

Test Report No.: 244159367a 002

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Client:**Contact Information:****Identification/
Model No(s):** PLA biodegradable material(zs7065's/zs7050's/zs7065w's/zs7080's)**Sample Receiving date:** 2019-08-12**Sample obtaining
method:** Sending by customer**Testing Period:** 2019-08-30 to 2020-04-09**Test specification:****Test result:**

With reference to DIN EN 13432:2000/ASTM D 6400-19,
Testing according to customers specification for the following parameter:

Aerobic Biodegradation Test(ISO14855-1:2012)

Pass

Other information:

Sample information is provided by customer.

Country of Origin: China

Please be kindly informed that all the content recorded in the captioned report 244159367a 001 is cancelled
and now superseded by 244159367a 002.

For and on behalf of
TÜV Rheinland (Shanghai) Co., Ltd.



2020-04-28 Lucy Lu / Senior Technical Executive

Date

Name/Position

Test result is drawn according to the kind and extent of tests performed.

This test report relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in
extracts. This test report does not entitle to carry any safety mark on this or similar products.

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Picture and detailed description of the test sample

M001

Material list:

Material no.	Material	Color	Location	Remark
M001	Plastic	White	Refer to photo	Sample for biodegradation

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1. Biodegradation

1.1 General test information

Reference material : Cellulose

Test vessels : 3000ml, the vessel used for biodegradation test is a high pressure conical flask, volume: 3000 ml. It was provided by Pyrex Co. Ltd.

CO₂-determination : Determination of the amount of carbon dioxide evolved by weighing the carbon dioxide absorbing system. The amount of carbon dioxide is calculated via the difference in the weight of the carbon dioxide absorbing trap in the beginning and in the end of the test.

Thermostat controlled oven : The biodegradation test is proceeded in a temperature controlled oven for maintaining the temperature needed.

1.2 Summary of test results

	Test material	Reference material
45 days biodegradation rate	55.0%	76.8%
Overall biodegradation rate	94.6%	103.5%
Test duration [days]	104	104
Observation	No abnormal findings	No abnormal findings

Validity Criteria :

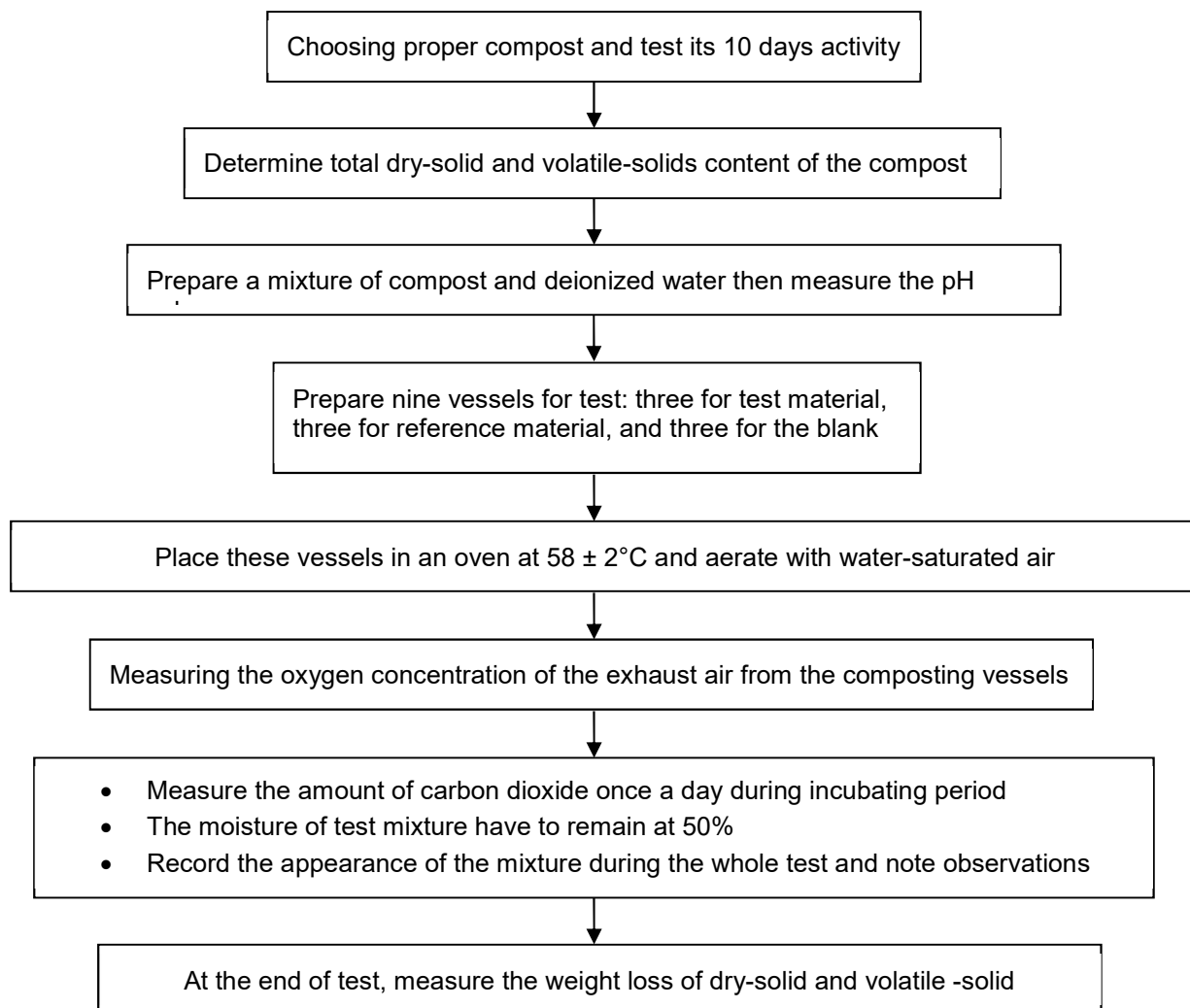
Degree of biodegradation of reference material after 45 days > 70%? ☒ Yes ☐ No

