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# LABORATORY REPORT

**A**dvanced  
**M**aterials  
**C**enter, Inc.

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**Client:** KTM Industries  
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**Date:** December 7, 2007

**Project #:** 07P1178-ASTM D 5338

## Purpose:

Evaluate the ASTM D 6400-04 biodegradation of a foam sheet and adhesive exposed for 64 days to Aerobic Composting (Biodegradation) per ASTM D-5338 @  $58 \pm 3$  °C through contact with compost medium. Compare the results to the biodegradation rate of a positive control of cellulose.

## Sample Identification:

- A. Positive Cellulose Control - One (1) Each
- B. Foam Sheet - Two (2) Each
- C. Adhesive - One (1) Each

## Source:

KTM Industries  
KTM Industries

## Conclusions:

**In our opinion, based on the overall weight loss and carbon conversion of the foam and adhesive, the ASTM D 6400 requirements have been met in the 64 day exposure time. The 90% weight loss and carbon conversion have been achieved by the materials being exposed in the compost.**

## Results :

Sample A (Positive Cellulose Control) has achieved the 90% carbon conversion and weight loss requirement for a compostable material per ASTM D 6400-04.

Sample B (Foam Sheet) has achieved the 90% carbon conversion and weight loss requirement for a compostable material per ASTM D 6400-04.

Sample C (Adhesive) has also achieved the 90% carbon conversion and weight loss requirement for a compostable material per ASTM D 6400-04.

**The Aerobic Biodegradation per ASTM D 5338 @  $58 \pm 3$  °C of the test samples yielded the following based on (%) carbon conversion (Also refer to Table II and Figure I for individual sample details):**

<u>Sample:</u>	<u>Description:</u>	<u>Carbon Conversion (%)</u> <u>(Based on CO<sub>2</sub> Production)</u>
A	Positive Cellulose Control - 1 Sample	91.46%
B	Foam Sheet - Two (2) Samples (Avg)	93.21%
C	Adhesive - One (1) Sample	117.60%

**The test samples % weight loss of those recovered (Refer to Table I and Figure II):**

<u>Sample:</u>	<u>Description:</u>	<u>% Weight Loss</u>
A	Positive Cellulose Control - 1 Sample	100.00%
B	Foam Sheet - Two (2) Samples (Avg)	91.13%
C	Adhesive - One (1) Sample	98.20%

**Discussion:**

The evaluation of the samples were run per ASTM D-5338 at  $58 \pm 3$  °C per the Tier Two Level testing per ASTM D 6400-04. Samples weighing approximately 1.0-2.0 g were placed into 90 g of wet composting material. Composting material was obtained from Monterey Mushrooms Inc. in Princeton, IL. The composting medium had a Carbon: Nitrogen ratio of 14 :1, which was within the specifications for this test. The pH of the compost material was 7.2 with a total dry solids percentage of 50% when dried at 105 °C until constant weight was achieved and was within the 50%-55% range. The volatile solids had a dry matter content of 30% which was under the 70% allowed. Samples had degraded in the compost material for 64 days. Figure I represents the cumulative CO<sub>2</sub> production of the cellulose samples as well as the tested materials. Figure II exhibits the % weight loss that was calculated over the 64 day testing period.

The cellulose control had total degradation. The carbon conversion (%) for the cellulose was normal for this test and also confirmed a viable, active compost mixture. The carbon conversion value was over the **90%** requirement for this type of material.

The amount of carbon from sample A (Positive Cellulose Control) converted to CO<sub>2</sub> during the test had an average of **91.46%** of the total carbon present in the sample.

The amount of carbon from sample B (Foam Sheet) converted to CO<sub>2</sub> during the test had an average of **93.21%** of the total carbon present in the sample.

The amount of carbon from sample C (Adhesive) converted to CO<sub>2</sub> during the test had an average of **117.60%** of the total carbon present in the sample. This value also represents that priming effect took place, which is CO<sub>2</sub> produced by bacteria feeding on each other and the compost.

The efficiency of CO<sub>2</sub> produced compared to the maximum theoretically calculated CO<sub>2</sub> which should have been produced had an average of **91.46%** for sample A (Cellulose) since a very large amount of the sample had degraded.

The efficiency of CO<sub>2</sub> produced compared to the maximum theoretically calculated CO<sub>2</sub> which should have been produced had an average of **102.45%** for sample B (Foam Sheet) since a very significant amount of the sample had degraded.

The efficiency of CO<sub>2</sub> produced compared to the maximum theoretically calculated CO<sub>2</sub> which should have been produced had an average of **119.50%** for sample C (Adhesive) since most of the sample had degraded.

Based on the 64 day weight loss and carbon conversion, the foam sheet and adhesive have met the ASTM D 5338 and ASTM 6400-04 requirements for a compostable material.



