

SEPDI ANAEROBIC DIGESTION



RIVERBEND COLONY FARMS

LOCATED SE OF CARBERRY, MB



SAMSON ENGINEERING INC.

THE OPERATION

RIVERBEND COLONY FARMS

- 1500 ISO-WEAN FACILITY
- GENERATES ~ 14000 GAL MANURE/DAY
- 5.2M GAL / YEAR
- CONSTRUCTED A 3 M GAL STORAGE IN 2000
- EMPTY 2X PER YEAR



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THE PROJECT

DESIGN A HOG MANURE MANAGEMENT STRATEGY WITH THE INTENT OF PROVIDING A SYSTEM THAT WOULD ADDRESS THE ISSUES OF:

ODOR

PATHOGENS

SOLIDS

NUTRIENTS (N, P & K), AND

COSTS



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THE NASA PROJECT MODEL

SIM CALLING TREE

- 1 Params of motion
- 2 Sensors
- 3 Flight Software - GNC
- 4 Actuators
- 5 Aerodynamics
- 6 forces & moments
- 7 calc output params
- 8 INTEGRATE EQUATIONS OF MOTION
- 9 log data

DYNAMIC INTERFERENCE

$F = m a$
 $lbf = (slugs) \left(\frac{ft}{s^2} \right)$

$M = \frac{2}{\gamma - 1} \left[\left(\frac{P_{tot}}{P_{amb}} \right)^{\frac{\gamma - 1}{\gamma}} - 1 \right]$

compressible subsonic

CONSTANTS

Speed of sound is ONLY a function of TEMP!

Dynamic Pressure
 $q = \frac{1}{2} \rho V_{true}^2$
 (NON-COMPRESSIBLE FLOW) ($M \leq 0.3$)

FLIGHT VEHICLE CONTROL PARAMETERS

AXIS	BODY (deg) ATTITUDE	ANGULAR RATES (deg/sec)	AERO MOMENTS (ft-lb)	AERO FORCES (lbf)
X _b	φ	P	L	~ Drag
Y _b	θ	q	M	
Z _b	ψ	r	N	~ Lift

Dynamic Instability Tests Complete! No issues

→ BUILD A LITTLE / TEST A LITTLE / FIX A LITTLE

Aerodynamic Uncertainties

	α	β	γ	δ
1	+	+	+	+
2	+	+	+	+
3	+	+	+	+
4	+	+	+	+
5	+	0	+	-
6	+	+	+	-
7	-	-	-	+
8	-	-	-	+
9	-	-	-	+

Lateral Control Departure Parameter will drive Transonic Stability

Vector Alignment of uncertainty dispersions can produce laterally unstable airframe

WORST CASES FOR LIFTING BODIES!

Remember: Test sample transonic flow. Only will work. Only on TESTS!

PROGRAMMATIC

- Flight Control Working Group Thursday 3-? pm
- Software Delivery (next month) - following verification
- B-52 Drop coord. final mtg - next Tues Fri
- Flight Software Certification - SCDI guidelines - 3 Review boards - NO INSTABILITIES
- Dryden Flight Ops Review in 2 days - complete!
- Real time Config Control
- FLIGHT READINESS REVIEW - 27th (ALL DAY)
- NEXT DROP: not soon enough!! 😊



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WHAT IS SEPDI?

SEPDI IS A HYBRID FOR:

