ASSESSING THE USAGE OF CLEAN DRYWALL IN THE COMPOST PROCESS

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Purpose

- To determine the technical and economic viability of adding clean waste drywall to the compost process
- To assess the impact of drywall on three types of compost processes:
  - Infrequently mixed, continuously aerated drums
  - Intermittently mixed, continuously aerated reactor
  - Static, continuously aerated industrial system
- To establish a maximum rate of drywall inclusion
- To determine the impact on product quality.

Drywall

- Wallboard, gyproc, gypsum board or sheet rock
- Plaster core primarily made of gypsum, or calcium sulphate dihydroxide ($CaSO_4 \cdot 2H_2O$)
- Drywall a sandwich—consisting of two outer sheets of heavy paper and the core of plaster
- Consists of 85–90% gypsum (inorganic) and 7–15% paper (organic) (Dillon Consulting Ltd., 2006)
- Unlike limestone ($CaCO_3$) does not change the soil's acidity levels
- Can be reformed into new drywall
- Natural and synthetic sources.

Benefits of Composting Drywall

- Drywall removes potential source of H_2S gas from C&D sites
- Upgrades the use of a waste product
- Absorbs *some* compost moisture
- Increases calcium and sulphur content
- Improves quality of alkaline soils by removing excess sodium (Planet Natural).

Drywall Waste

- Sources: construction sites (clean) & demolition sites (contaminanted?)
- USEPA estimates that drywall constitutes 5–15% of the C&D waste stream
- One pound of drywall waste is produced from each 1 ft^2 of covered wall (WasteCap Wisconsin Inc., 2005)
- Each new house produces approximately one ton of drywall waste Wolkovski (2003).

Drywall Waste (con't)

- NS produces 15,000–17,700 tonnes / year
- Canada produces 496,000–585,000 tonnes / year
- 15% of the C&D waste from new construction (Halifax C&D Recycling Ltd.)
- 2,500 tonnes of clean drywall is disposed of annually in Nova Scotia and 81,000 tonnes in Canada.

CONSTITUENTS

Constituent (lbs/ton)	Ground Drywall	Agricultural Gypsum
Calcium	444-456	534-570
Sulphur	320-328	402-424
Phosphorous	0.4-0.6	0.4
Potassium	1	0.1-0.2
Magnesium	11	3-3.8
Iron	4.24-4.82	0.94-1.61
Manganese	0.2-0.3	0.07-0.1
Boron	0.03-0.04	0.17-0.19
Sodium	1.8	1.8-2.0

University of Georgia, 2002

Heavy Metals

Metal	Drywall (mg/kg)	CCME Category A Compost (mg/kg)
Lead	< 4	150
Cadmium	<0.4	3
Nickel	<1 – 12.2	62
Chromium	1.1-1.5	210
Mercury	0.015 – 0.024	0.8

Thoresen, 2001

Past Work: Wisconsin Department of Natural Resources

- Study on drywall as substitute for agricultural gypsum
- Gypsum serves as a fertilizer and a soil amendment (calcium and sulphur are essential plant nutrients)
- Will not artificially increase the alkalinity
- Application based upon sulphur content of soil and the sulphur needs of the crop
- Crushed wallboard application rates of 2-5 ton / acre.

Past Work: Clean Washington Center and E&A Environmental Consultants, Inc. (1997)

- Four outdoor, aerated, static 21-yd^3 bins
- Four different mixtures (12.5-37.5% vol) of biosolids, gypsum and yard waste composted over eight weeks
- No substantial impact on compost process, expected increase in calcium
- Recommended use of drywall as a bulking agent, a means to balance (C:N) ratio and absorb excess water.

