Technologies for High Solids Biomass Reuse and Valorization

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ADVANTAGES OF ANAEROBIC VERSUS AEROBIC COMPOSTING (1)

- no oxygen or aeration equipment required
- no mixing requirement (some anaerobic designs)
- biogas rich in methane is produced in addition to digestate
- less odors

BIOGAS USE OPTIONS

- Direct Combustion/Co-generation
- Electricity Generation
- Vehicular Fuel
- Gas Pipeline

SOME OTHER ADVANTAGES OF ANAEROBIC DIGESTION

- can process wet or dry feeds
- does not require pure or defined mixed cultures
- does not require pretreatment for depolymerization
- produces less microbial biomass
- reduces animal and plant pathogens

PROBLEM

Most successful systems operate with liquid slurry feedstocks (<15% TS), which immediately dilute harmful organic/fatty acids as soon as they form.

Bulk solids feedstocks (>20% TS) pose problems with start-up and stabilization.

Localized high concentrations of organic/fatty acids quickly intoxicate the early consortia of working micro-flora, and bioconversion stops.

SEquential

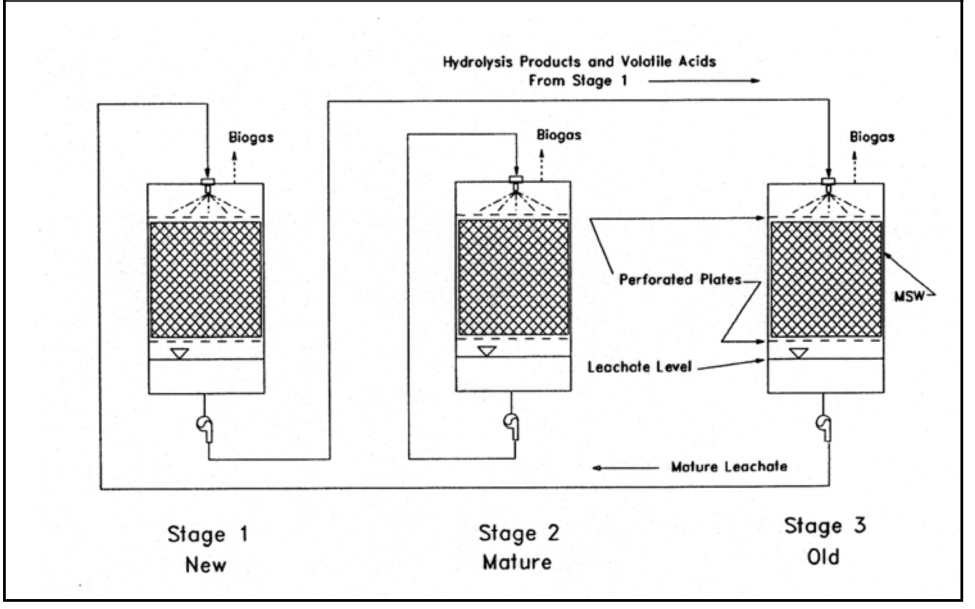
Batch

Anaerobic

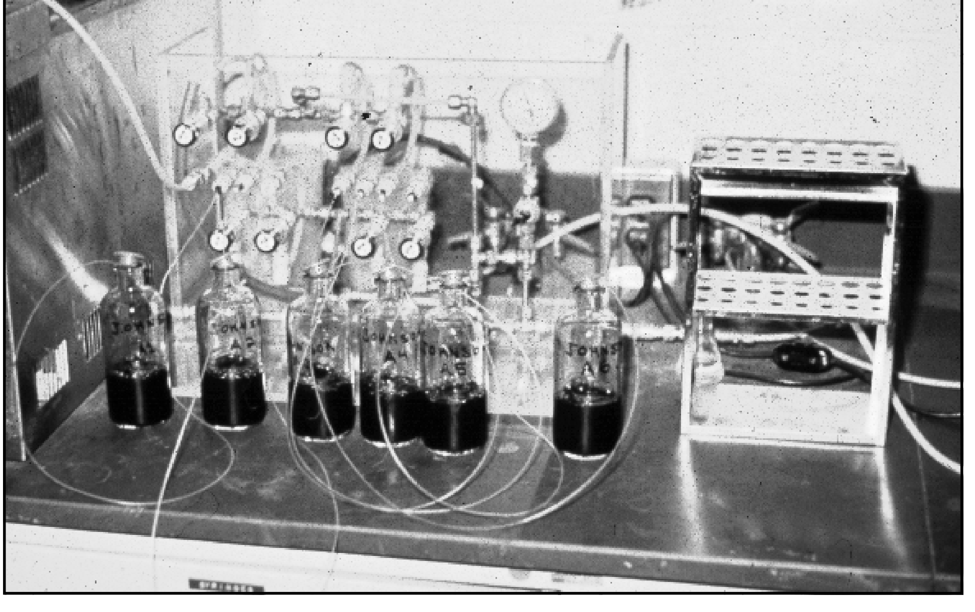
Composting

GATOR Engineering

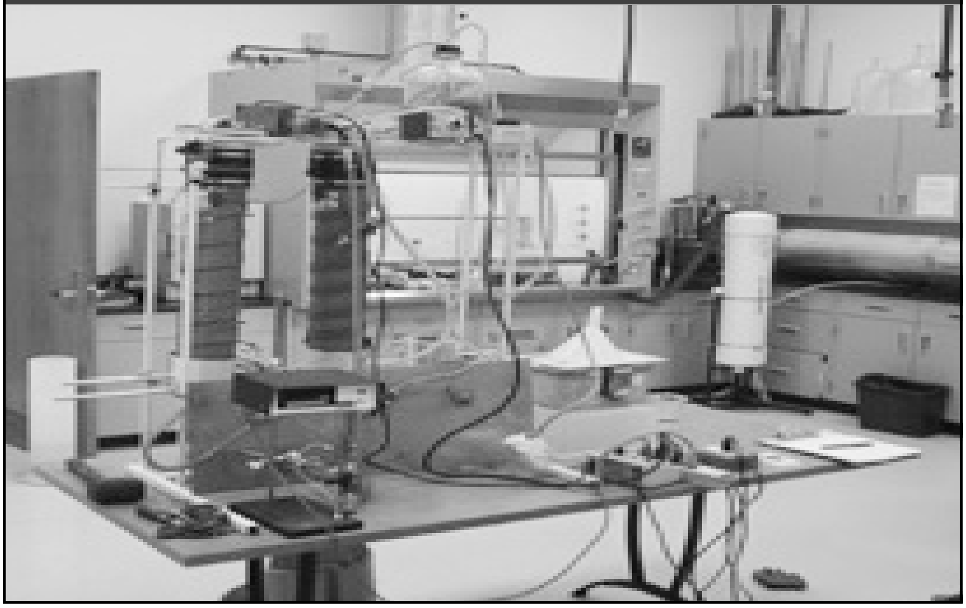
Schematic of Sequential Batch Anaerobic Composting Process



BMP REACTORS



BENCH-SCALE SEBAC



PILOT SEBAC

Pilot SEBAC test facility at University of Florida

PERFORMANCE OF SEBAC ON SEVERAL FEEDSTOCKS

Parameter	**MSW**	**Yard Waste**	**Brewery Chips**	**Shredded Office Paper**	**Space Mission Wastes***
Methane Yield, L/g VS added	0.30	0.07	0.06	0.35	0.3
Volatile Solids Reduction, %	57	20	26	96	85
Volume Reduction, %	65	15	15	94	86
Solids Retention Time, days	30	70	40	30	20