Difference between percentage biodegradation of reference material in the different vessels at the end of test <20%? ☒ Yes ☐ No

Average CO₂ production in the blank vessels after 10 days in the range 50 mg to 150 mg CO₂/g volatile solids? ☒ Yes ☐ No

As the three criteria above have been fulfilled, the test is considered to be valid.

For detailed information, please see the following pages

1.3 Flow chart of experiment

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1.4 Results

1.4.1 Appearance of compost and sample



Before test



After test

Compost without any material before and after test



Before test



After test

Compost with reference material before and after test



Before test



After test

Compost with test material before and after test

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1.4.2 Properties of compost

Total dry solids (%)	Moisture content (%)	Volatile solids (%)	Ash (%)	Compost Activity Test (mg CO ₂ /g volatile solid)	Carbon/ Nitrogen ratio (%)
48.0%	52.0%	50.0%	50.0%	118.3	13

1.4.3 Activity of the compost

The amount of CO₂ for the first 10 days

Days	Amount of carbon dioxide (mg)
1	3700
2~3	4470
4~7	5300
8	1630
9	1570
10	368
Total	17038

Compost Activity =118.3 (mg CO₂ /g volatile solid)

Calculation:

Amount of CO₂ absorbed during the first 10 days [g] / (600g * total dry solids * volatile solids)
 600g is the amount of compost used for each vessel.

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1.4.4 Total Amount of Organic Carbon for Test and Reference Samples

The content of organic carbon in sample and reference material (cellulose) is determined. Results are used for calculation of amount of test material necessary to have an amount of 20g organic carbon in each vessel.

For reference material: $m = \text{amount of organic carbon each vessel} / \text{TOC}$ $m = 20\text{g} / 0.421\text{g/g} = 47.5\text{g}$

20g of organic carbon lead to a theoretical amount of 73.3g CO₂ evolved by microorganisms when the rate of biodegradation reaches 100%.

Total amount of organic carbon

Parameter	Unit	Reference material	Test material
Total organic carbon (TOC)	(%)	42.1	40.6
Amount of organic carbon (TOC) in test vessel	(g)	20.0	20.0
Theoretical amount of evolved carbon dioxide	(ThCO ₂), (g)	73.3	73.3
Size	(cm × cm)	—	—
Thickness	(mm)	—	—
Shape	—	powder	powder
Total dry solids	(%)	98.0	94.8
Moisture content	(%)	2.0	5.2

1.4.5 The amount of sample and compost in the test vessel

	Compost		Sample	
	Weight (g)	Total dry solids (g)	Weight (g)	Total dry solids (g)
Blank	600	288	None	None
Reference	600	288	47.5	46.5
Sample	600	288	49.3	46.7

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1.5 pH Value

The pH value of the compost is checked at the beginning and at the end of the test. It is determined by diluting compost with distilled water by 1:5 and measuring the value with an electrical pH-meter.