Trial #1: Experimental Design

Recipe

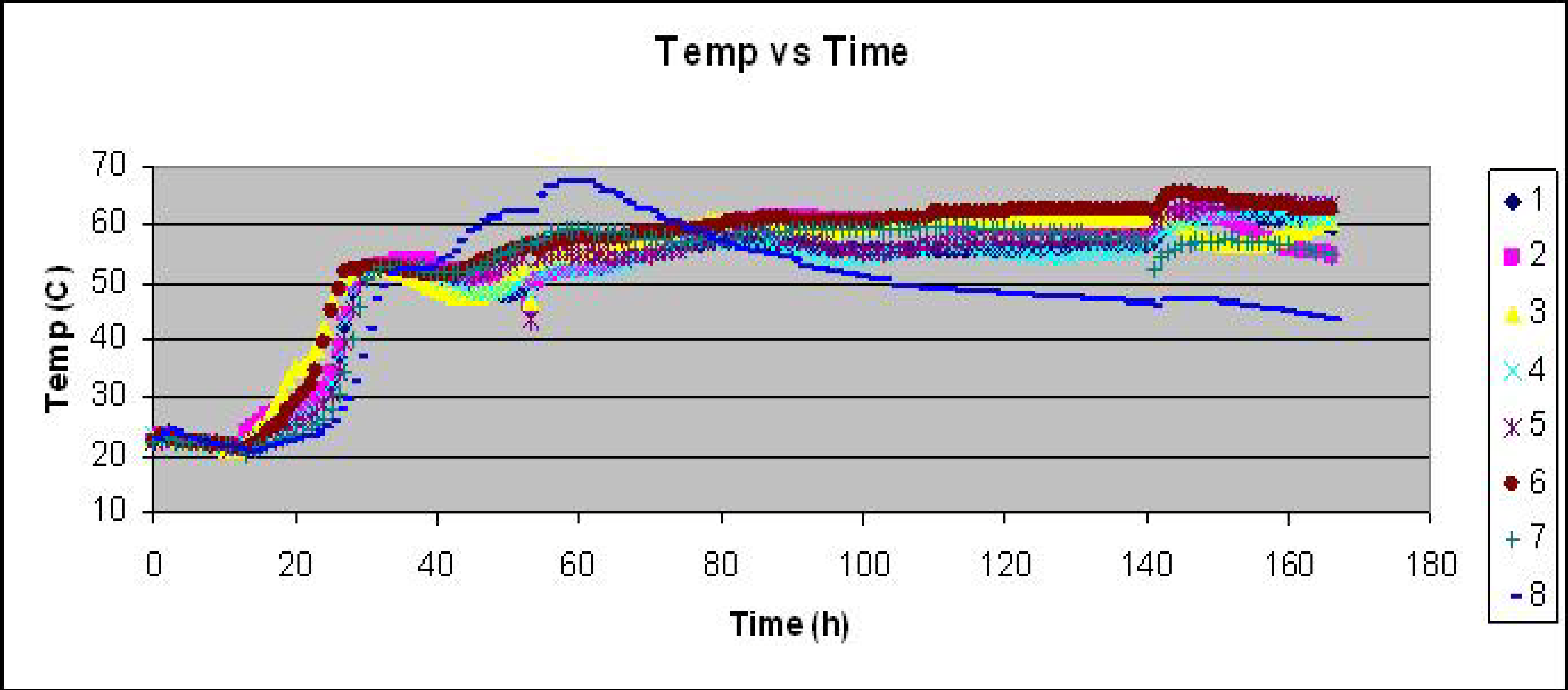
- Grass:wood chips:food=1:3.5:3.1
- 48.5 kg / reactor
- 55% moisture overall (Grass 67%, wood chips 20%, food 90%)
- Aerated continuously @ 10 L / minute
- Agitated by hand daily.