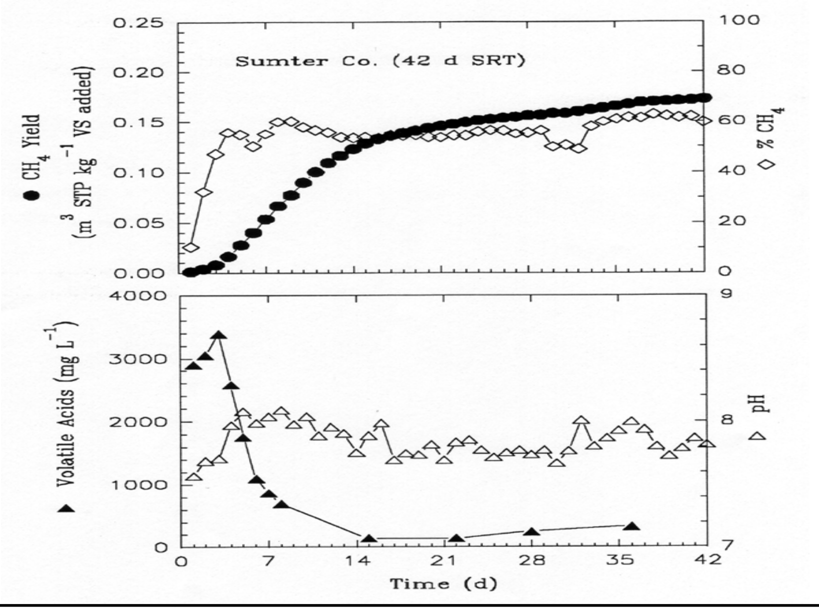
Biochemical methane potential data

Feedstock	CH_4 Yield, L/g VS added	conversion, % of cellulose	k, d^{-1}
This Study			
celllulose control	0.36		
wheat stems	0.27	75	0.109
wheat roots	0.18	50	0.112
tomato	0.23	64	0.095
peanut	0.30	83	0.224
sweet potato	0.24	67	0.175
potato	0.28	78	0.212
rice	0.28 - 0.30	75 - 83	0.22 - 0.17

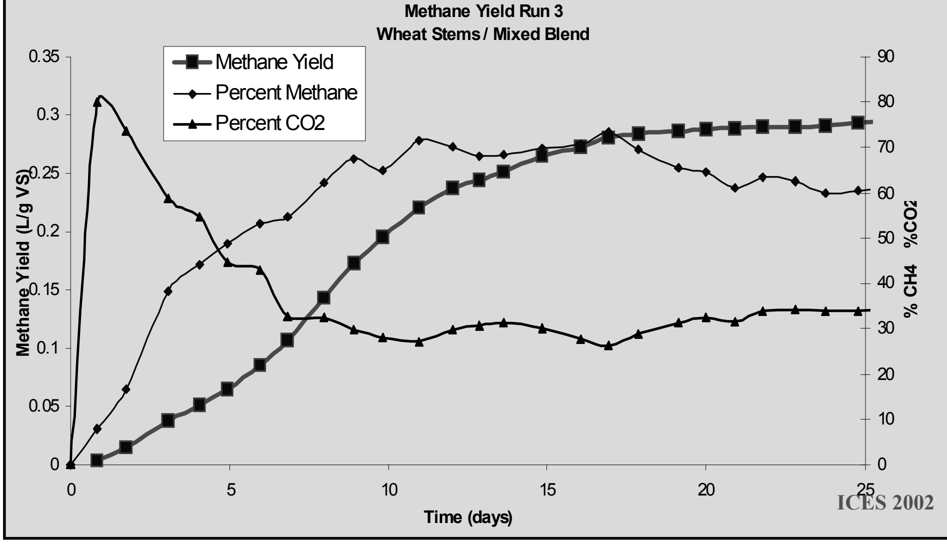
BMP DATA FOR DIFFERENT PAPER TYPES

Sample	M_y, L/g VS	k, d^{-1}
cellulose	0.37	0.14
office	0.37	0.14
news (no ink)	0.084	---
news (ink)	0.10	0.12
cellophane	0.35	0.10
food board (coated)	0.34	0.12
food board (uncoated)	0.33	0.14
milk carton	0.32	0.09
waxed paper	0.34	0.08

Performance data for a typical SEBAC run receiving 40 kg Volatile Solids from OFMSW, T = 55°C.