SEPARATION

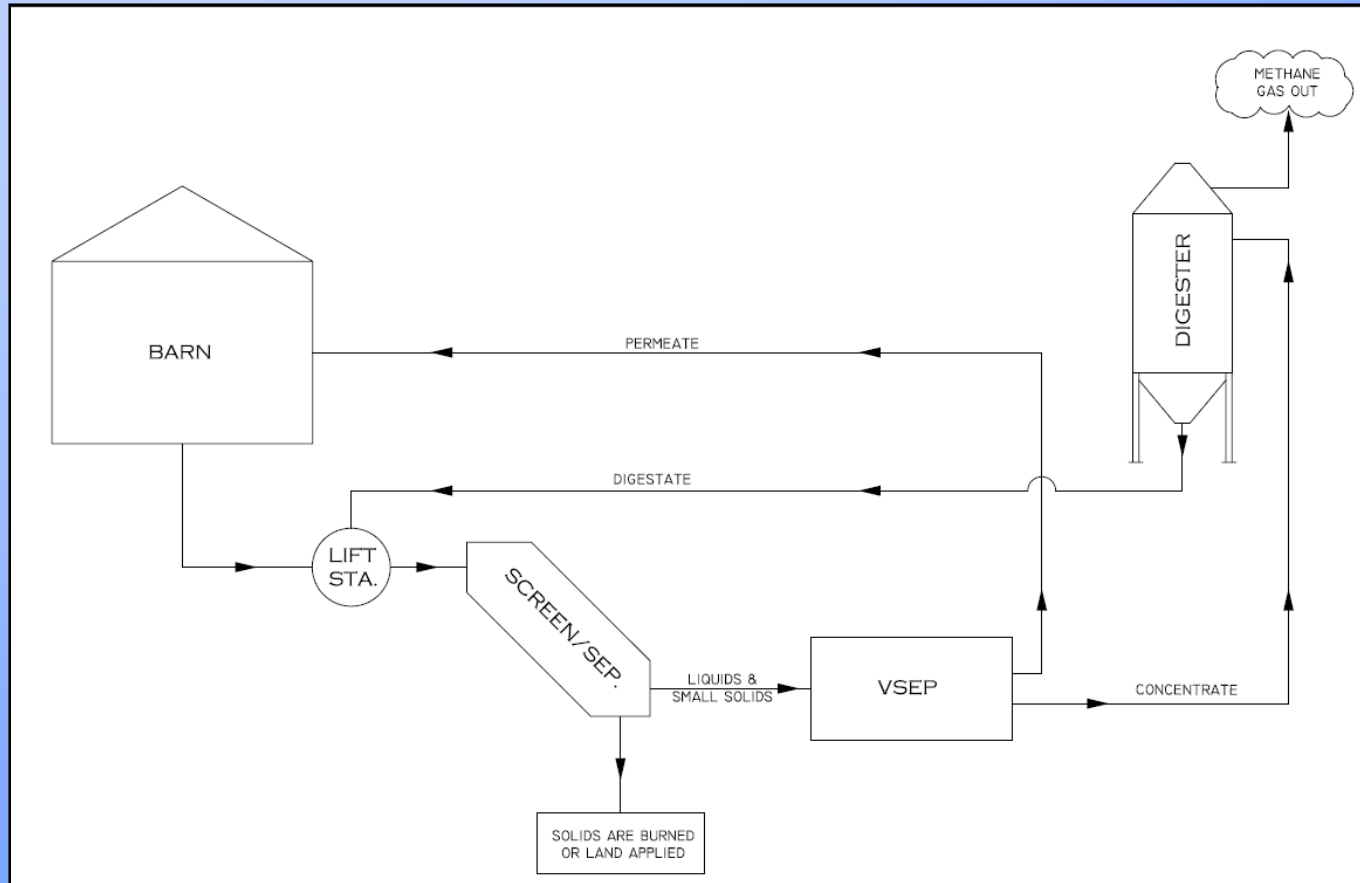
AND

DIGESTION



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