The pH values before and after test

	Blank 1	Blank 2	Blank 3
Before Test	7.2	7.3	7.4
After Test	7.1	7.2	7.2

The pH values before and after test

	Reference material 1	Reference material 2	Reference material 3
Before Test	7.5	7.4	7.5
After Test	7.3	7.2	7.2

The pH values before and after test

	Test material 1	Test material 2	Test material 3
Before Test	7.4	7.3	7.3
After Test	7.3	7.1	7.1

The pH values of the vessels do not show any obvious differences to the other vessels. Big differences in the pH value could ask for rejecting single values.

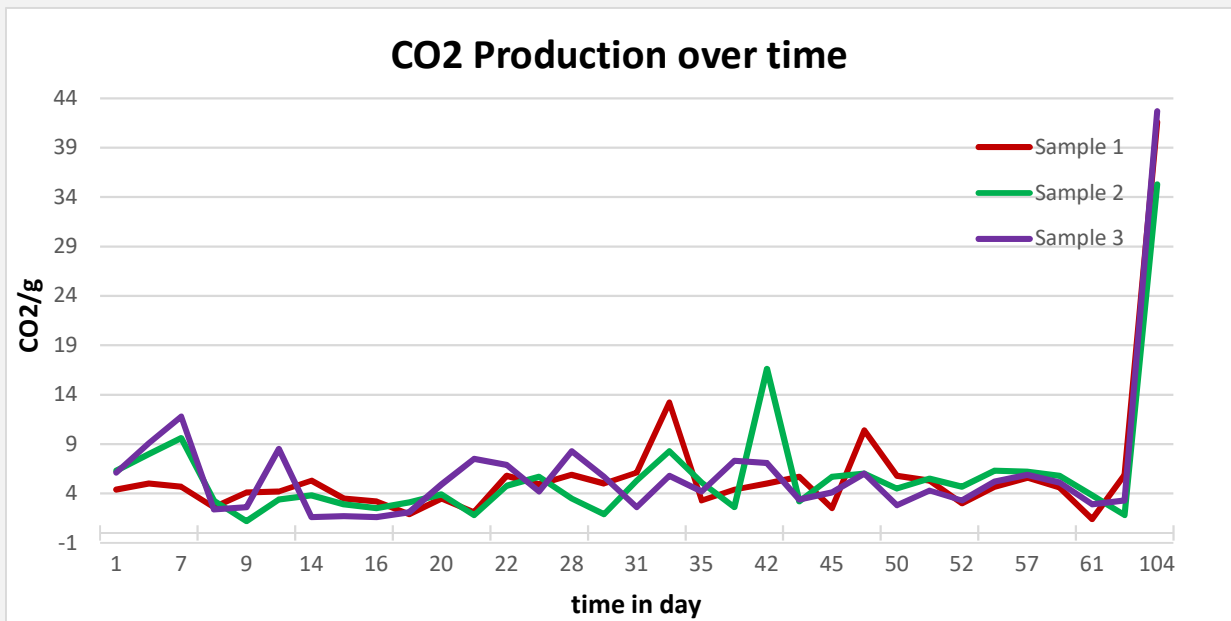
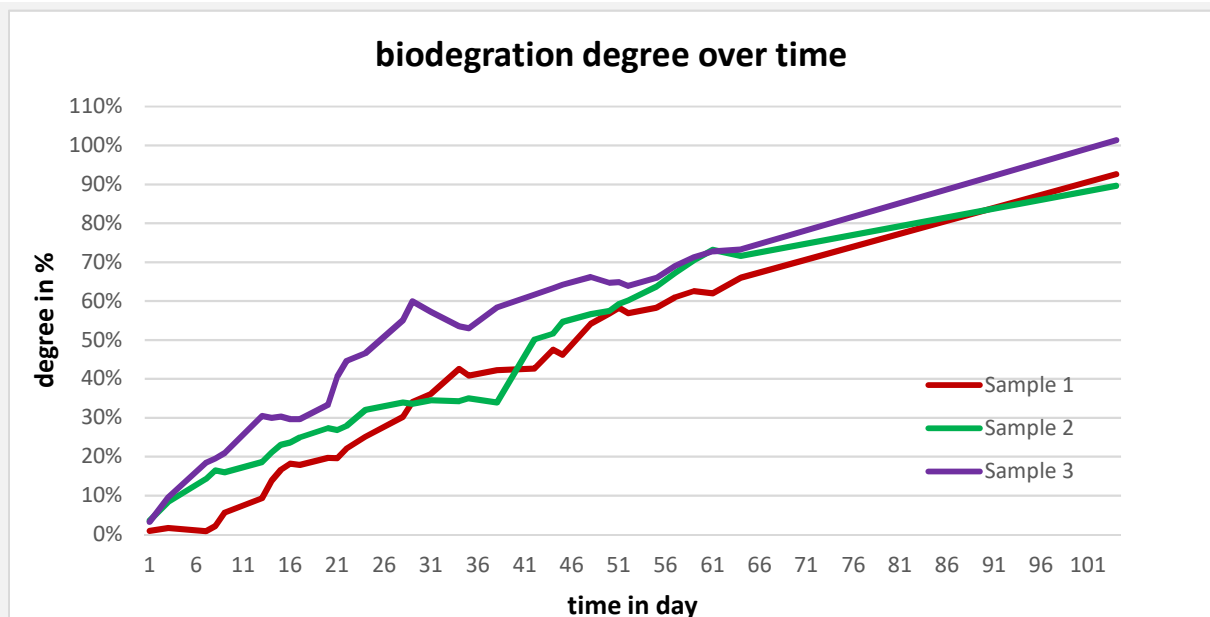
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1.6 Controlled Aerobic Composting Test (Mass of Organic Matter)

