ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California
SOIL CONTROL LAB
42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

ASTM D 6400

Determing Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions

Work Order #:
0020396-01

Report Prepared For:
Aseem Das
World Centric
2121 Staunton Court
Palo Alto, CA 94306

Tested By:
Soil Control lab
42 Hangar Way
Watsonville, CA 95076
U.S.A.
phone: 831-724-5422
www.compostlab.com

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Summary of Results from Compostability Testing

Product Tested: Sample Product Box Custom, 100 KN-PS-6, Knives
Thickness of Material: The thickest portion of the material is 2.68 mm

Summary of Results: The product met all the requirements to be considered "compostable" as judged by the United States standard ASTM D 6400.

Description of requirements to pass ASTM D 6400:

To be considered “compostable” by either ASTM D 6400 the product must demonstrate the three following items:

1.) **Disintegration**
- After starting with the product cut to 2cm lengths, in 12 twelve weeks of composting under laboratory controlled composting conditions 90% of the product must pass a 2mm sieve.

2.) **Biodegradation**
- 60% of the organic carbon must be converted to carbon dioxide by the end of the test period, when compared to the positive control (cellulose).

3.) **No Adverse Effects on the Quality of the Compost**
- **Plant Growth**
  The germination rate and the plant biomass of the sample composts shall be no less than 90 % that of the corresponding blank composts for two different plant species following OECD Guideline 208 with the modifications found in Annex E of EN 13432.
- **Heavy Metals** - see the table on the following page for levels that are acceptable based on geographical region.

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Table 1: Acceptable Levels of Heavy Metals based on Geographical Region

Analyte	Limits for US (ppm)	Limits for Canada (ppm)	Limits for Europe (ppm)	Limits for Japan (ppm)
Arsenic (As)	21.5	37.5	5	5
Cadmium (Cd)	19.5	10	0.5	0.5
Copper (Cu)	750	NA	50	60
Lead (Pb)	150	250	50	10
Mercury (Hg)	8.5	2.5	0.5	0.2
Nickel (Ni)	210	90	25	30
Selenium (Se)	50	7	0.75	NA
Zinc (Zn)	1400	925	150	180
Cobalt (Co)	NA	75	NA	NA
Chromium (Cr)	NA	NA	50	50
Molybdenum (Mo)	NA	10	1	NA
Fluorine (F)	100	100	100	NA

Notes:

Metal limits for US are 50% of those proscribed by CFR 503.13 Table 3 (per ASTM 6400 requirements).

Metal limits for Canada are 50% of those proscribed in Table II of “Standards for Metals in Fertilizers and Supplements”.

Fluorine level is consistent with EU regulations.

Results for this product:

Disintegration - Passed

- 92% of the sample passed the 2mm sieve after 12 weeks of composting

Biodegradation - Passed

- It took 119 days for 69% of the organic carbon in the material being tested to be converted to carbon dioxide when compared to the positive control (cellulose), thus meeting the standard of 60%.
- ASTM D 6868 & EN 13432 standards require 90% biodegradation - it took 140 days for 93% of the organic carbon in the material being tested to be converted to carbon dioxide when compared to the positive control (cellulose), thus meeting the standard of 90%.
- End of test - the testing was stopped after 175 days, the cumulative carbon dioxide production was 103%.

No Adverse Effects on Compost Quality - Passed

- Plant Growth Study - Passed. Corn showed 100% emergence and 112% biomass; cucumber showed 99% emergence and 93% biomass.

- Heavy Metals - The heavy metals results meet the standards for the US, Canada, Europe, and Japan.

Sincerely,

Mike Galloway
Lab Director

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Heavy Metals Concentration

Product Name: Sample Product Box Custom, 100 KN-PS-6, Knives
Portion of Product Analyzed: Whole Sample

Analyte	Results mg/Kg dry weight	Reporting Limit	Pass or Fail of Standards by Region			
			US	Canada	Europe	Japan
Arsenic (As)	ND	0.5	Pass	Pass	Pass	Pass
Cadmium (Cd)	ND	0.5	Pass	Pass	Pass	Pass
Copper (Cu)	ND	0.5	Pass	NA*	Pass	Pass
Lead (Pb)	ND	0.5	Pass	Pass	Pass	Pass
Mercury (Hg)	ND	0.2	Pass	Pass	Pass	Pass
Nickel (Ni)	ND	0.5	Pass	Pass	Pass	Pass
Selenium (Se)	ND	0.5	Pass	Pass	Pass	NA*
Zinc (Zn)	7.4	0.5	Pass	Pass	Pass	Pass
Cobalt (Co)	ND	0.5	NA*	Pass	NA*	NA*
Chromium (Cr)	ND	0.5	NA*	NA*	Pass	Pass
Molybdenum (Mo)	ND	0.5	NA*	Pass	Pass	NA*
Fluorine (F)	ND	10	Pass	Pass	Pass	NA*

The analyses above were conducted in-house by Soil Control Lab using the following methods.
As & Se - Digestion EPA 3050B, Analysis EPA Method 6020 (ICPMS)
Cd, Cu, Pb, Ni, Zn, Co, Cr, & Mo Digestion EPA 3050B, Analysis EPA Method 6010 (ICP-AES)
Mercury (Hg) by EPA 7471 (Cold Vapor)
Fluorine (F) by EPA 300.0 (IC)

Also, please note: The criteria for Pass/Fail for each region are listed in the "Summary of Results from" "Compostability Testing" Section of the Report (earlier in this report).

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Preliminary Tests, Part II - FTIR, Ash, Thickness (and Biobased if tested)

Product Name: Sample Product Box Custom, 100 KN-PS-6, Knives

Layer/Material:

Ash Content: 29.3%

Thickness: 2.68 mm

FTIR Summary (Full FTIR Report Attached in Appendix F): The following is a quote from the report "In our opinion, the spectrum for Sample A verifies that the Cutlery is composed of a modified bio-polyester. Talc was also found to be in the compostion. the cutlery spectrum matches closely to that of Nature Works PLA."

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Disintegration Study

Product Name: Sample Product Box Custom, 100 KN-PS-6, Knives
Portion of Product Analyzed: Whole product broken down in 2cm x 2cm squares

Week	% Passing 2mm sieve	Criteria	Pass/Fail
12	92	greater than 90 %	**Pass**

Pictures of the disintegration study can be found in Appendix E.

Plant Growth Study

Portion of Product Analyzed: Whole product after it had been put through the disintegration test

Plant Species		% Emgerence	% Biomass	Pass/Fail
Cucumber	25% compost	99	93	**Pass**
	50% compost	96	72	NA*
Corn	25% compost	100	112	**Pass**
	50% compost	95	88	NA*

*****It should be noted that both plant species were affected at the higher concentrations of the compost, but at the 25% compost concentration the plants did fine. This is typical of what we tend to see.

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Biodegradation Study

Product Name: **Sample Product Box Custom, 100 KN-PS-6, Knives**
Number of layers/material tested for above mentioned product: 1