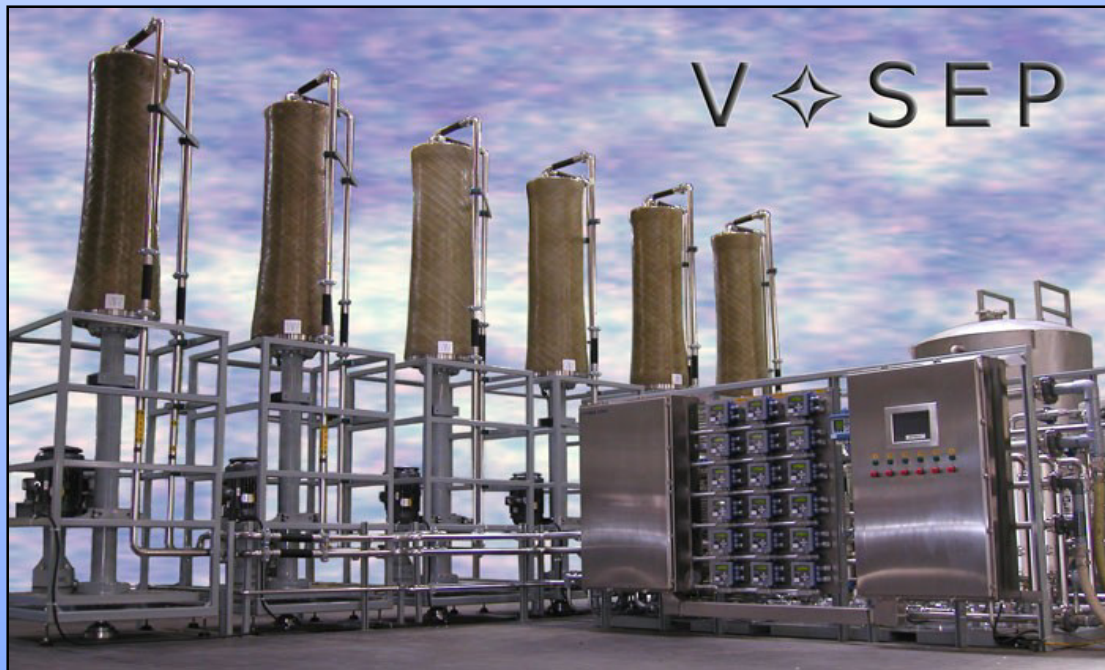
THE SEPD I SYSTEM



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HOW ?