Greg Geil  
Environmental Scientist  
*Attachments: Tables (I-II) and Figures (I-II)*

# ASTM D-5338 Aerobic Biodegradation

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**Table I: Sample Summary**

Sample ID	Sample Reference	Sample Size	Initial Weight (g)	Final Weight (g)	% Weight Loss	% Carbon	% C to CO <sub>2</sub> (g)	Flask Number
A	Cellulose	Cut Pieces	1.7000	0.0000	100.00	45.05	91.46	16
B	Foam Sheet	Cut Pieces	2.8151	0.2208	92.16	41.04	93.88	17
C	Foam Sheet	Cut Pieces	2.8610	0.2831	90.10	41.04	92.54	18
D	Adhesive	Cut Pieces	1.6542	0.0301	98.20	20.67	117.60	19

**Table II: Conversion Data**

	A (16) Cellulose	B (17) Foam Sheet	C (18) Foam Sheet	D (19) Adhesive
Sample Reference				
Galbraith Carbon %:	45.0500	41.04	41.04	20.67
Initial Weight (g):	1.7000	2.8151	2.8610	1.6542
Final Weight (g):	0.0000	0.2208	0.2831	0.0301
Actual Total CO <sub>2</sub> (mg):	2569	3984.75	3967.2	1467

Initial Weight (g):	1.7000	2.8151	2.8610	1.6542
Carbon Fraction:	0.4505	0.4104	0.4104	0.2067
Available Grams C:	0.7660	1.1600	1.1700	0.3420
Theoretical CO <sub>2</sub> (g):	2.8100	4.2500	4.2900	1.2500

% C to CO <sub>2</sub> :***	91.46	93.88	92.54	117.60
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Actual Weight Loss (g):	1.7000	2.5943	2.5779	1.6241
Carbon Fraction:	0.4505	0.4104	0.4104	0.2067
Related Available Grams C:	0.7660	1.0600	1.0600	0.3360
Max.Theo.Available CO <sub>2</sub> (g):**	2.8100	3.8800	3.8800	1.2300

Carbon Conv. Efficiency (%):*	91.46	102.58	102.31	119.50
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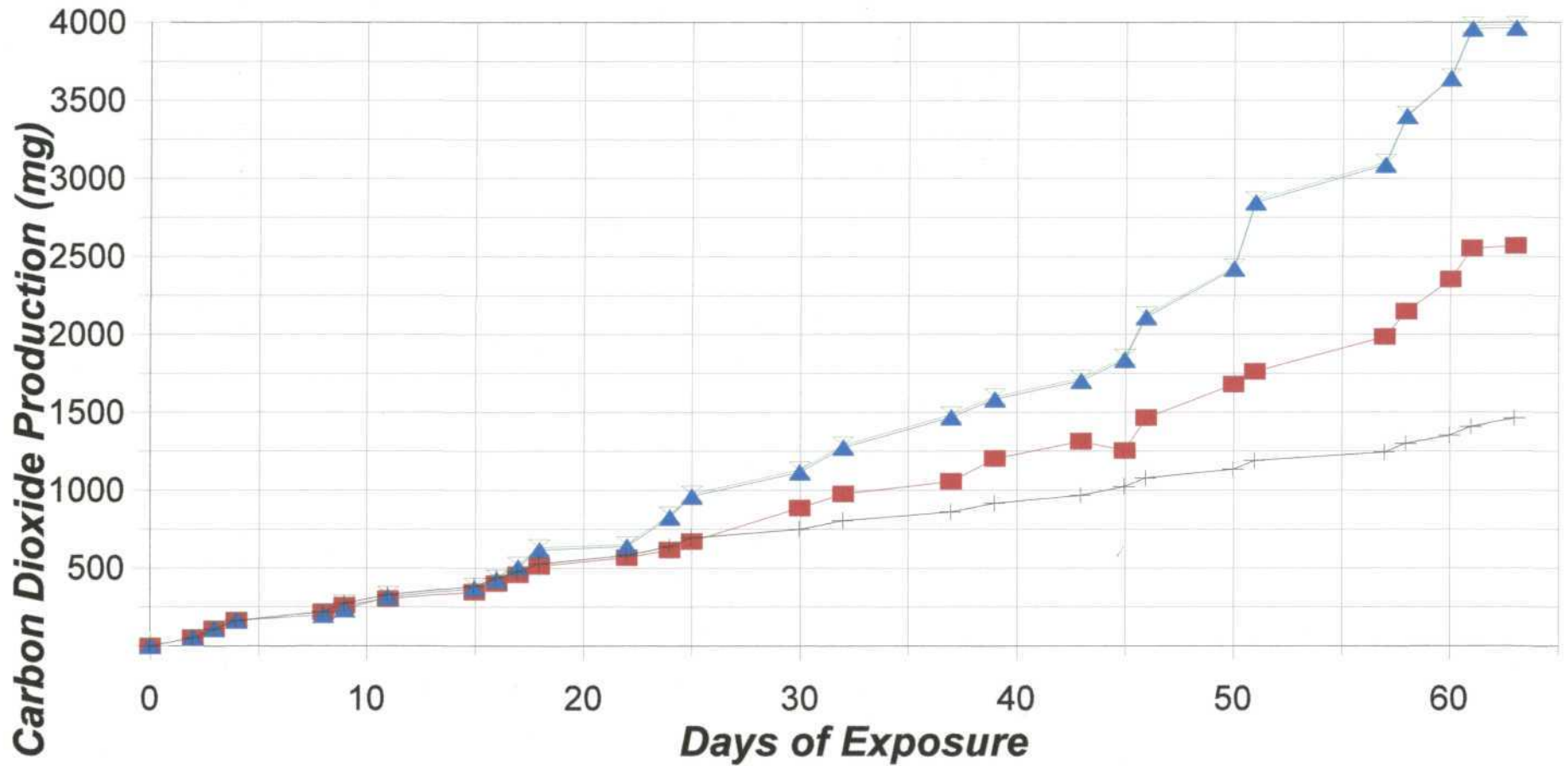
\*\*\* This refers to amount of carbon in sample actually converted to carbon dioxide.