Layer/Material Number 1 of 1
Layer/Material Analyzed: Whole Sample

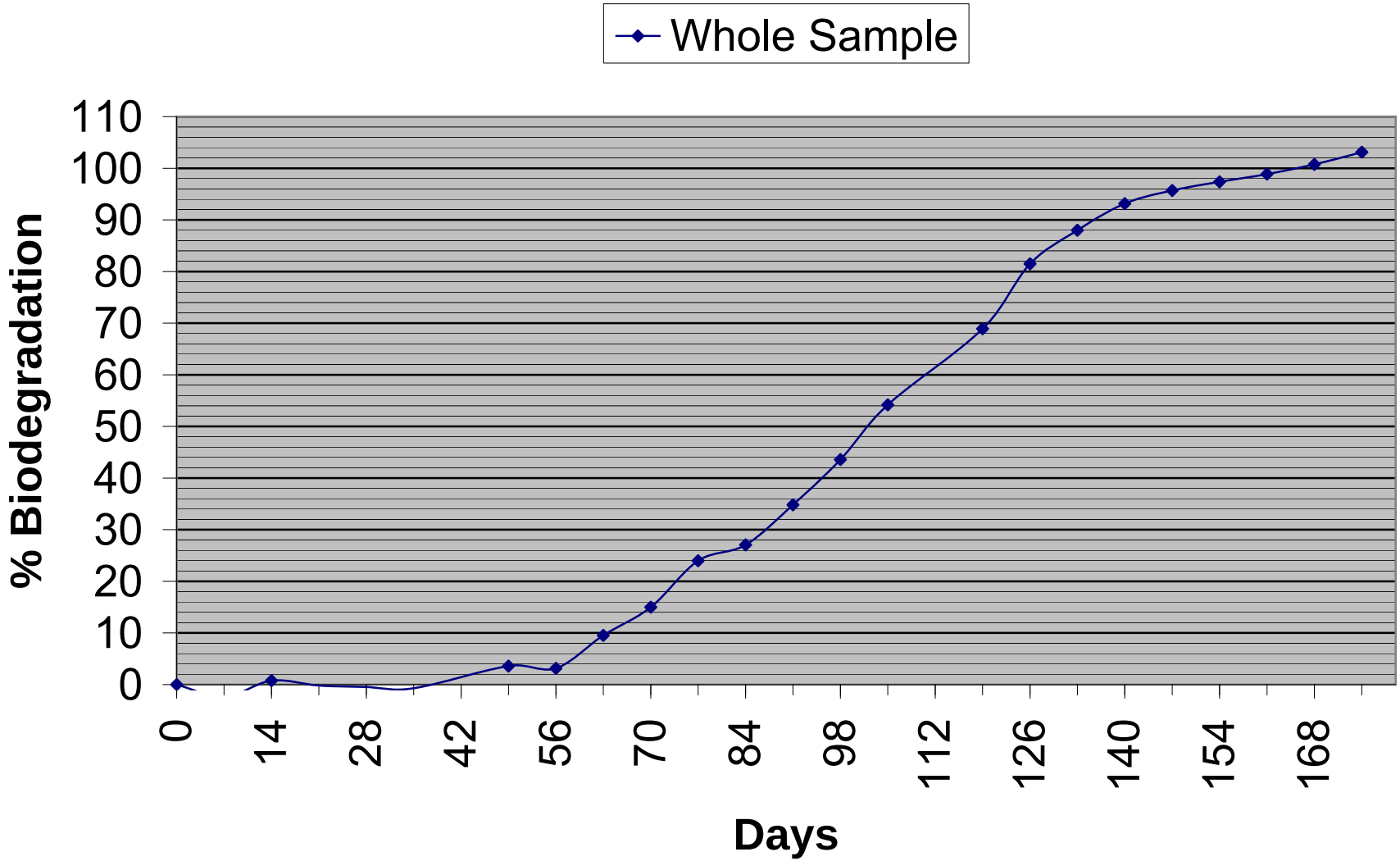
Amount of Carbon Converted to Carbon Dioxide

(as compared to cellulose as the positive control)

Day	% Converted to CO2
0	0
7	-2
14	1
21	0
28	0
35	-1
49	4
56	3
63	10
70	15
77	24
84	27
91	35
98	44
105	54
119	69
126	81
133	88
140	93
147	96
154	97
161	99
168	101
175	103

Please see following page for a graph of the results.

% of Organic Carbon Converted to Carbon Dioxide as Compared to Cellulose



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Description of Test Procedure

Description of the Equipment Used:

A temperature controlled incubator capable of holding it's temperature at 58°C ± 2°C over the entire length of the test procedure. Cylinderical composting vessels that have a capacity of 7.5 liters each. The containers are sectioned into two parts using a porous pad so that the top section has a volume of 6 liters. One liter of water is placed in the bottom section and the test material in the top. Carbon dioxide free air is bubbled through the water to saturate the air with water, then through the porous pad, into the main test chamber, then out of the top.

Description of the Test Procedure (how we executed ASTM D 5338):

Inoculum: A suitable 3 month old stable compost from the Monterey District composting facility is used for the inoculum. The compost is sieved through a 9.5mm sieve and then mixed. When we are ready to use it, we add ammonium chloride so that the C/N ration is less than 15 plus the appropriate volume of water to adjust the moisture content to 50%.

Disintegration Test: The "Disintegration Testing" and the "Biodegradation Testing" are tested separately, but in the same incubator. For the disintegration test we conduct ASTM D 5338 without the CO2 trapping componento the method. We start off with 200g of 2cm X 2cm squares of the product being tested and add it to 1200g of compost and put the mixture in the composting vessels as described in the "Equipment" section above. The mixture is composted for 12 weeks at 58°C ± 2°C. The composting vessel is shaken weekly to mix the sample & compost and to prevent extensive channelling, provide uniform attack on the test specimen, and provide an even distribution of moisture. Any observations made by the analyst are recorded, such as "material starting to appear grainy & brittle". Also, pictures are taken at key times to visually document the products progress during the study. At the end of 12 weeks material is emptied from the composting vessels and screened through a 2mm sieve. In order to pass this test, no more than 10% of the original dry weight of the product can be retained on the sieve.

Biodegradation Test: The biodegradation testing has to be conducted in triplicate on each of the following: 1.) the sample (100g of sample + 600g dry weight of compost), 2.) positive control (100g of cellulose + 600g dry weight of compost), 3.) negative control (100g of polyethylene + 600g dry weight of compost), 4.) blank (600g dry weight of compost). The moisture content of the mixtures is adjusted to 50%, then they are put into the composting vessels as described in "Equipment" above. The composting vessels are placed in the incubator at 58°C ± 2°C. The CO2 free air is then connected and adjusted so that the flow rate is between 150 and 200 ml per minute. The gases exiting the test chambers are plumbed to a solenoid valve which is controlled to divert air for 2 minutes out of every 2 hours. These diverted gases flow into 1 liter adsorption units containing a known volume of 1N sodium hydroxide to adsorb the carbon dioxide being produced in the vessels (for the remainder to the 2 hours the exhaust is simply vented to the room).

The sodium hydroxide is periodically titrated to measure the CO2 production; our standard days for the titration are 3, 7, 14, and every 7 days after that. We titrate to pH 8.5 with 0.5N HCl after adding BaCl2 to precipitate the carbonates formed by the CO2. Fresh 1N sodium hydroxide is placed in the absorption units and the whole process is repeated. The testing is carried out until the CO2 production from both the sample and the positive control have plateaued up to a maximum of 180 days.

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Description of Test Procedure (continued)

Plant Growth Study:

The pots used were cups with clear plastic covers, which holds in moisture, thus reducing the need to water which could lead to leaching of phytotoxins out of the material being tested.

Several dilutions are made by diluting the sample with vermiculite; the same dilutions are also conducted on the positive control (cellulose). The dilutions are necessary because compost is not a good a potting mix due to excess salts and excess nutrients. Triplicates of each dilution were made and all were seeded. The highest concentration of the control that produced healthy plants was used for interpreting the results. The method that this is based off of is OECD Guideline 208 with the modifications found in Annex E of EN 13432.

The method is the same for all seeds except Farm Lawn which is described in the next paragraph. Seeds are counted when planted and percent germination is determined using percent germination of the control as 100 percent. The average height of healthy plants is used to determine biomass.

Farm Lawn (this species is not always used): A half gram (500mg) of seed was planted into each cup. A plant density scale was developed using 0, 100, 200, 300, 400, and 500 mg of seeds in a series of cups and given an index of 0, 1, 2, 3, 4, 5 respectively to be used in determining percent germination. The index value of the control is considered 100 percent germination when determining the index of the sample. Biomass is based on average height of healthy plants.

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Description of Inoculum Used

Inoculum: A suitable 3 month old stable compost from the Monterey District composting facility was used for the inoculum. The compost was sieved through a 9.5mm sieve and then mixed. Before using it, we added ammonium chloride so that the C/N ration was approximately 15 plus the appropriate volume of water to adjust the moisture content to 50%.

pH at start of tests = 7.4

pH at end of tests = 7.3

% dry solids = 37%, but adjusted to 50% for test

% volatile solids = 45% on a dry weight basis

Total Nitrogen = 1.4% on a dry weight basis, but added 8 grams of NH_4Cl to each composting vessel/reactor (containing 600g dry weight of compost) to lower C/N ratio to 15.

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Evaluation of QC Criteria for the Analytical Batch

Carbon Dioxide production of the inoculum for the first 10 days:
Our result = 60mg (suggested range is 50-150mg)

At day 45 cellulose must have converted 70% or more of it's carbon to CO2 and the standard deviation of the % converted at the end of the test must be below 20%
Our result = 72.4% at 45 days, 82.5% at the end, and a standard deviation of 5.0%

At the end of the test the pH of the compost + sample material must be greater than 7.0.
Our results = 7.3

Incubator must be maintained at 58 deg C +/- 2 deg C.
Temperature was maintained within limits through out the testing.