IT'S CALLED A VSEP



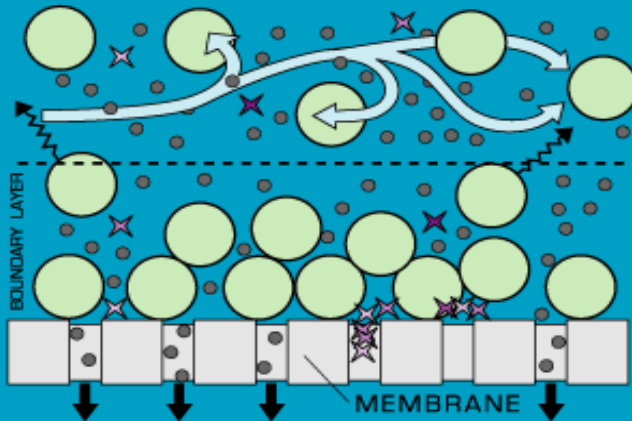
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SEPDI SYSTEM



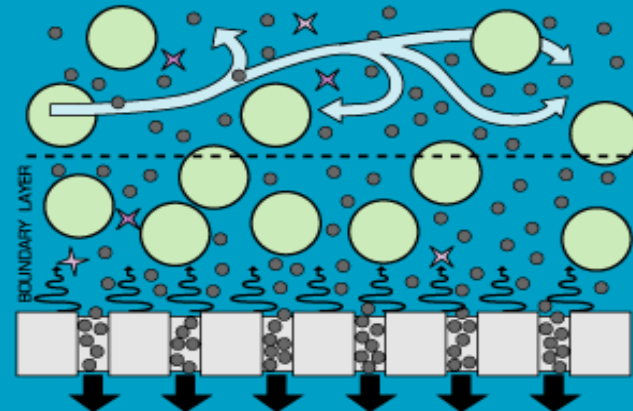
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HOW DOES IT WORK?



CROSSFLOW FILTRATION

Traditional crossflow membranes plug and foul because the majority of shear created by the turbulent flow is away from the boundary layer and cannot efficiently remove retained particles. This inefficient use of shear accounts for the eventual loss of flux over time experienced in traditional systems.



VSEP

VSEP's vibrational energy focuses shear waves at the membrane surface repelling solids and foulants within the boundary layer. This patented method allows for high concentrations while maintaining long term sustained rates up to ten times higher than conventional filtration systems.

Vibration, not brute force.



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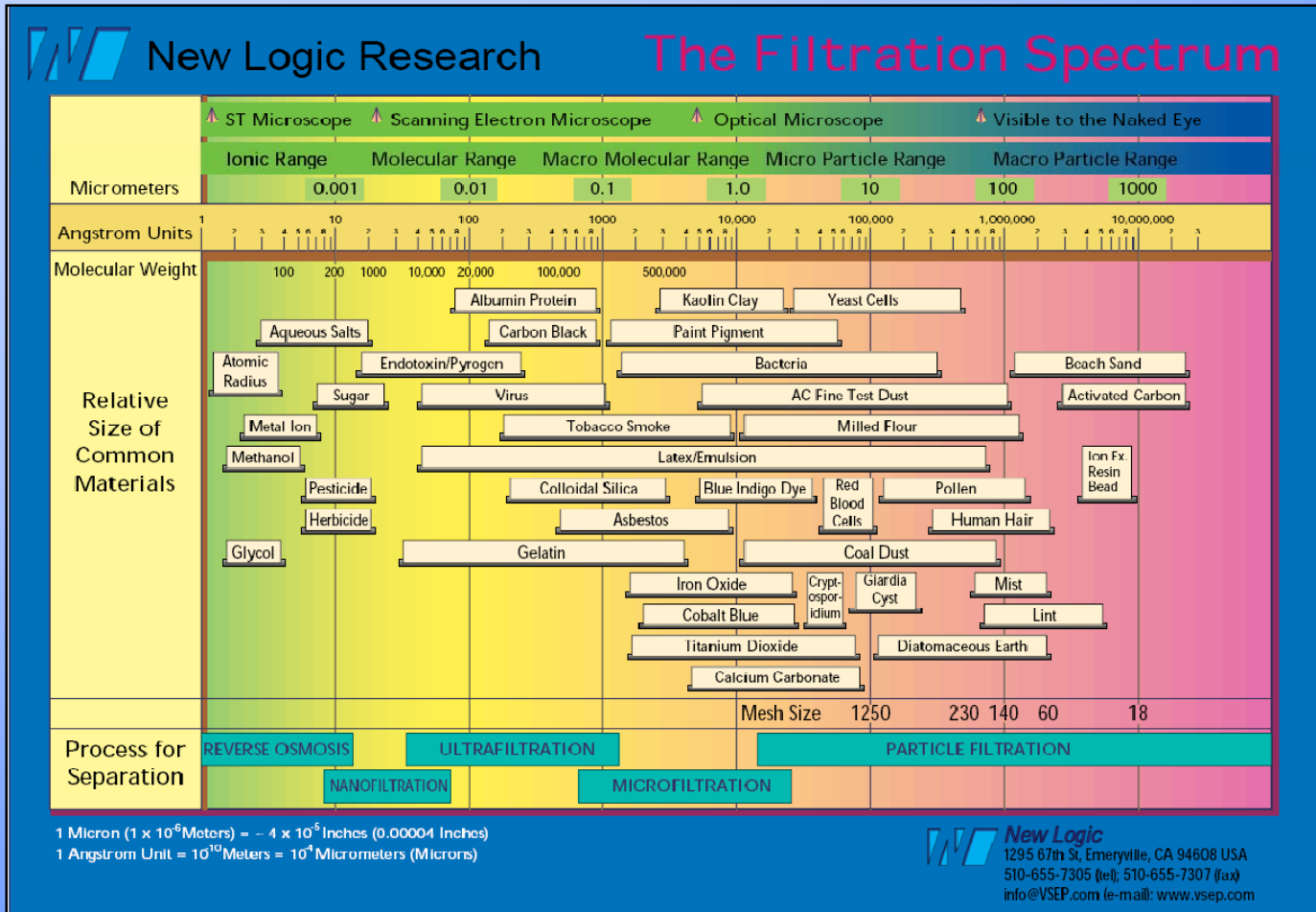
SEPDI SYSTEM