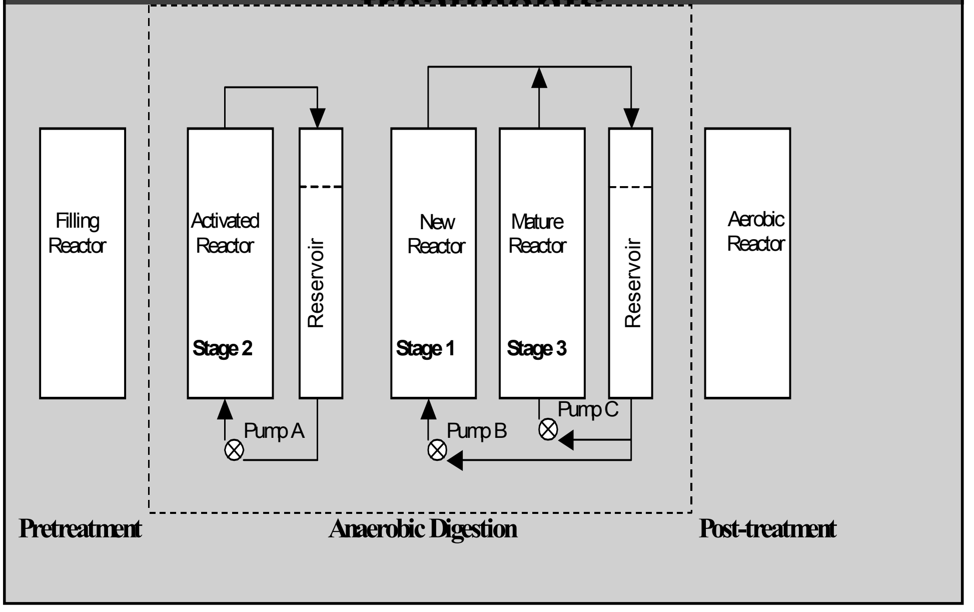


Methane Yield Flooded Operation



ICES 2002

Flooded operation SEBAC system showing 2 additional reactors for pre/post treatments



SPACE SEBAC

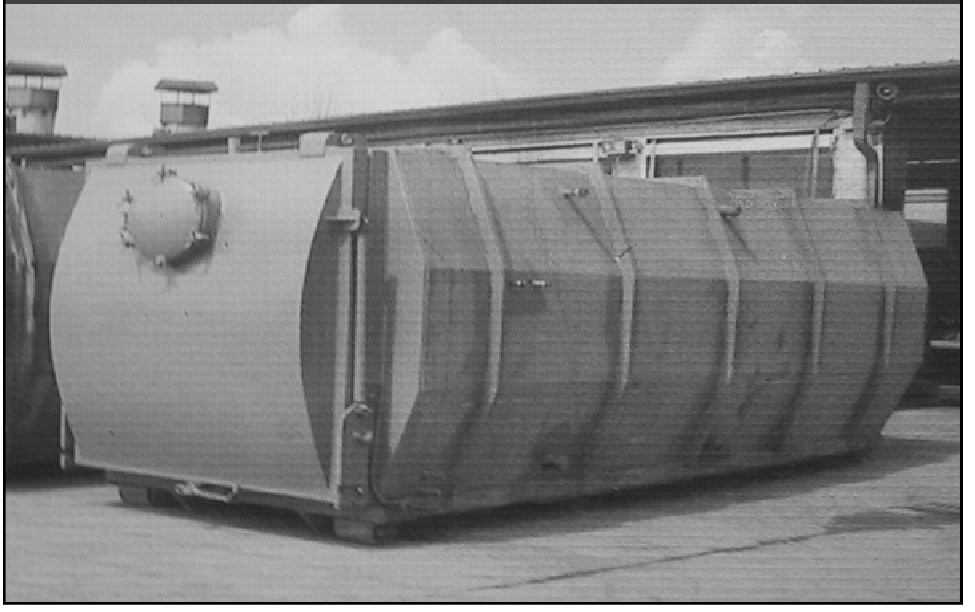
ABE students at work on prototype SEBAC reactors for NASA long-term space missions.