Satisfactory appearance, odor, & moisture content must be maintained in all composting vessels.
We were able to accomplish this throughout the study.

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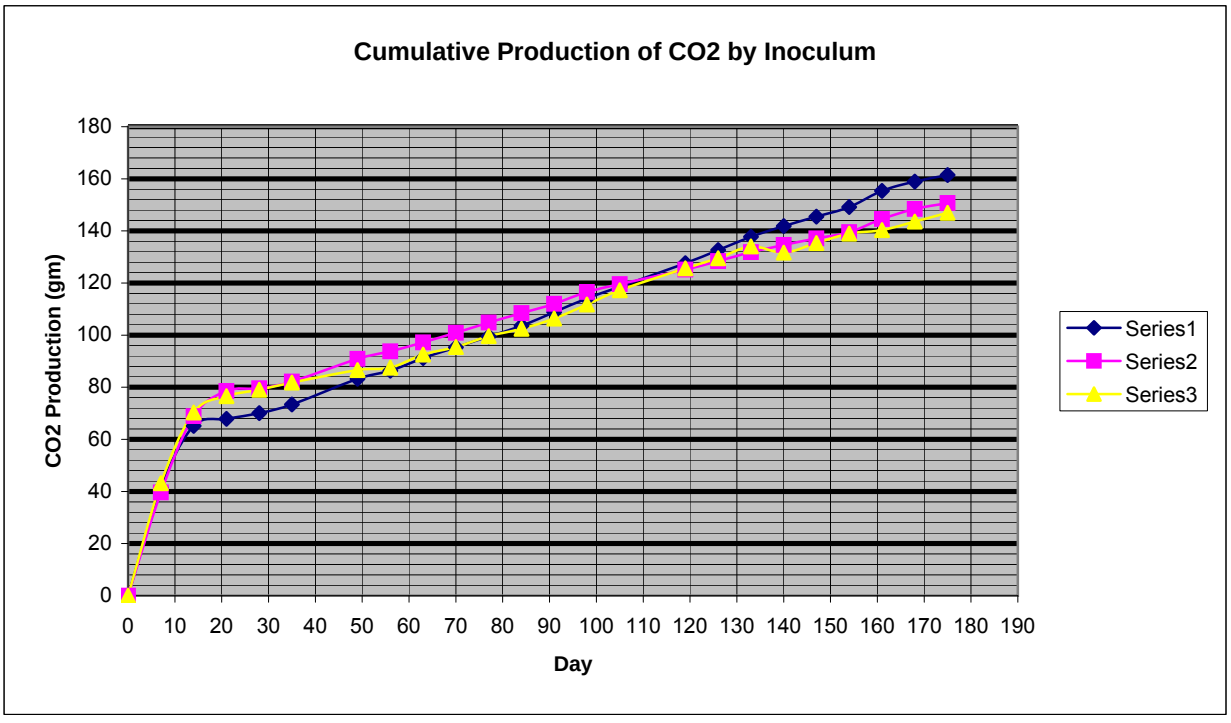
Carbon Dioxide Production from Inoculum

Measured production (gm)				Cumulative production (gm)			
Day	Reactor 1	Reactor 2	Reactor 3	Day	Reactor 1	Reactor 2	Reactor 3
0	0.00	0.00	0.00	0	0	0	0
7	41.45	39.64	43.19	7	41	40	43
14	23.71	29.28	27.11	14	65	69	70
21	2.71	9.62	6.26	21	68	79	77
28	2.22	1.02	2.47	28	70	80	79
35	3.28	2.61	2.77	35	73	82	82
49	9.87	8.70	4.77	49	83	91	87
56	3.08	2.91	0.93	56	86	94	88
63	4.87	3.43	5.03	63	91	97	93
70	4.11	3.66	2.87	70	95	101	95
77	4.18	3.94	4.18	77	99	105	100
84	4.11	3.66	2.87	84	104	108	102
91	5.22	3.54	3.92	91	109	112	106
98	5.27	4.53	5.38	98	114	117	112
105	4.51	3.05	5.45	105	119	120	117
119	9.04	5.53	8.42	119	128	125	126
126	5.03	3.28	3.87	126	133	128	130
133	5.08	3.46	4.59	133	138	132	134
140	4.15	2.72	-2.43	140	142	135	132
147	3.61	2.52	3.68	147	145	137	135
154	3.68	2.45	3.65	154	149	140	139
161	6.21	4.99	1.34	161	155	145	140
168	3.52	3.91	3.28	168	159	148	144
175	2.53	2.25	3.36	175	161	151	147



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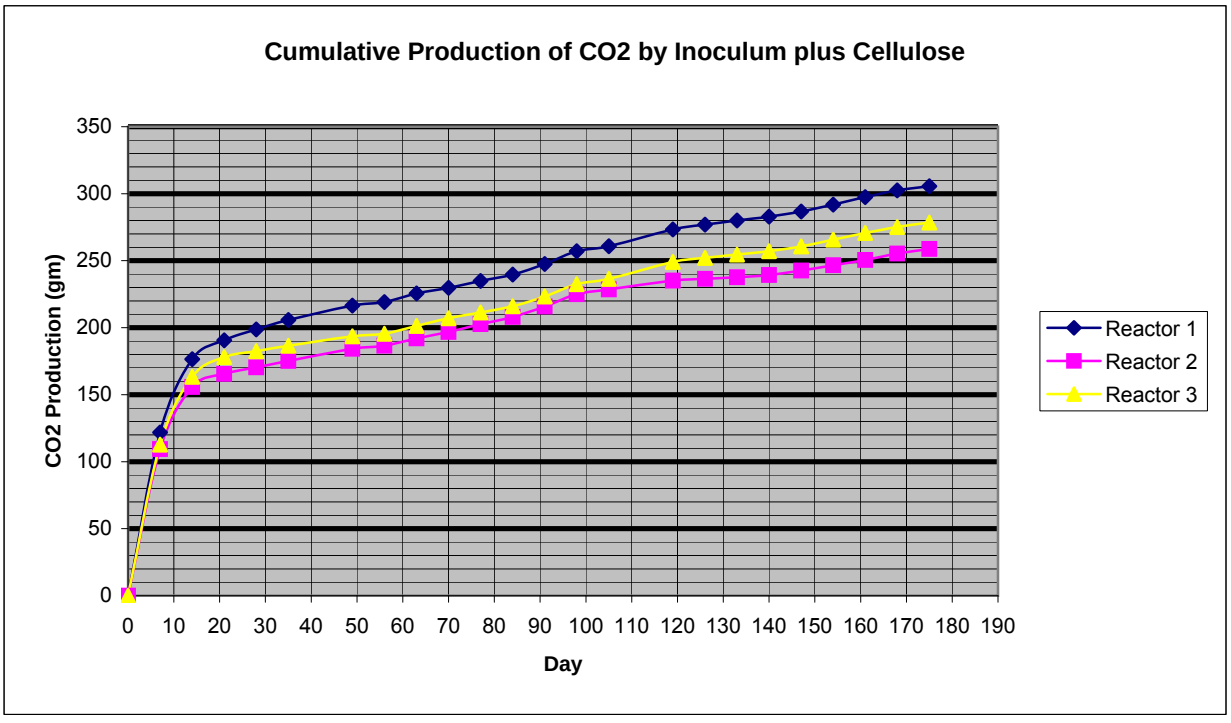
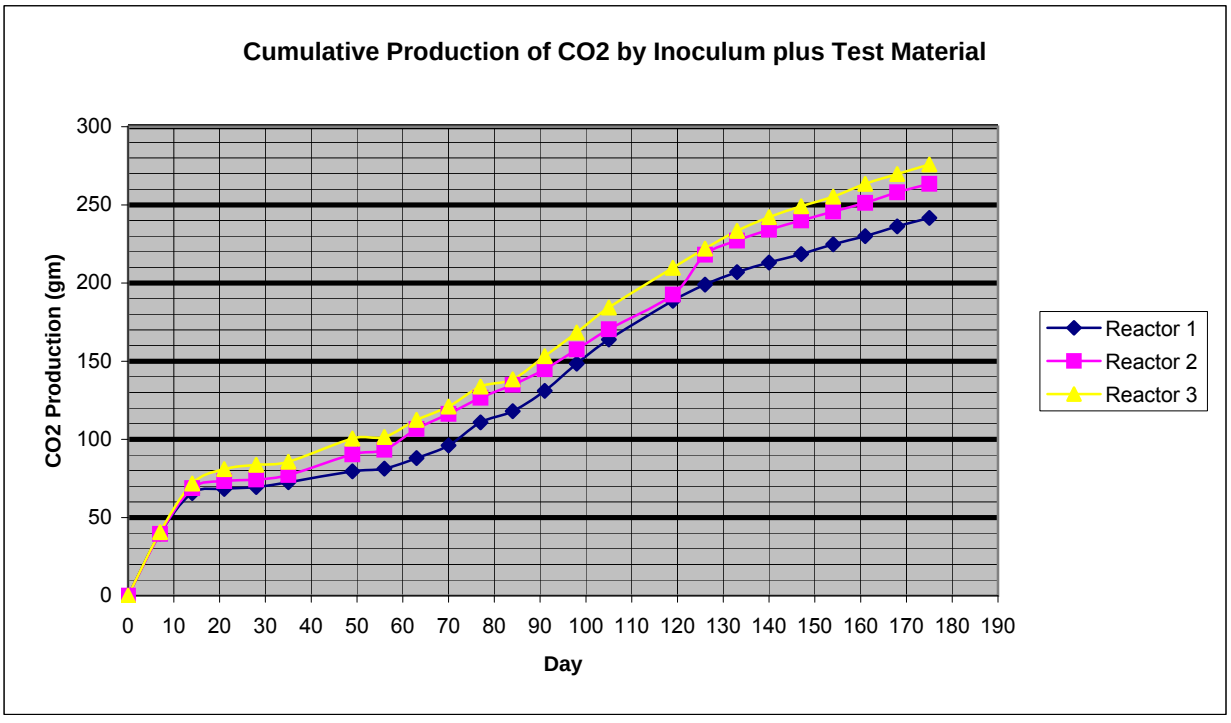
Carbon Dioxide Production from Inoculum plus Cellulose