VSEP FILTER



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FILTRATION METRICS



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SEPDI SYSTEM



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SEPDI SYSTEM

ARE YOU SURE YOU WANT TO DRINK THAT?



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WATER RECYCLING PAPER

An ASABE Meeting Presentation

Paper Number: 074047

Membrane Filtration of Untreated vs. Anaerobically Digested Swine Manure

Ron Fleming

University of Guelph Ridgetown Campus
Ridgetown, Ontario, Canada, N0P 2C0

Malcolm MacAlpine

University of Guelph Ridgetown Campus
Ridgetown, Ontario, Canada, N0P 2C0



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WHY ANAEROBIC DIGESTION?

SO AS TO DEVELOP A REGIME OF BUGS THAT WILL GENERATE METHANE GAS



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HOW DOES ANAEROBIC DIGESTION WORK?

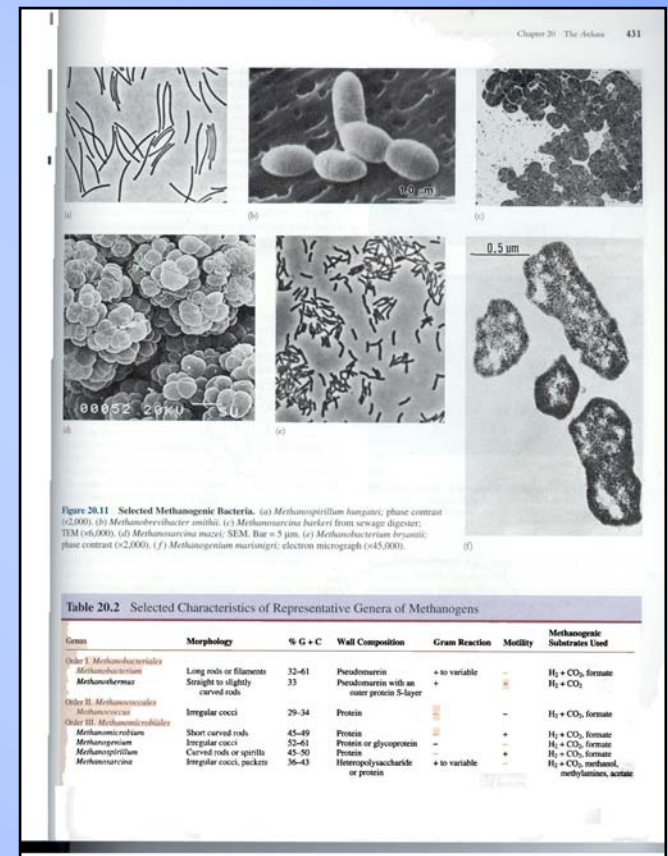
IT'S A NATURAL PROCESS

WHERE IN THE ABSENCE OF OXYGEN

LIQUEFIER BUGS

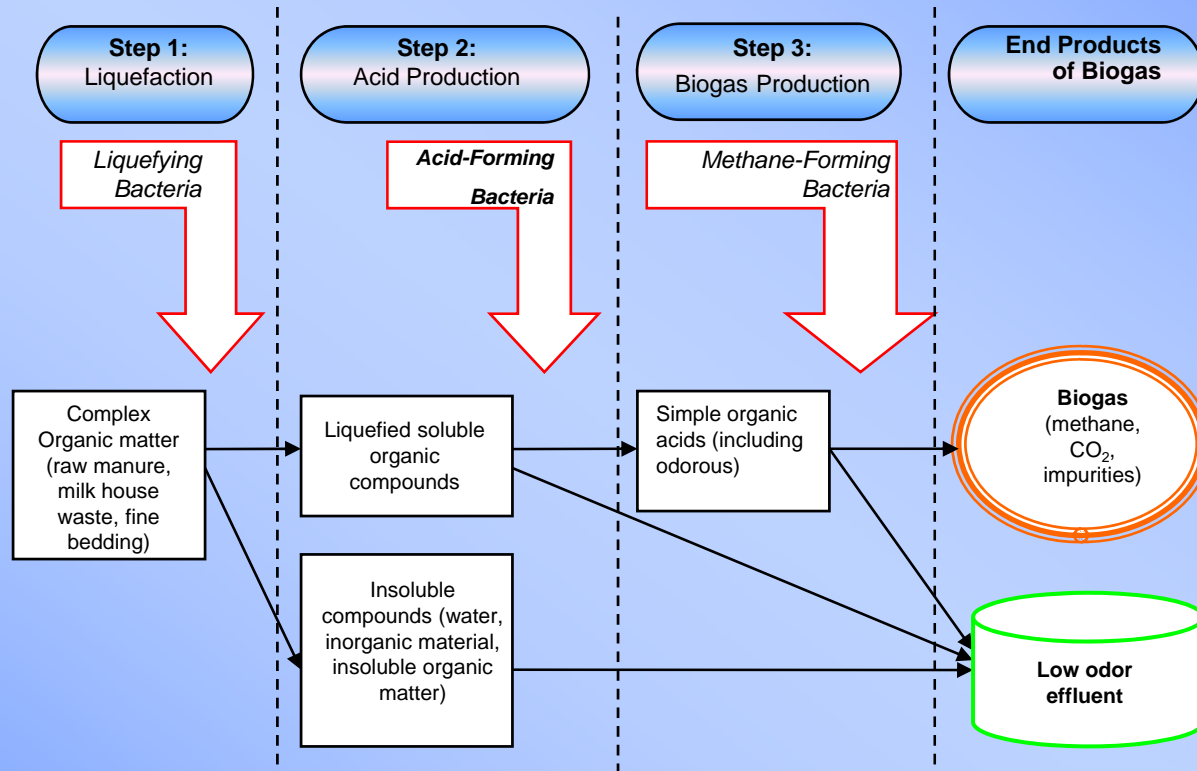
ACID FORMERS

METHANOGENIC BACTERIA



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HOW DOES ANAEROBIC DIGESTION WORK?



THE ROLE OF TEMPERATURE

PSYCHROPHILIC (COLD)

1 YEAR

- CAN GROW AT 0°C, SOME EVEN LOW AS -10°C , THEIR UPPER LIMIT IS OFTEN 25°C

MESOPHILIC (WARM)

21 DAYS

- TEMPERATURE RANGE 20°C TO 45°C

THERMOPHILIC (HOT)