1.6.1 Test Material

Amount of total organic carbon (TOC) of the test material placed in each vessel	20.0g
This TOC leads to a theoretical amount of evolved carbon dioxide (ThCO ₂), caused by the degradation of the test material	73.3g

CO₂: Evolution curve of test materialProduction of CO₂ over time

Biodegradation curve of test material

Degree of degradation over time

Controlled aerobic composting test data of test material

Day	CO ₂ (g/vessel)								D (%)			
	B1	B2	B3	B _{mean}	t1	t2	t3	t _{mean}	t1	t2	t3	t _{mean}
1	2.90	3.50	4.70	3.70	4.40	6.30	6.10	5.60	0.95%	3.55%	3.27%	2.59%
3	3.70	3.60	6.10	4.47	5.00	8.00	9.10	7.37	0.73%	4.82%	6.32%	3.95%
7	4.10	5.80	6.00	5.30	4.70	9.60	11.80	8.70	-0.82%	5.86%	8.86%	4.64%
8	1.50	2.10	1.30	1.63	2.60	3.30	2.40	2.77	1.32%	2.27%	1.05%	1.55%
9	1.30	2.40	1.00	1.57	4.10	1.20	2.60	2.63	3.45%	-0.50%	1.41%	1.45%
13	1.20	1.80	1.40	1.47	4.20	3.40	8.50	5.37	3.73%	2.64%	9.59%	5.32%
14	1.10	2.70	2.20	2.00	5.30	3.80	1.60	3.57	4.50%	2.45%	-0.55%	2.14%
15	1.80	1.20	1.30	1.43	3.50	2.90	1.70	2.70	2.82%	2.00%	0.36%	1.73%
16	1.90	3.20	1.20	2.10	3.20	2.50	1.60	2.43	1.50%	0.55%	-0.68%	0.45%
17	2.30	1.80	2.20	2.10	1.90	3.10	2.10	2.37	-0.27%	1.36%	0.00%	0.36%
20	2.70	1.20	2.70	2.20	3.50	3.90	4.90	4.10	1.77%	2.32%	3.68%	2.59%
21	1.20	2.90	2.40	2.17	2.10	1.80	7.50	3.80	-0.09%	-0.50%	7.27%	2.23%
22	4.40	5.10	2.40	3.97	5.80	4.80	6.90	5.83	2.50%	1.14%	4.00%	2.55%
24	3.20	3.00	1.90	2.70	4.90	5.70	4.20	4.93	3.00%	4.09%	2.05%	3.05%
28	3.00	1.90	1.50	2.13	5.90	3.50	8.30	5.90	5.14%	1.86%	8.41%	5.14%
29	1.80	3.60	1.00	2.13	5.00	1.90	5.70	4.20	3.91%	-0.32%	4.86%	2.82%
31	2.30	4.80	6.70	4.60	6.10	5.30	2.60	4.67	2.05%	0.95%	-2.73%	0.09%
34	2.70	13.90	8.90	8.50	13.20	8.30	5.80	9.10	6.41%	-0.27%	-3.68%	0.82%
35	1.90	8.90	2.90	4.57	3.30	5.10	4.20	4.20	-1.73%	0.73%	-0.50%	-0.50%
38	2.00	2.80	5.30	3.37	4.40	2.60	7.30	4.77	1.41%	-1.05%	5.36%	1.91%
42	4.60	5.90	3.60	4.70	5.00	16.60	7.10	9.57	0.41%	16.23%	3.27%	6.64%
44	1.90	2.40	2.20	2.17	5.70	3.20	3.40	4.10	4.82%	1.41%	1.68%	2.64%
45	2.70	4.30	3.40	3.47	2.50	5.70	4.10	4.10	-1.32%	3.05%	0.86%	0.86%
After 45 days	56.20	88.80	72.30	72.43	106.30	112.50	119.50	112.77	46.18%	54.64%	64.18%	55.00%
48	3.30	3.50	6.80	4.53	10.40	6.00	6.00	7.47	8.00%	2.00%	2.00%	4.00%
50	3.40	4.30	3.90	3.87	5.80	4.50	2.80	4.37	2.64%	0.86%	-1.45%	0.68%
51	4.10	4.20	4.30	4.20	5.30	5.50	4.30	5.03	1.50%	1.77%	0.14%	1.14%
52	3.50	4.30	4.30	4.03	3.00	4.70	3.30	3.67	-1.41%	0.91%	-1.00%	-0.50%
55	3.10	4.40	3.60	3.70	4.70	6.30	5.20	5.40	1.36%	3.55%	2.05%	2.32%
57	3.30	4.30	3.20	3.60	5.60	6.20	5.90	5.90	2.73%	3.55%	3.14%	3.14%
59	4.10	3.80	2.40	3.43	4.60	5.80	5.10	5.17	1.59%	3.23%	2.27%	2.36%
61	2.20	2.80	0.50	1.83	1.40	3.80	2.90	2.70	-0.59%	2.68%	1.45%	1.18%