Measured production (gm)				Cumulative production (gm)			
Day	Reactor 1	Reactor 2	Reactor 3	Day	Reactor 1	Reactor 2	Reactor 3
0	0.00	0.00	0.00	0	0	0	0
7	121.77	109.36	112.70	7	122	109	113
14	54.77	46.35	50.68	14	177	156	163
21	14.09	9.81	14.65	21	191	166	178
28	8.11	4.83	4.40	28	199	170	182
35	6.99	4.85	4.06	35	206	175	186
49	10.74	9.02	7.05	49	216	184	194
56	2.63	2.26	1.92	56	219	186	195
63	6.45	5.59	5.87	63	226	192	201
70	4.23	4.74	5.78	70	230	197	207
77	5.10	5.80	4.31	77	235	203	211
84	4.80	5.47	4.66	84	240	208	216
91	7.92	7.69	7.25	91	248	216	223
98	9.49	9.21	9.13	98	257	225	232
105	3.71	3.60	3.96	105	261	229	236
119	12.53	6.59	12.73	119	273	235	249
126	3.58	1.22	2.90	126	277	236	252
133	3.14	1.21	2.58	133	280	238	255
140	2.84	1.74	2.48	140	283	239	257
147	3.83	3.36	3.62	147	287	243	261
154	5.16	3.87	4.97	154	292	247	266
161	5.58	3.99	5.05	161	297	251	271
168	4.96	4.70	4.43	168	302	255	275
175	3.20	3.53	3.34	175	306	259	279



Carbon Dioxide Production from Inoculum plus Test Material

Measured production (gm)				Cumulative production (gm)			
Day	Reactor 1	Reactor 2	Reactor 3	Day	Reactor 1	Reactor 2	Reactor 3
0	0.00	0.00	0.00	0	0	0	0
7	39.81	39.55	40.65	7	40	40	41
14	25.83	29.21	31.13	14	66	69	72
21	2.66	4.52	9.16	21	68	73	81
28	1.17	1.06	2.76	28	69	74	84
35	3.14	2.81	1.98	35	73	77	86
49	6.98	13.20	14.80	49	80	90	100
56	1.67	3.01	1.09	56	81	93	102
63	6.76	13.34	10.90	63	88	107	112
70	8.12	9.56	8.48	70	96	116	121
77	14.71	10.38	12.79	77	111	127	134
84	7.21	8.30	4.69	84	118	135	138
91	12.95	9.87	14.80	91	131	145	153
98	17.36	12.72	15.21	98	148	158	168
105	15.55	12.85	15.87	105	164	170	184
119	24.75	22.21	25.44	119	189	193	210
126	10.27	25.49	12.24	126	199	218	222
133	8.07	9.03	11.44	133	207	227	233
140	6.12	7.00	8.77	140	213	234	242
147	5.36	5.94	6.91	147	218	240	249
154	6.32	5.72	6.18	154	225	246	255
161	5.14	5.51	8.20	161	230	251	263
168	6.31	6.73	6.21	168	236	258	270
175	5.44	5.45	6.19	175	242	263	276



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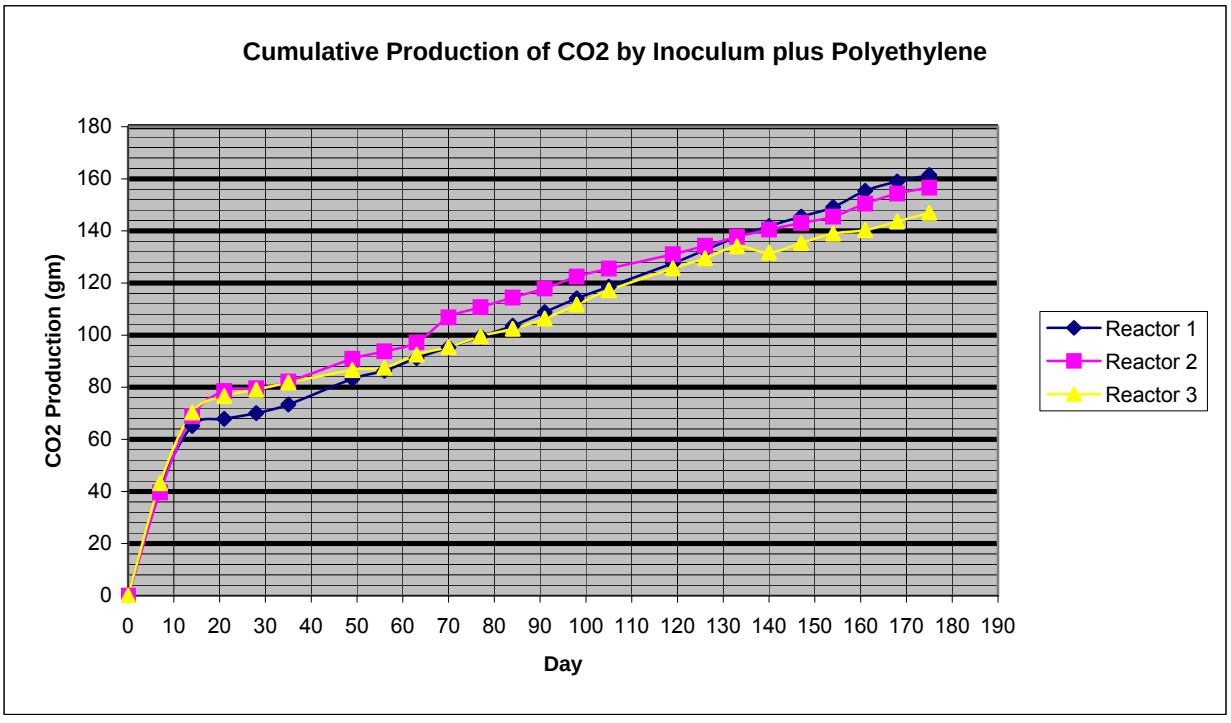
Carbon Dioxide Production from Inoculum plus Polyethylene