3 – 5 DAYS

- TEMPERATURE RANGE OF 50°C OR MORE, MAXIMUM 70°C . THE SEPDI DIGESTER OPERATES IN THIS TEMPERATURE RANGE



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THE ROLE OF PH

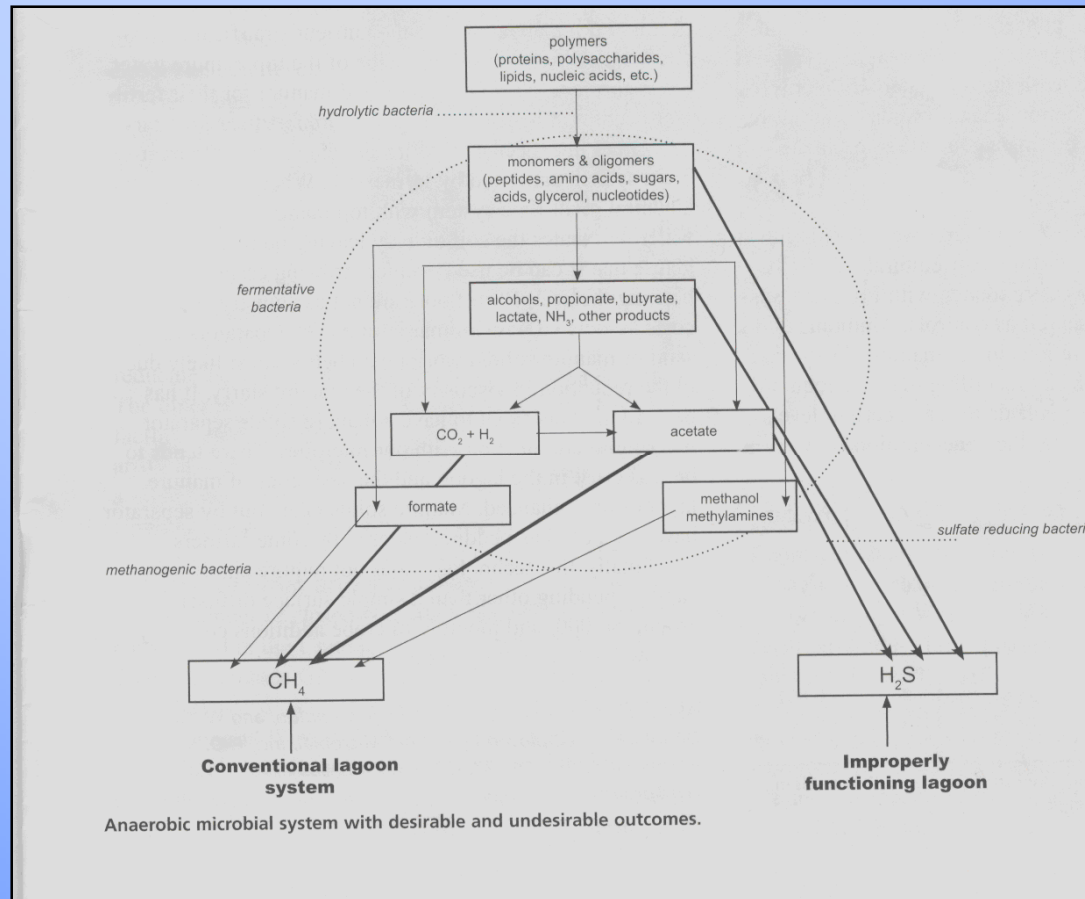
INDICATOR OF BALANCE IN THE SYSTEM



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WHAT CAN GO WRONG

WHY HYDROGEN SULPHIDE GAS IS GENERATED.



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OPPORTUNITIES

SEPMI ADVANTAGES

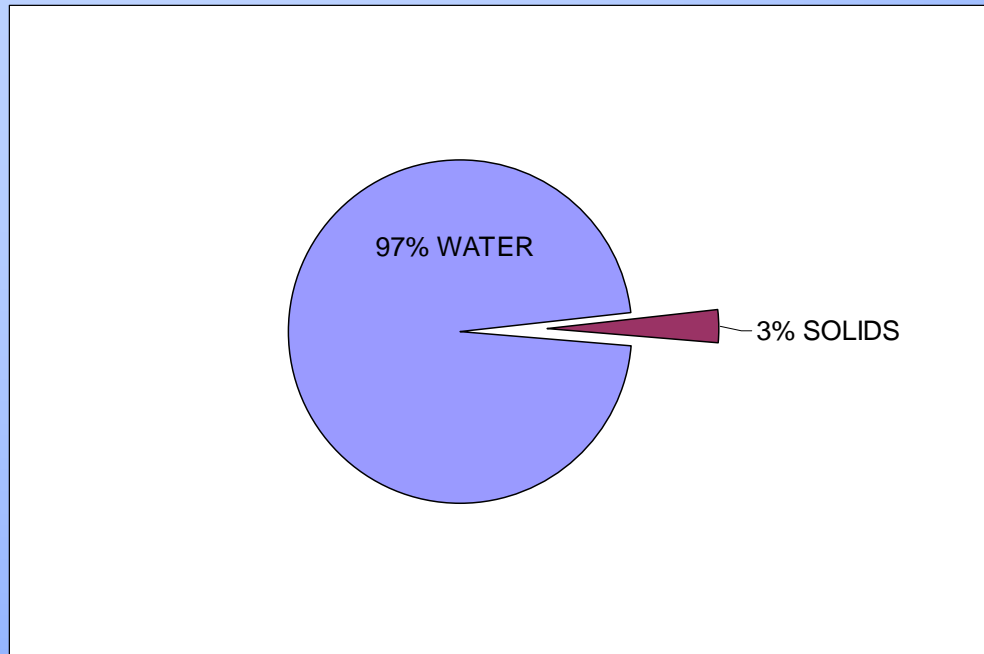
1. WATER USE REDUCTION
2. RECYCLING OF WATER
3. REDUCE DIGESTER SIZE
4. RAPID DIGESTION - THERMOPHILIC
5. LAGOON SIZE REDUCTION/ELIMINATION
6. INCREASE RETURNS



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OPPORTUNITY FOR WATER RECOVERY