Reactors

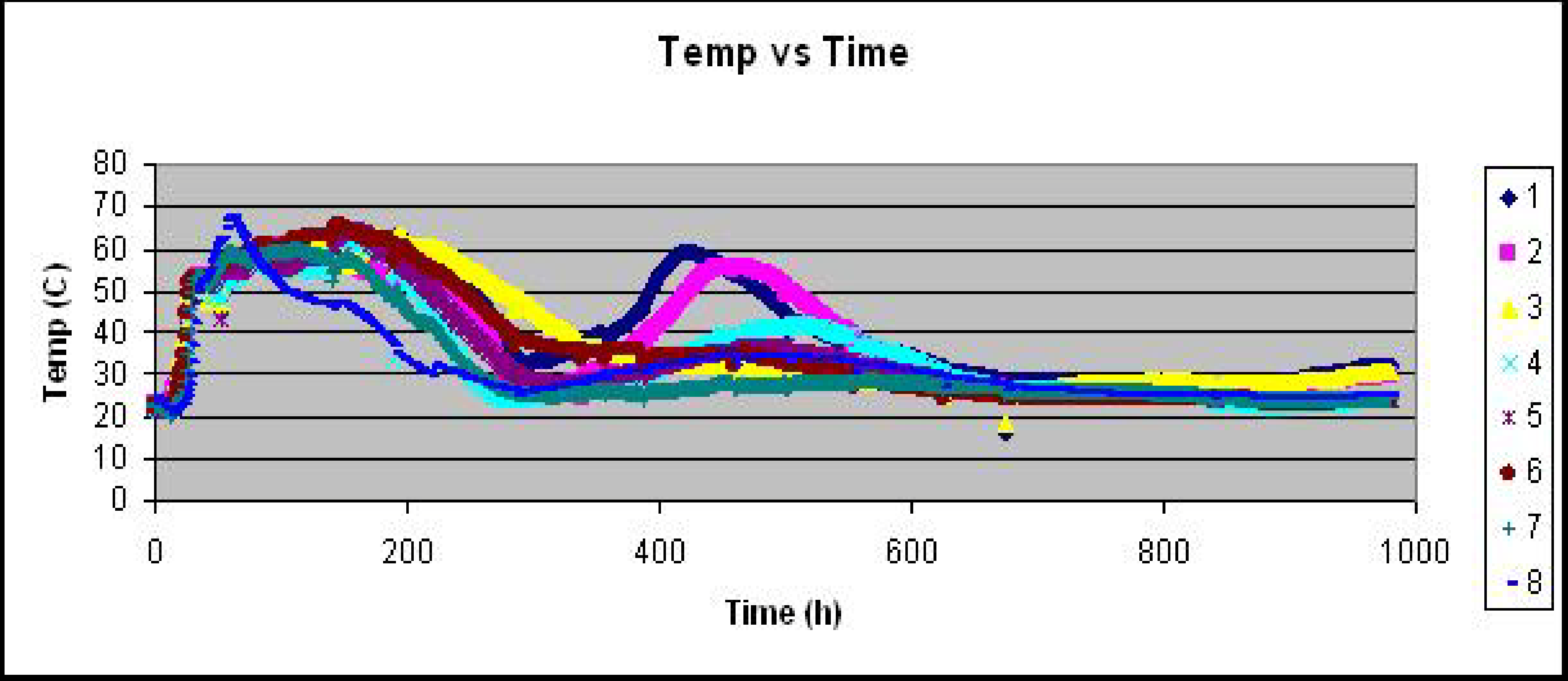
Organic Matter

Bioreactor	% Drywall	Organic Matter Content %
#1	0	89.30
#2	5	82.10
#3	10	67.24
#4	15	59.92
#5	20	58.82
#6	25	49.7
#7	30	46
#8	35	43