Measured production (gm)				Cumulative production (gm)			
Day	Reactor 1	Reactor 2	Reactor 3	Day	Reactor 1	Reactor 2	Reactor 3
0	0.00	0.00	0.00	0	0	0	0
7	41.45	39.64	43.19	7	41	40	43
14	23.71	29.28	27.11	14	65	69	70
21	2.71	9.62	6.26	21	68	79	77
28	2.22	1.02	2.47	28	70	80	79
35	3.28	2.61	2.77	35	73	82	82
49	9.87	8.70	4.77	49	83	91	87
56	3.08	2.91	0.93	56	86	94	88
63	4.87	3.43	5.03	63	91	97	93
70	4.11	9.56	2.87	70	95	107	95
77	4.18	3.94	4.18	77	99	111	100
84	4.11	3.66	2.87	84	104	114	102
91	5.22	3.54	3.92	91	109	118	106
98	5.27	4.53	5.38	98	114	122	112
105	4.51	3.05	5.45	105	119	125	117
119	9.04	5.53	8.42	119	128	131	126
126	5.03	3.28	3.87	126	133	134	130
133	5.08	3.46	4.59	133	138	138	134
140	4.15	2.72	-2.43	140	142	140	132
147	3.61	2.52	3.68	147	145	143	135
154	3.68	2.45	3.65	154	149	145	139
161	6.21	4.99	1.34	161	155	150	140
168	3.52	3.91	3.28	168	159	154	144
175	2.53	2.25	3.36	175	161	157	147

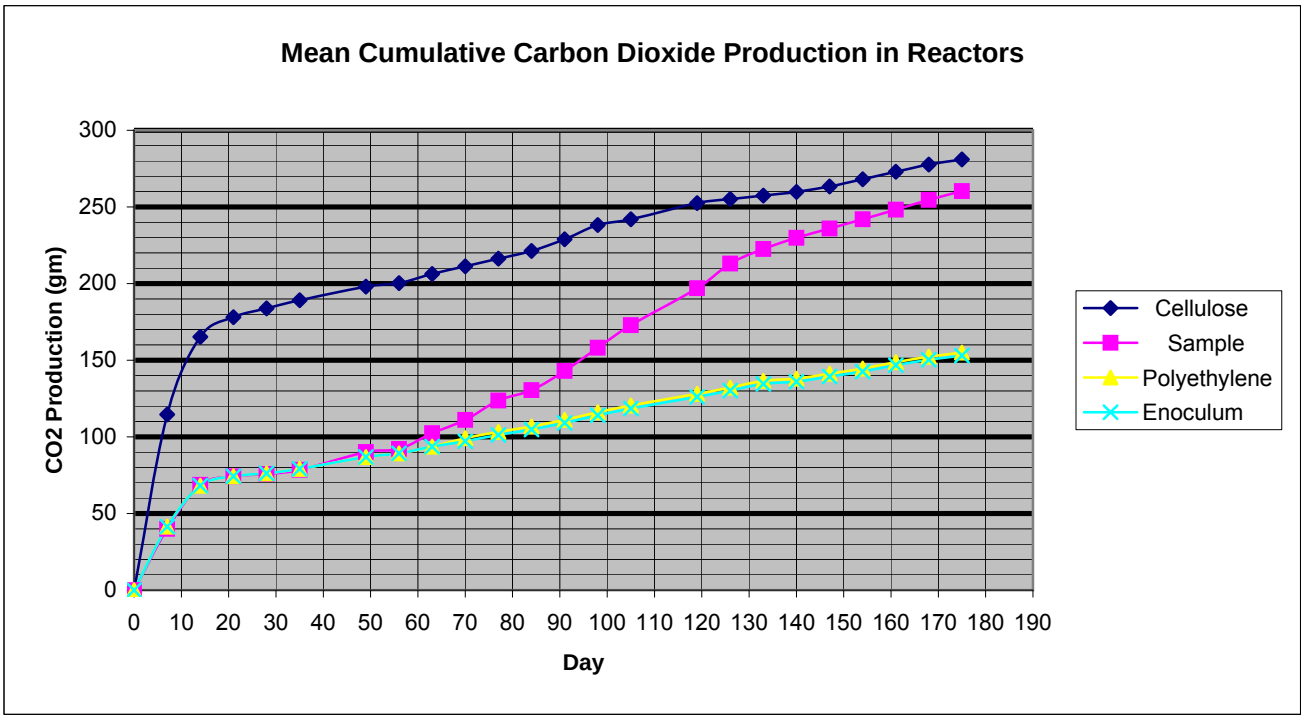


Work Order: 0020396-01
Account #: 5991
Date Reported: October 1, 2010

Mean Cumulative Carbon Dioxide Production in Reactors

Cumulative production (gm)

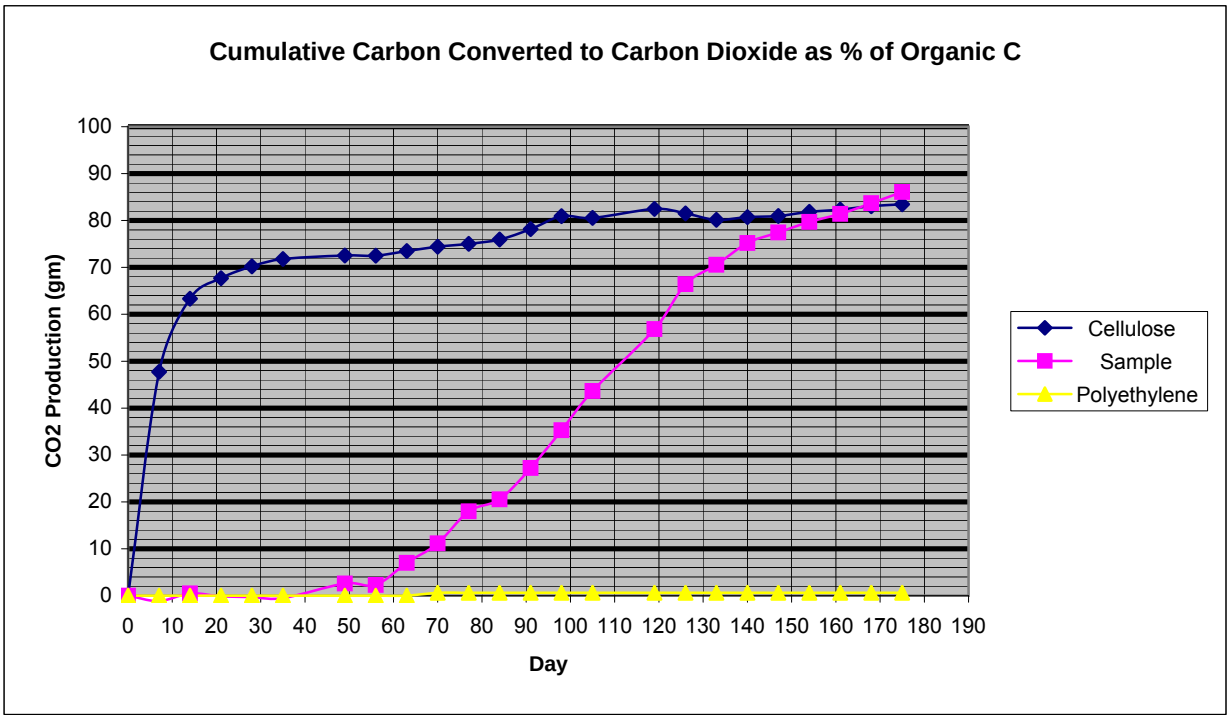
Day	Cellulose	Sample	Polyethylene	Enoculum
0	0	0	0	0
7	115	40	41	41
14	165	69	68	68
21	178	74	74	74
28	184	76	76	76
35	189	78	79	79
49	198	90	87	87
56	200	92	89	89
63	206	102	94	94
70	211	111	99	97
77	216	124	103	101
84	221	130	107	105
91	229	143	111	109
98	238	158	116	114
105	242	173	120	118
119	253	197	128	126
126	255	213	132	130
133	257	223	137	135
140	260	230	138	136
147	263	236	141	139
154	268	242	145	143
161	273	248	149	147
168	278	255	152	150
175	281	260	155	153



Work Order: 0020396-01
Account #: 5991
Date Reported: October 1, 2010

Cumulative Carbon as C Converted to Carbon Dioxide (mean)

	Cumulative Production (gm)				Cumulative Production(% of Organic C)		
Day	Cellulose	Sample	Polyethylene	Day	Cellulose	Sample	Polyethylene
0	0.00	0.00	0.00	0	0	0	0
7	19.96	-0.39	0.00	7	48	-1	0
14	26.48	0.16	0.00	14	63	0	0
21	28.29	-0.04	0.00	21	68	0	0
28	29.35	-0.11	0.00	28	70	0	0
35	30.00	-0.18	0.00	35	72	-1	0
49	30.32	0.88	0.00	49	73	3	0
56	30.31	0.78	0.00	56	73	2	0
63	30.72	2.38	0.00	63	74	7	0
70	31.10	3.79	0.54	70	74	11	1
77	31.36	6.12	0.54	77	75	18	1
84	31.75	6.99	0.54	84	76	21	1
91	32.68	9.25	0.54	91	78	27	1
98	33.83	11.99	0.54	98	81	35	1
105	33.67	14.83	0.54	105	81	44	1
119	34.47	19.33	0.54	119	82	57	1
126	34.07	22.58	0.54	126	82	66	1
133	33.50	23.98	0.54	133	80	71	1
140	33.74	25.57	0.54	140	81	75	1
147	33.84	26.34	0.54	147	81	77	1
154	34.22	27.10	0.54	154	82	80	1
161	34.41	27.67	0.54	161	82	81	1
168	34.72	28.45	0.54	168	83	84	1
175	34.89	29.26	0.54	175	83	86	1