ARRANGEMENT OF CONTAINERS IN SMALL PLANT

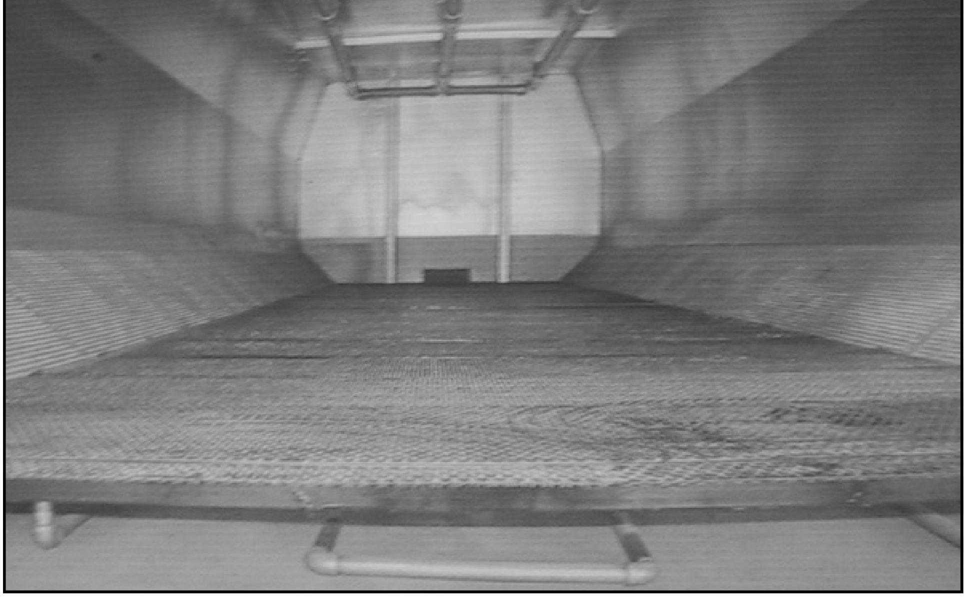
CONTAINERS (1)

CONTAINERS (2)

Single large-size container/module (27m^3) for use in a commercial SEBAC system.



INSIDE VIEW



STATISTICS FOR ANAEROBIC DIGESTION OF MSW

Parameter	Value
Population	100,000
MSW Production, tpd (wet wt.)	500
Organic Fraction, tpd (dw)	250
Methane Potential via An. Dig., m^3/d	50,000
Compost Generated, tpd (dw)	125 tpd
Land Required for Sustainable Application @ 25 tph/yr, hectares	1800

CAPACITY AND SIZE OF SEVERAL SEBAC REACTORS

EcoContainer Type	Capacity, m^3	Length, m	12-modules, Capacity, tpd
S	7.6	3.7	3
M	15.3	4.9	6
L	22.9	6.1	8
X	26.8	7.6	10

SEBAC Processing of Sugar Beet Tailings

producing

Methane for Dryer Fuel

and

Organic Compost as Value-added By-product

Potential from 100,000 tpy sugar beet tailings

100,000 tons per year	= 400 tpd
@ 20% solids	= 80 tpd solids
@ 65% organic	= 50 tpd vs
Methane production	= 17,500 m^3 pd
Compost production	= 25 tpd

Full Scale System Requirements

- 100,000 tons "tailings" per year.
- 400 tons per day.
- 16,000 ft^3 per day @ 50 lbs./(ft^3).
- 20 containers (reactors) per day @ 800 ft^3
- Assume 18-day residence time,
  plus 1-day charge and 1-day discharge.
- System will require 20 x 20 = 400 reactors.

SEBAC Processing of Poultry Layer Manure

producing

Biogas (Methane) for Energy

and

Organic Compost as Value-added By-product

Problems and Pitfalls

- **High ammonia content**
- **High sulfur content**
- **High mineral/salt content**

Solution:

- **Add nitrogen-free bulking agent as carbon source (1/1 – 5/1).**

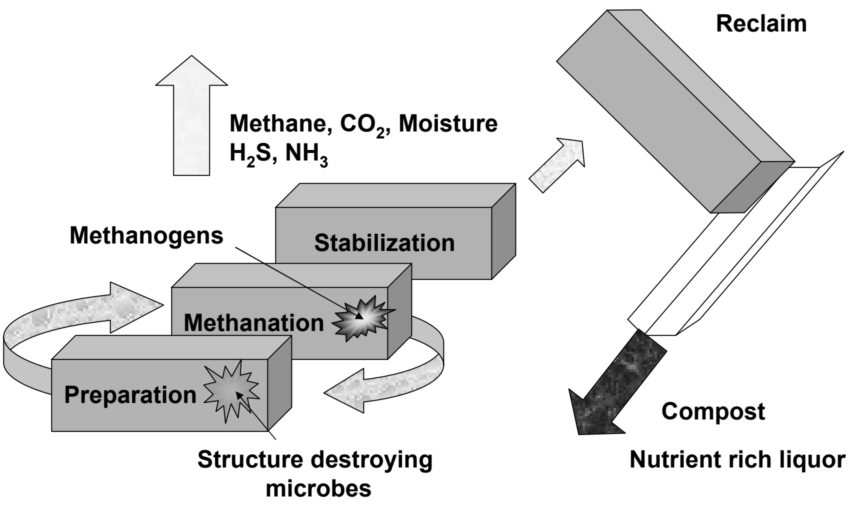
Potential from 230 tons per week poultry layer manure
[with 1/1 bulking agent (wood chips)]