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Day	CO ₂ (g/vessel)								D (%)			
	B1	B2	B3	B _{mean}	t1	t2	t3	t _{mean}	t1	t2	t3	t _{mean}
64	2.70	4.20	2.00	2.97	5.90	1.80	3.30	3.67	4.00%	-1.59%	0.45%	0.95%
104	47.50	8.80	9.90	22.07	41.60	35.30	42.70	39.87	26.64%	18.05%	28.14%	24.27%
Total	133.40	133.40	113.20	126.67	194.60	192.40	201.00	196.00	92.64%	89.64%	101.36%	94.55%

The rate of biodegradation reached 90% for average degree

 $(CO_2)_B$ = Measured cumulative CO₂ production by blank

 $(CO_2)_t$ = Measured cumulative CO₂ production by test material

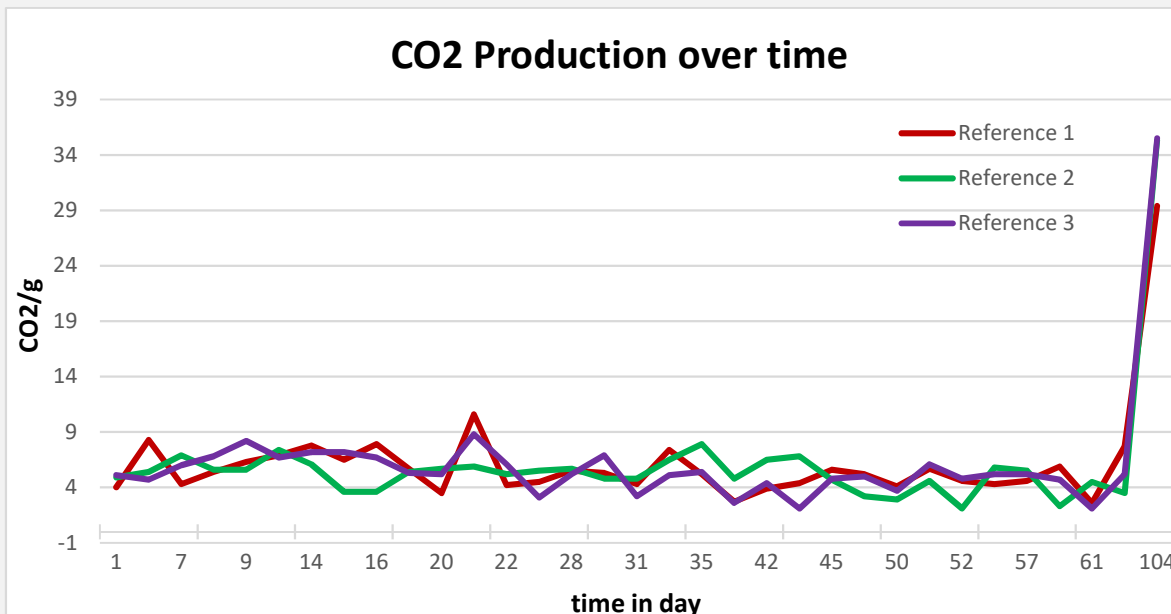
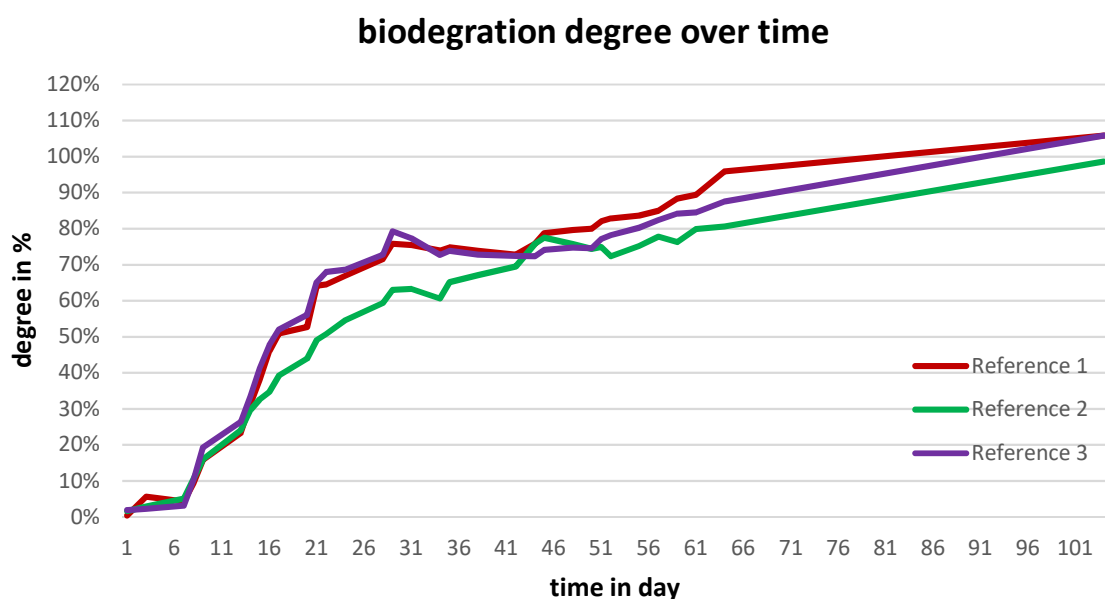
 $(CO_2)_{Bmean} = [(CO_2)_{B1} + (CO_2)_{B2} + (CO_2)_{B3}] / 3$
 $D = [(CO_2)_t - (CO_2)_{Bmean}] / ThCO_2$
 $D_{mean} = (D_{t1} + D_{t2} + D_{t3}) / 3$

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1.6.2 Reference Material

Amount of total organic carbon (TOC) of the reference material placed in each vessel	20.0g
This TOC leads to a theoretical amount of evolved carbon dioxide (ThCO ₂), caused by the degradation of the reference material	73.3g