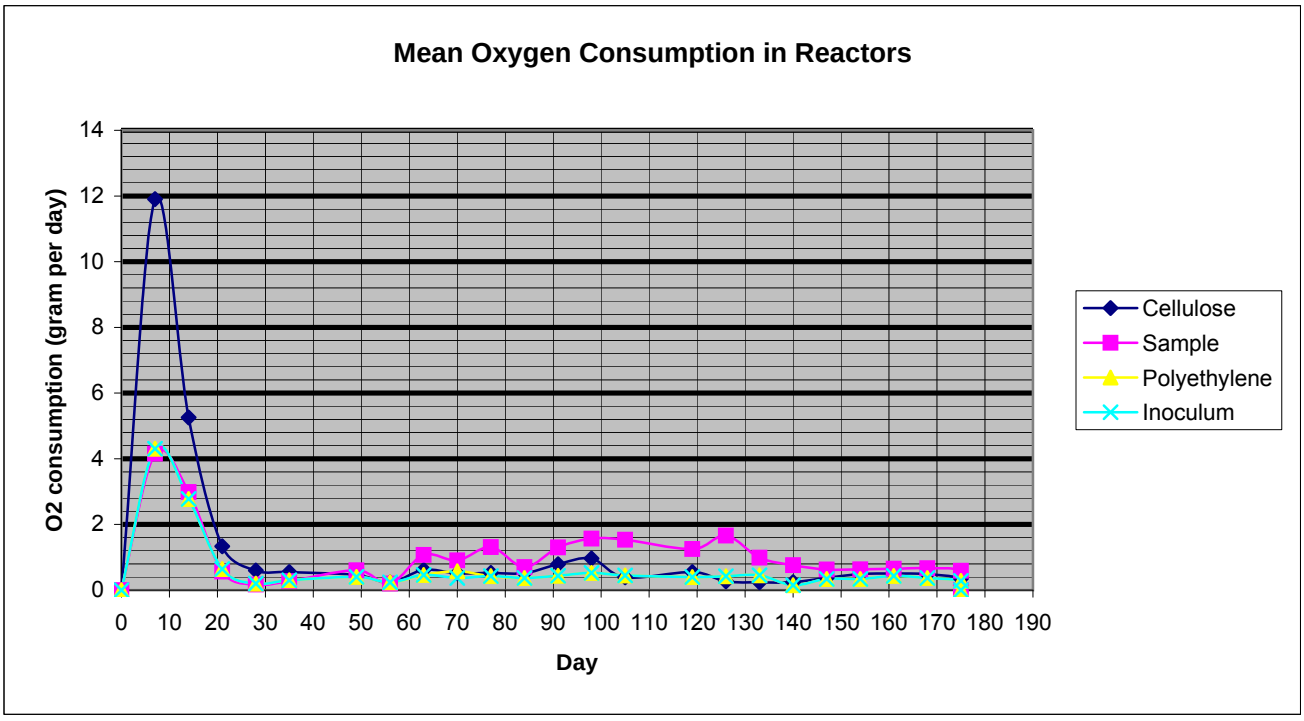


Work Order: 0020396-01
Account #: 5991
Date Reported: October 1, 2010

Mean Oxygen Consumption in Reactors

Oxygen Consumption (grams per day)

Day	Cellulose	Sample	Polyethylene	Inoculum
0	0	0	0	0
7	11.91	4.16	4.30	4.30
14	5.26	2.98	2.77	2.77
21	1.33	0.57	0.64	0.64
28	0.60	0.17	0.20	0.20
35	0.55	0.27	0.30	0.30
49	0.46	0.61	0.40	0.40
56	0.24	0.20	0.24	0.24
63	0.62	1.07	0.46	0.46
70	0.51	0.91	0.57	0.37
77	0.53	1.31	0.43	0.43
84	0.52	0.70	0.37	0.37
91	0.79	1.30	0.44	0.44
98	0.96	1.57	0.53	0.53
105	0.39	1.53	0.45	0.45
119	0.55	1.25	0.40	0.40
126	0.27	1.66	0.42	0.42
133	0.24	0.99	0.45	0.45
140	0.24	0.76	0.15	0.15
147	0.37	0.63	0.34	0.34
154	0.49	0.63	0.34	0.34
161	0.51	0.65	0.43	0.43
168	0.49	0.67	0.37	0.37
175	0.35	0.59	0.28	0.28
175	0.00	0.00	0.00	0.00



ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Work Order: 0020396-01
Account #: 5991
Date Reported: October 1, 2010

Description of the Pictures

Picture 1 - Product as it was submitted to us

Picture 2 - Disintegration Study at end (12 weeks)

Picture 3 - Plant Growth Study (Corn) - Sample at 25% concentation

Picture 4 - Plant Growth Study (Corn) - Control at 25% concentation

Picture 5 - Plant Growth Study (Corn) - Sample at 50% concentation

Picture 6 - Plant Growth Study (Corn) - Control at 50% concentation

Picture 7 - Plant Growth Study (Cucumber) - Sample at 25% concentation

Picture 8 - Plant Growth Study (Cucumber) - Control at 25% concentation

Picture 9 - Plant Growth Study (Cucumber) - Sample at 50% concentation

Picture 10 - Plant Growth Study (Cucumber) - Control at 50% concentation


0020396
World Centric
2031 Burroughs Avenue
San Leandro Ca 94577-5611
Compostable
WORLD CENTRIC


20396
12 weeks


0020396-1
Corn
25 % compost (sample)
Rep 2
0020396-1
Corn
25 % compost (sample)
Rep 1
0020396-1
Corn
25 % compost (sample)
Rep 3


Control
Corn
25 % compost (control)
Rep 1
Control
Corn
25 % compost (control)
Rep 2
Control
Corn
25 % compost (control)
Rep 3


0020396-01
Corn
50 % compost (sample)
Rep 3
0020396-01
Corn
50 % compost (sample)
Rep 1
0020396-01
Corn
50 % compost (sample)
Rep 2


Control
Corn
50 % compost (control)
Rep 1
Control
Corn
50 % compost (control)
Rep 2
Control
Corn
50 % compost (control)
Rep 3


0020396-01
Cucumber
25 % compost (sample)
Rep 1
0020396-01
Cucumber
25 % compost (sample)
Rep 2
0020396-01
Cucumber
25 % compost (sample)
Rep 3


Control
Cucumber
25 % compost (control)
Rep 1
Control
Cucumber
25 % compost (control)
Rep 3
Control
Cucumber
25 % compost (control)
Rep 2


cm
0020396-01
Cucumber
50 % compost (sample)
Rep 3
0020396-01
Cucumber
50 % compost (sample)
Rep 1
0020396-01
Cucumber
compost (sample)
Rep 2


cm
Control
Cucumber
50 % compost (control)
Rep 1
Control
Cucumber
50 % compost (control)
Rep 2
Control
Cucumber
50 % compost
Rep 3

CONFIDENTIAL! Not to be released without appropriate authorization!

LABORATORY REPORT

Advanced Materials Center, Inc.
125 Swanson Street Ottawa, IL. 61350 (815) 433-1495 Fax (815) 433-1795

To: Soil Control Lab
Frank Shields

Date: March 17, 2010
Project: 10P1084 FTIR/Ash/DSC
PO#: 1144

Purpose:
Evaluate one (1) sample for material composition using FTIR infrared spectrometry and DSC Differential Scanning Calorimeter. An ash test was also conducted on the sample.

Sample Identification:
A. SCL-0020396 "Cutlery - Knives"

Source:
Soil Control Lab

Conclusions:
In our opinion, the analysis of the Cutlery shows the major components to be a modified bio-polyester. The filler in the cutlery appears to be talc.