Short Term Temperature Profiles



Long Term Temperature Profiles



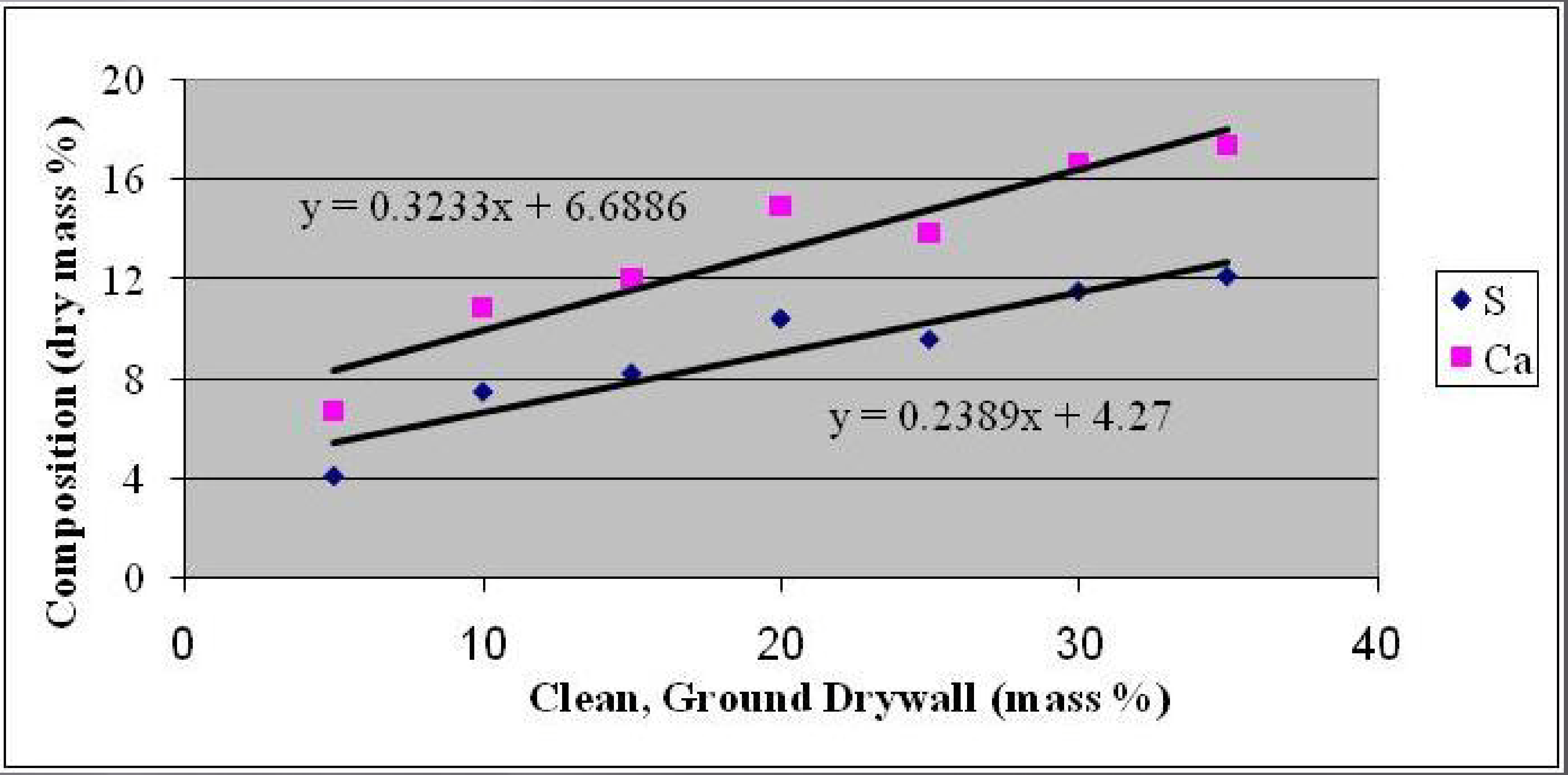
Assessment After 40 Days

Sample	Moisture (%)	CO_2	NH_3	Maturity Index	
Bioreactor 1	48.54	4	5	4	Immature
Bioreactor 2	47.31	4	5	4	Immature
Bioreactor 3	49.12	4	5	4	Immature
Bioreactor 4	52.27	6	5	6	Mature
Bioreactor 5	52.84	7	5	7	Very Mature
Bioreactor 6	52.39	7	5	7	Very Mature
Bioreactor 7	46.24	7	5	7	Very Mature
Bioreactor 8	50.01	7	5	7	Very Mature