\*\* This refers to amount of carbon in weight loss that appears as carbon dioxide.

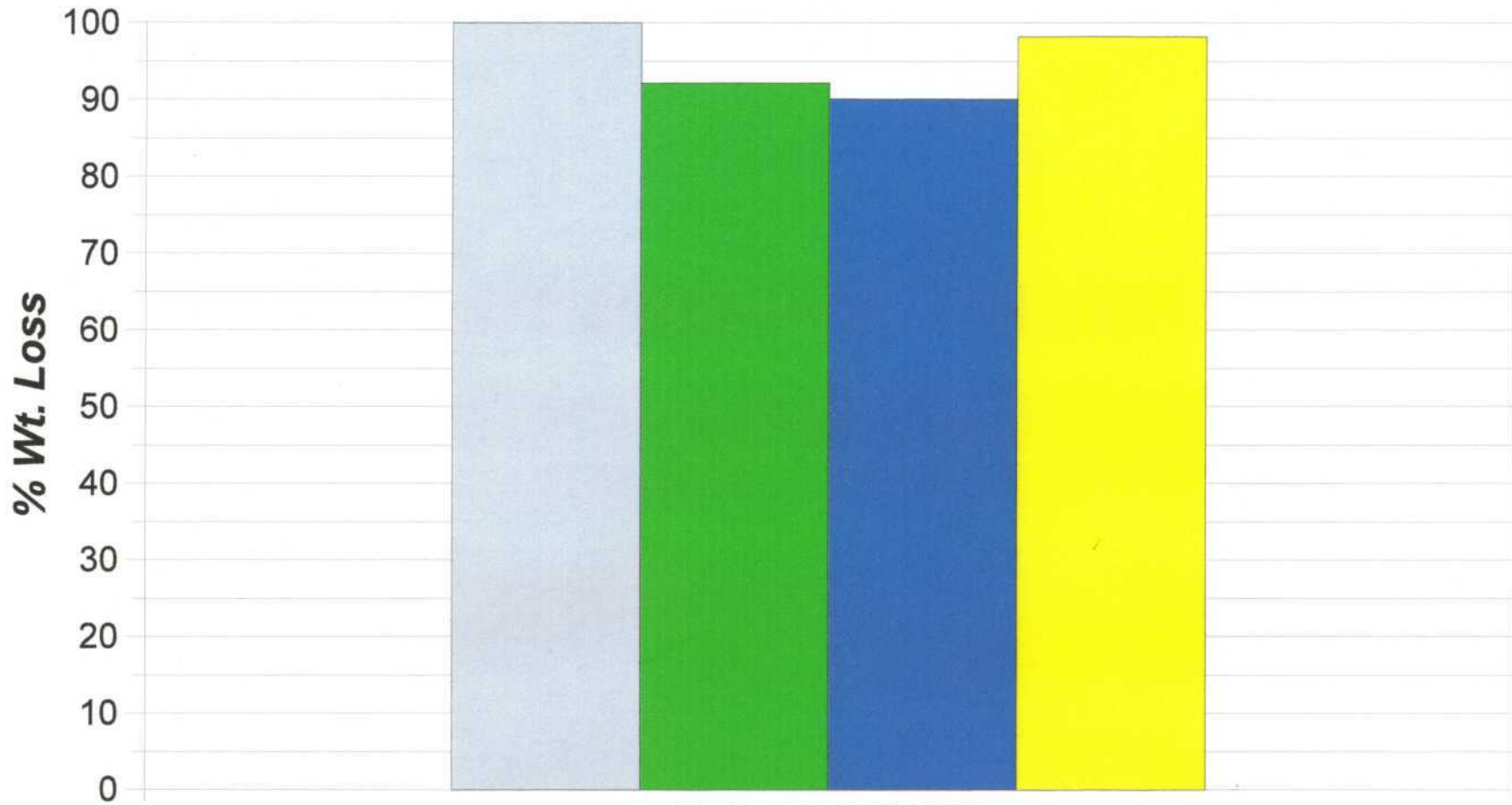
\* This refers to amount of carbon biodegraded in actual sample compared to what was available in weight loss.

# Figure I: D-5338

## Cumulative Carbon Dioxide Production



# Figure II: ASTM D-5338 Percent Weight Loss



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**Sample Identification**

 **Cellulose**    **Foam Sheet**    **Foam Sheet**    **Adhesive**