Results:
The FTIR transmission spectra for the samples were obtained to ID the material composition evaluated of the samples and are attached for reference.

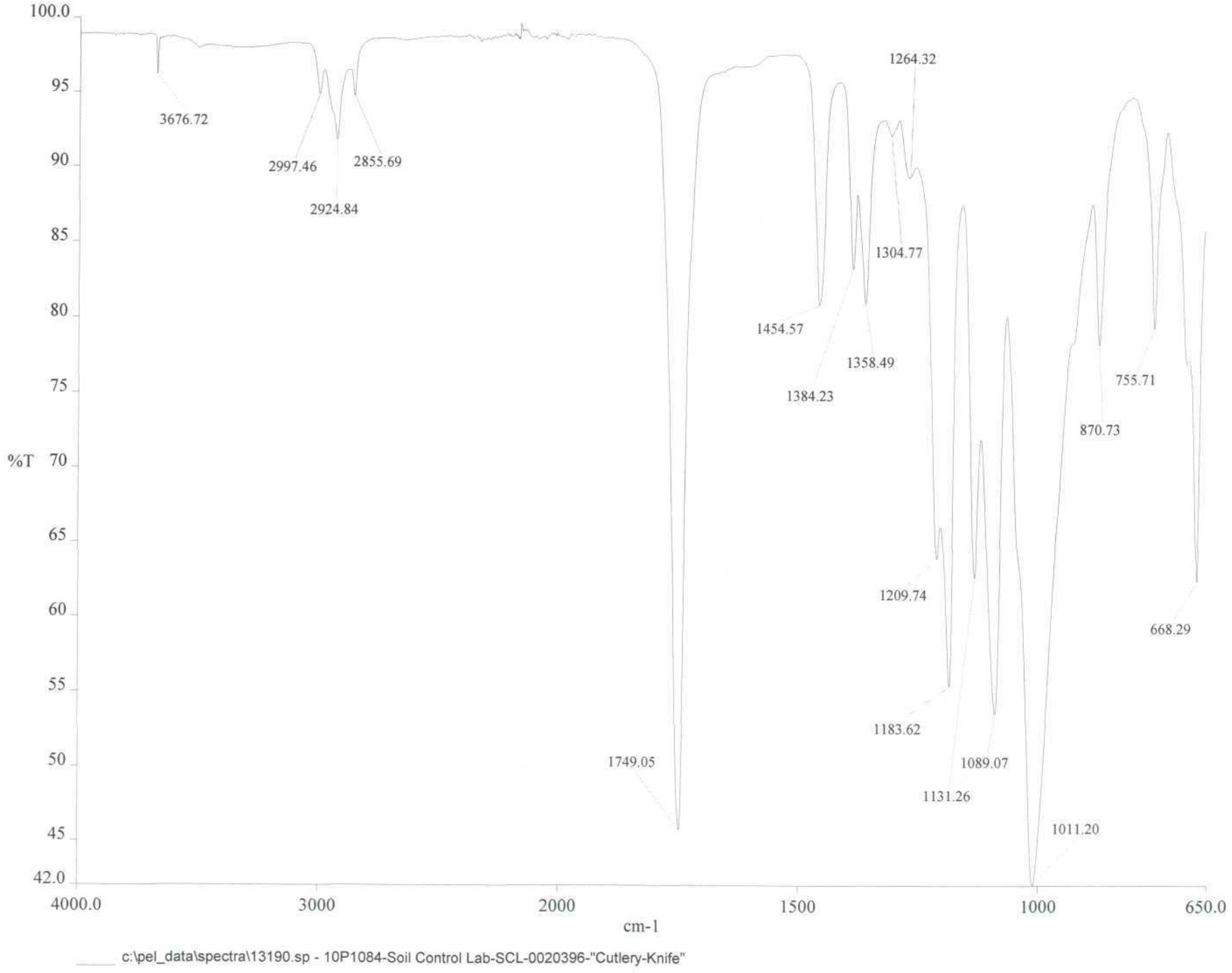
In our opinion, the spectrum for Sample A verifies that the Cutlery is composed of a modified bio-polyester. Talc was also found to be in the composition. The cutlery spectrum matches closely to that of Nature Works PLA.

The DSC analysis showed that the cutlery material had a major absorption peak at 157.97° C. This implies that polypropylene, polyethylene or polystyrene are not present.

Ash testing shows an inorganic residue of **28.81%** by weight on Sample A as received.

Discussion / Experimental:
Sample A was evaluated using an FTIR transmission infrared spectrometer fitted with an ATR accessory, Perkin Elmer Spectrum 100. The DSC analysis was conducted using a Perkin Elmer DSC Series Seven Thermal Analyzer upgraded with a Temperature Programmer Interface for Perkin Elmer. The ash test of the material was run using a crucible, controlled pre burning and final heating at 650 Celsius in a Thermolyne 6000 Muffle Furnace.