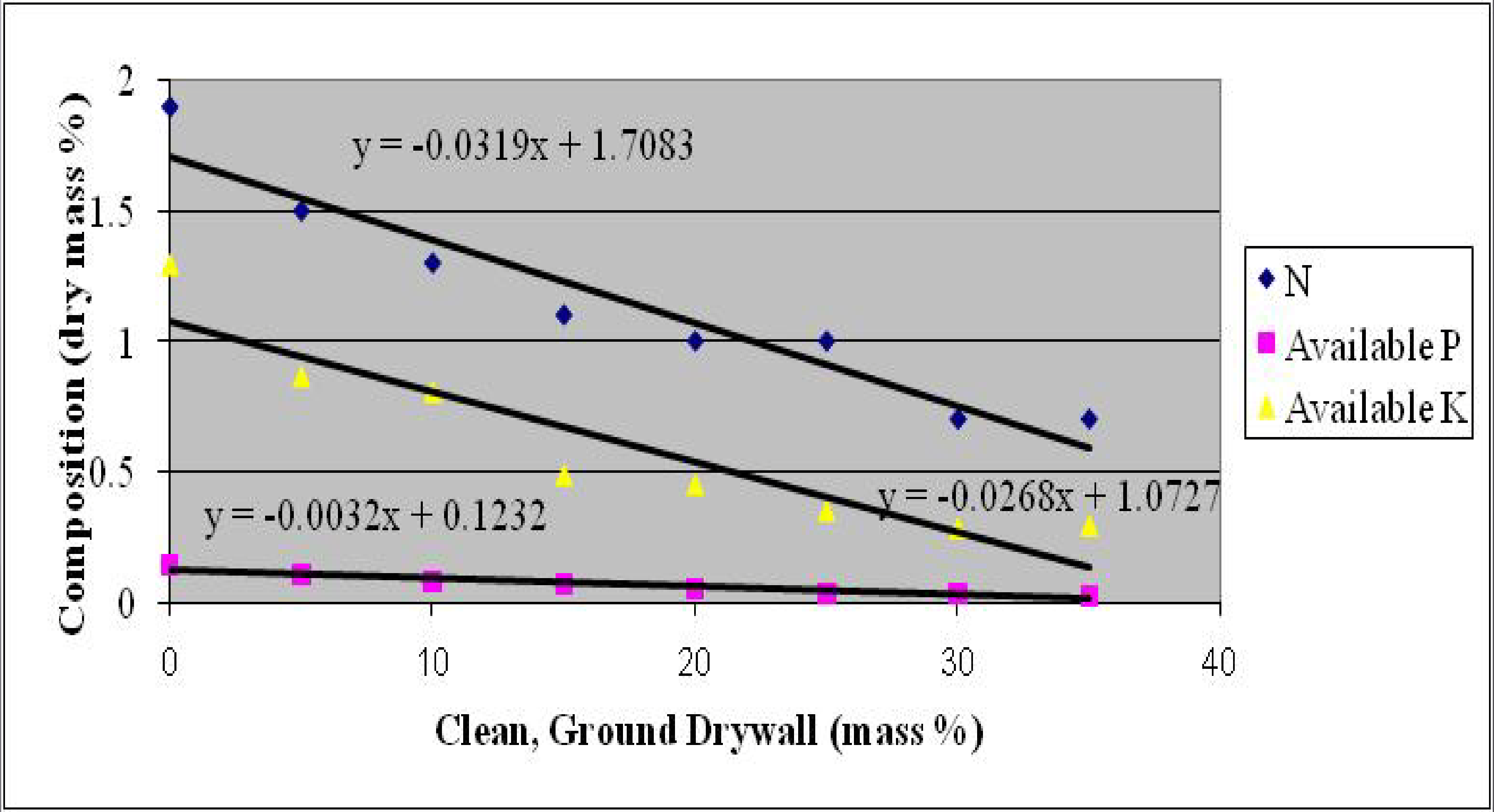
Metals

			mg/kg										
Reactor	S (%)	Ca (%)	As	Cd	Cr	Co	Cu	Pb	Hg	Mb	Ni	Se	Zn
1	0.2	1.1	<1	0.3	7	<1	23	4	<0.05	1.2	8	<0.5	138
2	4.1	6.7	<1	0.3	8	2	20	7	<0.05	1.5	9	<0.5	206
3	7.5	10.8	<1	0.2	8	3	20	9	<0.05	1.2	8	<0.5	134
4	8.2	12.0	<1	0.3	7	2	18	9	<0.05	1.1	6	<0.5	150
5	10.4	14.9	<1	0.3	5	2	12	5	<0.05	0.7	5	0.6	103
6	9.4	13.6	<1	0.2	7	2	11	10	<0.05	0.7	5	<0.5	81
7	11.5	16.6	1	0.2	7	4	16	25	<0.05	0.7	7	<0.5	116
8	12.1	17.3	<1	0.2	8	3	15	17	<0.05	0.8	7	<0.5	107
Class A Limit			**13**	**3**	**210**	**34**	**100**	**150**	**0.8**	**5**	**62**	**2**	**500**

Rate of Increase in Ca and S



Rate of Decrease in N, P and K



Trial #2:
Pilot Scale Reactor Run

- 0.2 RPM and 10 L / minute
- 30% drywall (mass)

Process Analysis

	Time (h)							
	0	**24.3**	**53**	**82**	**100**	**124**	**146**	**215**
Reactor Temperature (^{o}C)	27	40.5	57	30	25	25	24	
Compost pH	6	6.5	7.1	6.7	6.7	6.7	6.8	
Moisture Content (%)	45	46	38	44	42	41	41	Emptied Reactor
Condensate Collected (mL)		328	926	432				
Condensate pH		7.5	7.6	8				

Product Analysis

	Feedstock		Product	
	Mass (kg)	Volume (L)	Mass (kg)	Volume (L)
Organics	16.1	39.52		
Drywall	8.7	17.5		
Total	24.8	57.02	21.27	47.84
14.2% Mass Reduction				
16.1% Volume Reduction				

Trial #3: Industrial Application

- New Era Technologies
- 25,000 t / yr

Recipe

- 9 tonnes drywall + 18 tonnes SS organics
- Static pile, continuously aerated

Process Analysis

	Day								
	1	2	3	4	5	6	9	10	12
Condensat pH With Drywall	5.4	5.3	5.2	5.3	5.5	5.7			5.8
Condensate pH Without Drywall	4.9	4.8	5.1	5.4	5.4				5.1
Temperature with Drywall	40	42	49	49	51	48	54	53	
Temperature without Drywall	37	49	55	57	60	57	57	38	47

Product Analysis

	With Drywall	Without Drywall
Empty Container (kg)	8780	9030
Full Container (kg)	35080	36110