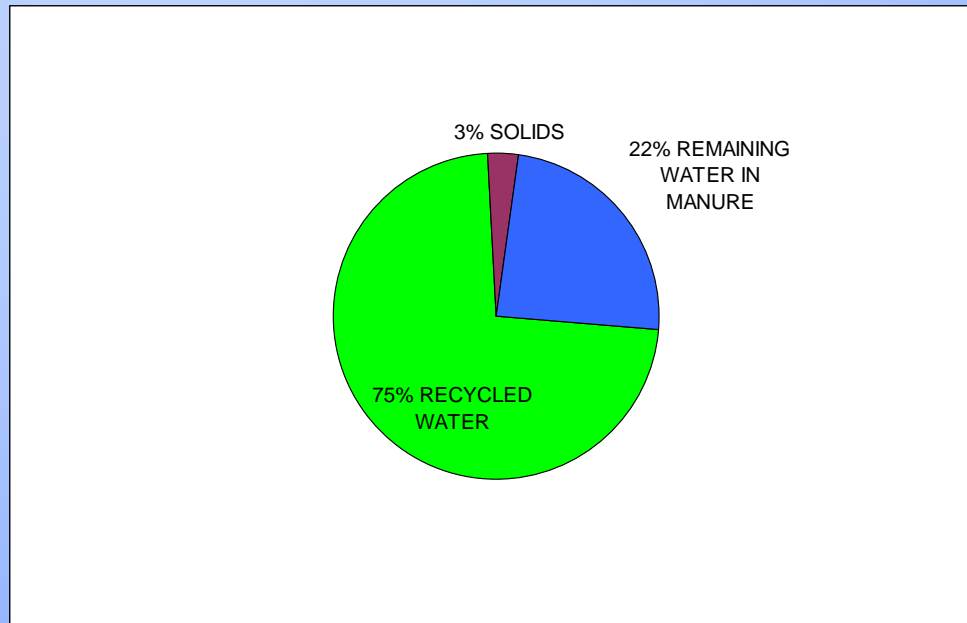
VOLUME: 14000 GAL / DAY @ ~3% SOLIDS



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VSEP WATER RECOVERY

VSEP RECOVERS 75% OF WATER IN MANURE



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CONVENTIONAL MANURE HANDLING STRATEGIES



Livestock Operation



Manure Storage (Agitation)



Manure Application

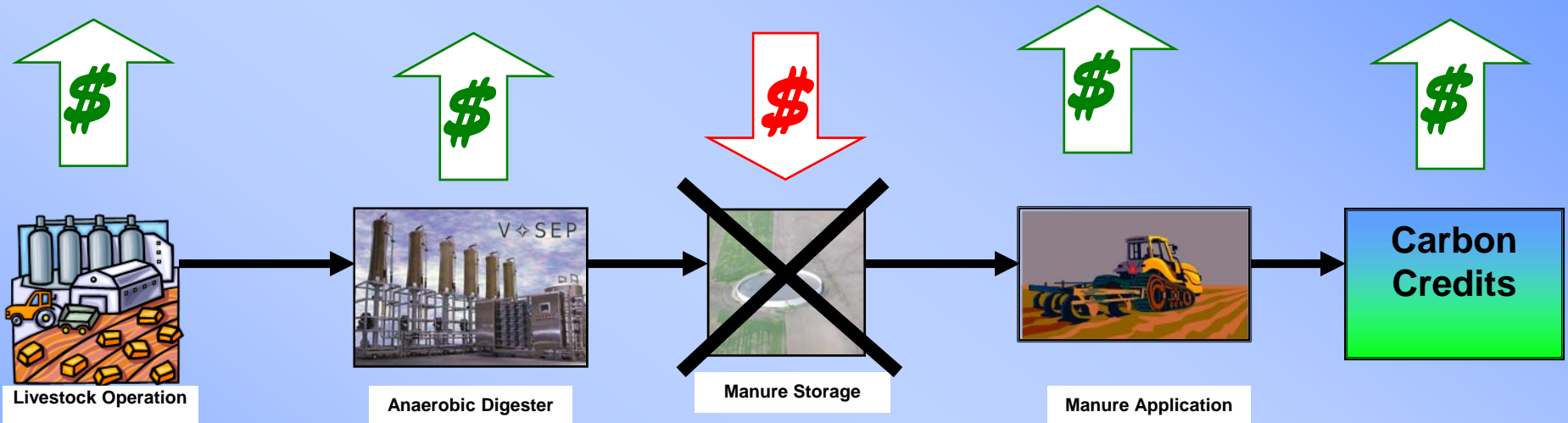
Challenges:

- Odour Solids
- Pathogens GHG
- Cost \$



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SEPDI MANURE MANAGEMENT STRATEGY



Solutions:

- Nutrient Rich Fertilizer 90% Odor Reduction
- Solids Reduction 95% Pathogen Reduction
- GHG Emission Reduction Energy \$ and Kyoto \$



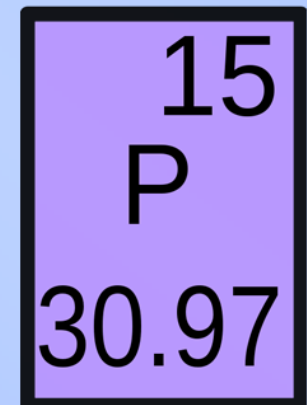
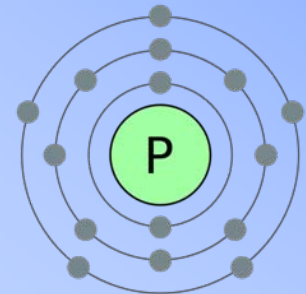
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WHAT ABOUT PHOSPHORUS?