Greg Geil
Environmental Scientist
Attachments: FTIR Spectra, DSC Graph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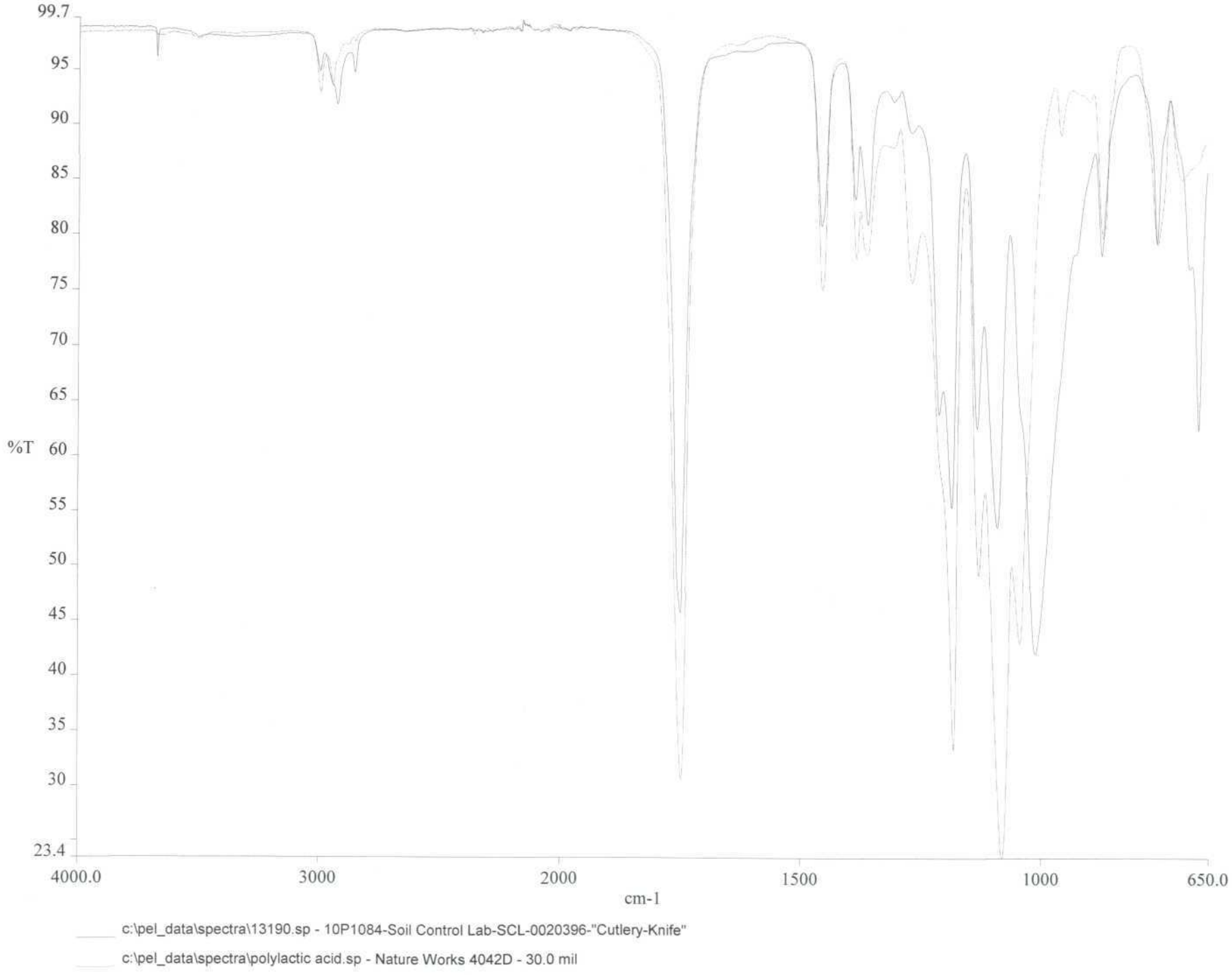
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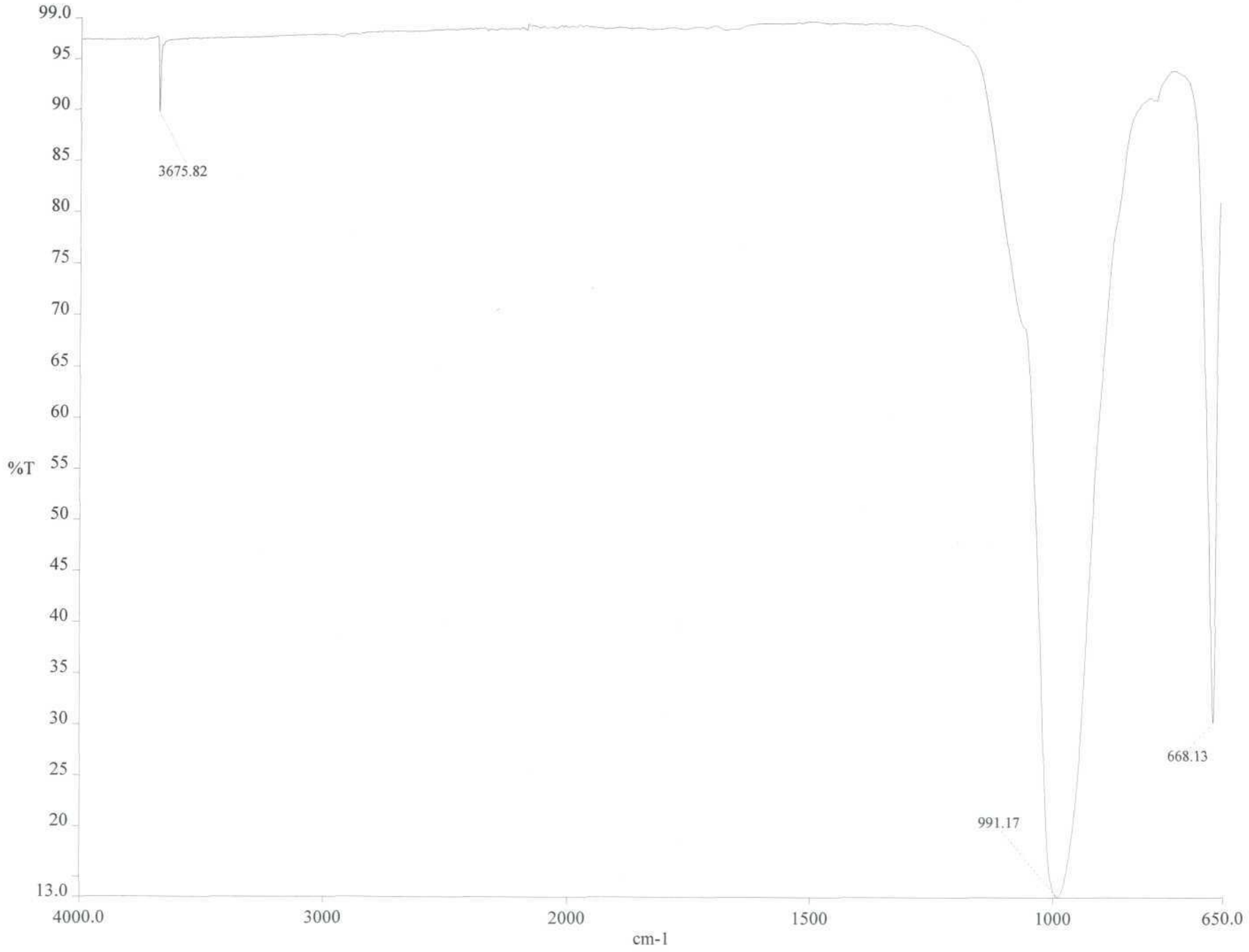
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991.17
668.13
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13190b.sp - 10P1084-Soil Control Lab-SCL-0020396 Cutlery Ash

Advanced Materials Center, Inc

DSC

File Name: 10P1084.DSC
Size: 4.00
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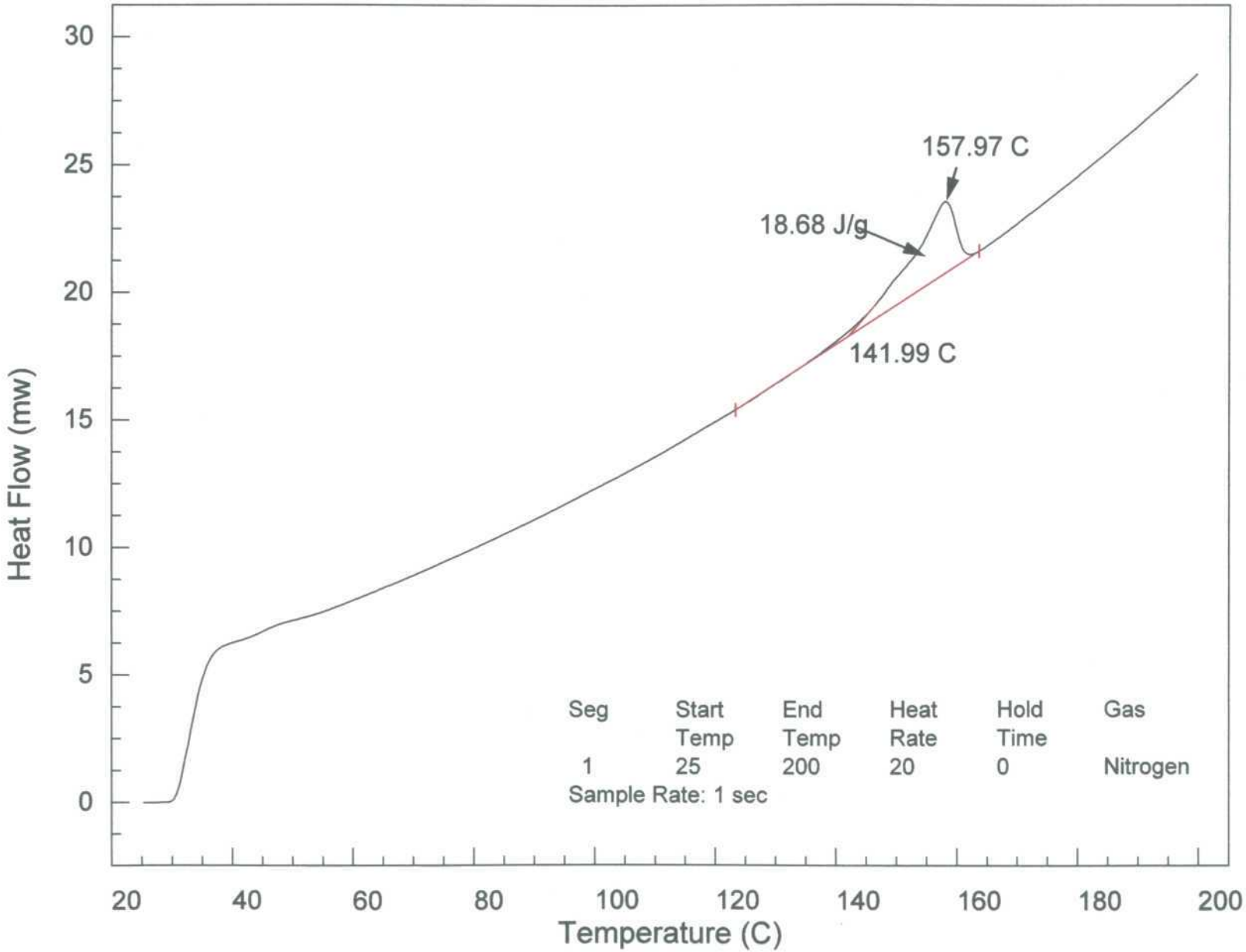
Desc. 2 :

Operator: GGG
Date: 03/02/2010
Time: 13:55:26
Instrument: DSC 7



Seg	Start Temp	End Temp	Heat Rate	Hold Time	Gas
1	25	200	20	0	Nitrogen

Sample Rate: 1 sec

Printed(3/2/2010 2:25:33 PM) Program(Version 4.2.109)