Mass Organics/Drywall	26300	27080
Total Mass After Processing	31560	29170
Weight Organics/Drywall Lost	3520	6940
% lost	13%	26%
Processing Time (days)	12	12

Synthetic Gypsum

- Decrease soil acidity increasing availability of P, Ca, Zn, Mg, Cu; better penetration of $CaSO_4$ than $CaCO_3$
- Produced from power plants (Colson Cove, Belledune) as by-product of air pollution control

$$CaCO_3 + SO_2 + \frac{1}{2} O_2 \rightarrow CaSO_4 + CO_2$$

- Source of most of gypsum for drywall in Maritimes
- Contains micro-contaminants
- US EPA approval; chemical analysis be provided
- Cautions: excessive Ca, B, As, Cd, Cr, Ni, Pb, Se, V.

Conclusions

- Clean drywall can be added to the compost process (<30% by mass) without inhibition providing an alternative that is more responsible than C&D disposal or landfilling
- The amount of drywall included in the compost process is less dependent on microbial suppression and more dependent upon the facility's ability to maintain aerobic conditions throughout the pile.

Conclusions

- Obvious increase in Ca & S, decrease in C
- Product application rates based upon S and Ca tolerances of receiving environment
- Metals of little concern in natural gypsum; *may be* of concern with synthetic gypsum .

Recommendations

- Notwithstanding the detection of unacceptable contaminants or process constraints, clean drywall can be added to compost processes up to 30% by mass
- Synthetic gypsum products should be tested at source for known possible contaminants prior to inclusion in a compost process
- Test results should be submitted to provincial environment departments to develop a database and establish “average” values
- On-going research should be monitored to determine future policy.

Thanks To……

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- New Era Technologies