Feed Stock	= 66 tons per day
Methane	= 5,540 m^3 CH_4/day
Energy Value	= 60,000 kW-hr/day
@ $ 0.05/kW-hr	= $ 3,000 /day revenue
Compost	= 12 tons per day

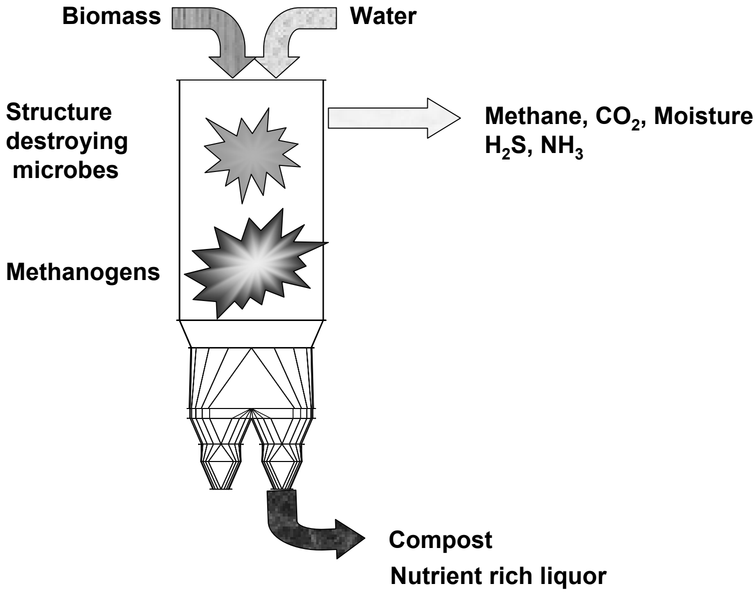
Full-scale system requirements for 230 tpw poultry layer manure (with bulking agent [1/1wood chips])

- 66 tons per day (including bulking agent).
- 3,070 ft^3 per day @ 43 lbs./(ft^3).
- 4 SEBAC containers (reactors) per day @ 800 ft^3
- Assume 18-day residence time,
  plus 1-day charge and 1-day discharge.
- System will require 20 x 4 = 80 reactors.

Batch Anaerobic Digestion



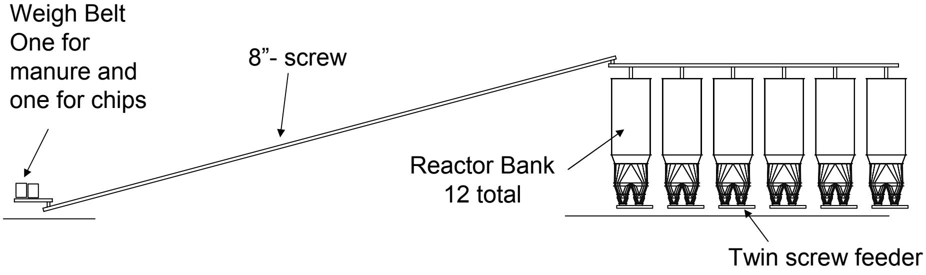
Continuous Anaerobic Digestion



Continuous	Batch
Large Scale	Small Scale
Optimal Rate	Rate losses
Small Feed System	Large Feed System
A few large vessels	Many small vessels
Permeability issues	Less permeability issues

What would your system look like?

66 tons per day feed stock --- 1/1 wood chips and manure



Methane = 190,000 (5,540 m^3) CH_4/ day
Energy = 60,000 kW-hr / day
Compost = 12 tons / day

Thank You