15: Phosphorus

2,8,5

- ELEMENT # 15 OF THE PERIODIC TABLE
- IMPORTANT COMPONENT IN BONE, TEETH, DNA AND ENERGY TRANSFER IN LIVING ORGANISMS
- ESSENTIAL NUTRIENT FOR PLANT GROWTH (USED IN FERTILIZER)



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VSEP FILTERED WATER NUTRIENT CONTENT

ASABE, Paper Number: 074047

Membrane Filtration of Untreated vs. Anaerobically Digested Swine Manure, R. Fleming and M. MacAlpine

Average Nutrient Content			
<u>Parameter</u>	<u>Manure</u>	<u>Digested Manure</u>	<u>Recovered Water</u>
NH ₄ -N (mg/kg)	2200	2000	130
TKN (%,"as is")	0.36	0.27	0.011
Phosphorus (%,"as is")	0.085	0.027	0.0
Potassium (%,"as is")	0.26	0.21	0.0
Dry Matter (%,"as is")	3.1	1.3	.02
E.C. (mS/cm)	16	14	1.1
pH	7.9	8.3	8.5



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ALS ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	By	Batch
L608036-1 #1 RIVERBEND ANAEROBIC DIGESTOR SLUDGE								
Sampled By: CLIENT on 03-MAR-08								
Matrix: waste								
Ammonia as N	32		1	lb/1000gal	13-MAR-08	13-MAR-08	JRB	R641295
% Moisture	84.5		0.5	%	13-MAR-08	13-MAR-08	JRB	R641001
Total Kjeldahl Nitrogen	10.8		0.1	lbs/ton	14-MAR-08	14-MAR-08	JRB	R641298
Total P,K & S - solid manure- as rec'd								
Phosphorus (P)	1.2		0.2	lbs/ton	13-MAR-08	13-MAR-08	DAD	R640583
Potassium (K)	0.2		0.2	lbs/ton	13-MAR-08	13-MAR-08	DAD	R640583
Sulfur (S)	0.3		0.2	lbs/ton	13-MAR-08	13-MAR-08	DAD	R640583
L608036-2 #2 RIVERBEND ANAEROBIC DIGESTOR SLUDGE								
Sampled By: CLIENT on 03-MAR-08								
Matrix: waste								
Ammonia as N	33		1	lb/1000gal	13-MAR-08	13-MAR-08	JRB	R641295
% Moisture	84.2		0.5	%	13-MAR-08	13-MAR-08	JRB	R641001
Total Kjeldahl Nitrogen	10.6		0.1	lbs/ton	14-MAR-08	14-MAR-08	JRB	R641298
Total P,K & S - solid manure- as rec'd								
Phosphorus (P)	1.8		0.2	lbs/ton	13-MAR-08	13-MAR-08	DAD	R640583
Potassium (K)	0.2		0.2	lbs/ton	13-MAR-08	13-MAR-08	DAD	R640583
Sulfur (S)	0.3		0.2	lbs/ton	13-MAR-08	13-MAR-08	DAD	R640583
* Refer to Referenced Information for Qualifiers (if any) and Methodology.								



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SEPDI PHOSPHORUS CONTENT

- SEPDI DIGESTER SLUDGE CONTAINS 1.5 LBS OF PHOSPHORUS/TON OF SLUDGE ON AVERAGE.
- RANGE OF CROP P REQUIREMENTS:
40 -105 LBS OF P/ACRE
- RANGE OF VOLUME OF SEPDI DIGESTER SLUDGE PER ACRE:
(P-BASED APPLICATION) 6000 -17,500 GAL/ACRE.



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WHAT ABOUT COSTS?



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GAS POTENTIAL SCHEDULE

Biogas Production Estimate - Riverbend Colony Farms

Livestock Type	No. of Livestock	Solid %	Manure Volume Produced		Methane Volume Produced m3 / year	\$ Value
			ft3 / head / day	m3 / year		
Hogs - Isowean	1,500	4.5	1.5	23,360	269,892	\$91,763
Pullet (caged)	11,000	21	0.001	156	12,149	\$4,131
Layers (caged)	8,000	25	0.004	327	17,542	\$5,964
Totals				12,786	299,584	\$101,858



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SEPDI SYSTEM

METHANE GAS

MANITOBA 2 – 4 CENTS / KWH

ONTARIO 11 CENTS / KWH



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PAYBACK CALCULATIONS

Capital Cost	\$ 700,000.00
Est. Operation & Maintenance Cost	\$ 25,000.00
Total Costs	\$ 725,000.00
Electrical Energy Value	\$ 70,434.00
Thermal Energy Value	\$ 17,946.00
Manure Application Savings	\$ 66,000.00
Total Potential Benefits	\$ 154,380.00
Simple Payback Period (years)	4.53






- 1) VSEP Operating Cost ~ \$4/1000 gallon ~ \$1.00m³
- 2) Costs to Build Manure Storage Facility ~ 10¢ - 20¢/gallon



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ARE WE MEETING OUR OBJECTIVES?

ENVIRONMENTAL AND ECONOMIC BENEFITS

- SOLIDS  VSEP REMOVES 98% OF SOLIDS FROM SWINE MANURE
- ODORS  ODOR REDUCTION
- PATHOGENS  VSEP FILTRATION HAS BEEN PROVEN TO REMOVE VIRUSES FROM FILTERED WATER. MICROBIAL TESTS FROM SEPDI ARE YET TO BE PERFORMED
- NUTRIENTS  EFFECTIVE NUTRIENT MANAGEMENT
- COSTS  COST SAVINGS



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QUESTIONS ?



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