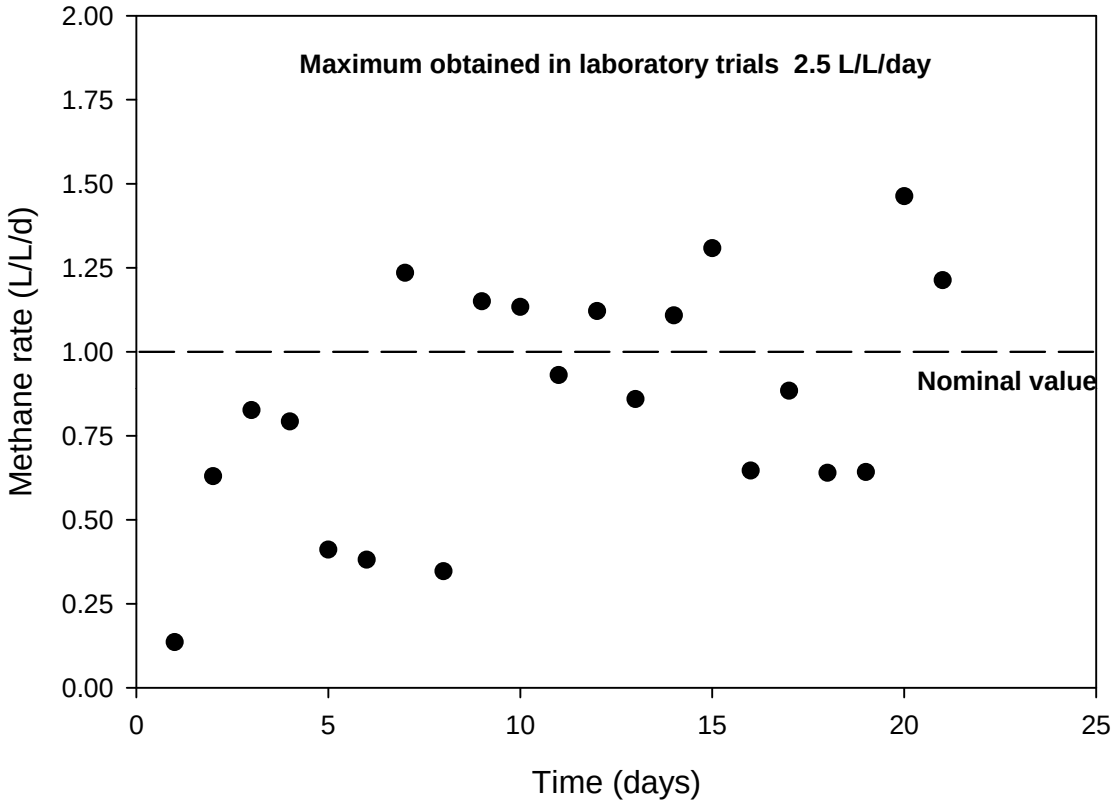
System Performance

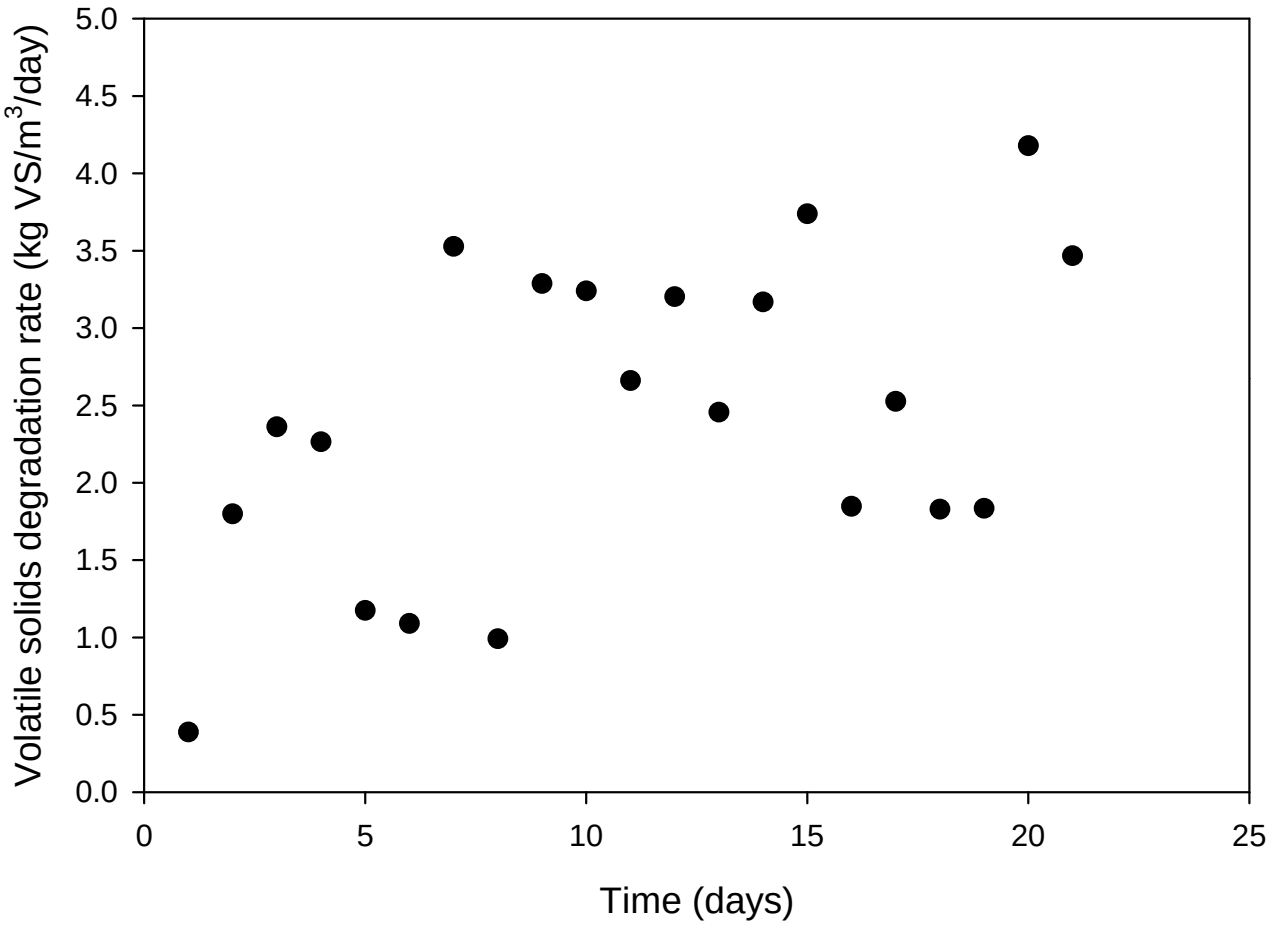
Parameter	Value
Reactor Configuration	Unmixed, bottom fed solids concentrating, two stage
Amount of tailings fed	18 tons
Reactor residence time HRT	 20 d
Current feed rate	2 tpd
Biogas production	41800 cu ft
Methane yield (most recent)	1,700 cu ft /ton (=1.7 MMBtu/ton)
Methane content of gas	53 – 68%
Volatile Fatty Acids	~ 200 mg/L


Biogas Methane content (%)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
Time (days)


Daily Biogas (cu ft)
Feed (tons)
Time (days)
0
500
1000
1500
2000
2500
3000
3500
4000
0.0
0.5
1.0
1.5
2.0
2.5
0
5
10
15
20
25


3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
Methane yield (cu ft/ton)
0
5
10
15
20
25
Time (days)
Methane yield
lab trials


Maximum obtained in laboratory trials 2.5 L/L/day
Nominal value
Methane rate (L/L/d)
Time (days)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25


Volatile solids degradation rate (kg VS/m3/day)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
Time (days)

CONCLUSIONS

- There was a need for an alternate process design to existing commercial scale biogasification processes.
- The process design was successfully scaled up from bench scale apparatus.
- Performance of the demonstration plant was comparable to that seen at bench scale.
- Performance comparable to that of commercial systems biogasifying other feedstocks (including wastewater).

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