CO₂ Evolution Curve of Reference Material*Production of CO₂ over time*

Biodegradation Curve of Reference Material

Degree of degradation over time

Controlled aerobic composting test data of reference material

Day	CO ₂ (g/vessel)								D (%)			
	B1	B2	B3	B _{mean}	R1	R2	R3	R _{mean}	R1	R2	R3	R _{mean}
1	2.90	3.50	4.70	3.70	4.00	4.90	5.10	4.67	0.41%	1.64%	1.91%	1.32%
3	3.70	3.60	6.10	4.47	8.30	5.40	4.70	6.13	5.23%	1.27%	0.32%	2.27%
7	4.10	5.80	6.00	5.30	4.30	6.90	6.00	5.73	-1.36%	2.18%	0.95%	0.59%
8	1.50	2.10	1.30	1.63	5.40	5.60	6.80	5.93	5.14%	5.41%	7.05%	5.86%
9	1.30	2.40	1.00	1.57	6.30	5.60	8.20	6.70	6.45%	5.50%	9.05%	7.00%
13	1.20	1.80	1.40	1.47	6.90	7.40	6.70	7.00	7.41%	8.09%	7.14%	7.55%
14	1.10	2.70	2.20	2.00	7.80	6.10	7.20	7.03	7.91%	5.59%	7.09%	6.86%
15	1.80	1.20	1.30	1.43	6.50	3.60	7.20	5.77	6.91%	2.95%	7.86%	5.91%
16	1.90	3.20	1.20	2.10	7.90	3.60	6.70	6.07	7.91%	2.05%	6.27%	5.41%
17	2.30	1.80	2.20	2.10	5.70	5.40	5.30	5.47	4.91%	4.50%	4.36%	4.59%
20	2.70	1.20	2.70	2.20	3.50	5.70	5.20	4.80	1.77%	4.77%	4.09%	3.55%
21	1.20	2.90	2.40	2.17	10.60	5.90	8.80	8.43	11.50%	5.09%	9.05%	8.55%
22	4.40	5.10	2.40	3.97	4.20	5.20	6.10	5.17	0.32%	1.68%	2.91%	1.64%
24	3.20	3.00	1.90	2.70	4.50	5.50	3.10	4.37	2.45%	3.82%	0.55%	2.27%
28	3.00	1.90	1.50	2.13	5.50	5.70	5.20	5.47	4.59%	4.86%	4.18%	4.55%
29	1.80	3.60	1.00	2.13	5.30	4.80	6.90	5.67	4.32%	3.64%	6.50%	4.82%
31	2.30	4.80	6.70	4.60	4.30	4.80	3.20	4.10	-0.41%	0.27%	-1.91%	-0.68%
34	2.70	13.90	8.90	8.50	7.40	6.50	5.10	6.33	-1.50%	-2.73%	-4.64%	-2.95%
35	1.90	8.90	2.90	4.57	5.20	7.90	5.40	6.17	0.86%	4.55%	1.14%	2.18%
38	2.00	2.80	5.30	3.37	2.70	4.80	2.60	3.37	-0.91%	1.95%	-1.05%	0.00%
42	4.60	5.90	3.60	4.70	3.90	6.50	4.40	4.93	-1.09%	2.45%	-0.41%	0.32%
44	1.90	2.40	2.20	2.17	4.40	6.80	2.10	4.43	3.05%	6.32%	-0.09%	3.09%
45	2.70	4.30	3.40	3.47	5.60	4.70	4.80	5.03	2.91%	1.68%	1.82%	2.14%
After 45 days	56.20	88.80	72.30	72.43	130.20	129.30	126.80	128.77	78.77%	77.55%	74.14%	76.82%
48	3.30	3.50	6.80	4.53	5.20	3.20	5.00	4.47	0.91%	-1.82%	0.64%	-0.09%
50	3.40	4.30	3.90	3.87	4.10	2.90	3.70	3.57	0.32%	-1.32%	-0.23%	-0.41%
51	4.10	4.20	4.30	4.20	5.70	4.60	6.10	5.47	2.05%	0.55%	2.59%	1.73%
52	3.50	4.30	4.30	4.03	4.60	2.10	4.80	3.83	0.77%	-2.64%	1.05%	-0.27%
55	3.10	4.40	3.60	3.70	4.30	5.80	5.20	5.10	0.82%	2.86%	2.05%	1.91%
57	3.30	4.30	3.20	3.60	4.60	5.50	5.20	5.10	1.36%	2.59%	2.18%	2.05%
59	4.10	3.80	2.40	3.43	5.90	2.30	4.70	4.30	3.36%	-1.55%	1.73%	1.18%
61	2.20	2.80	0.50	1.83	2.60	4.50	2.10	3.07	1.05%	3.64%	0.36%	1.68%

Day	CO ₂ (g/vessel)								D (%)			
	B1	B2	B3	B _{mean}	R1	R2	R3	R _{mean}	R1	R2	R3	R _{mean}
64	2.70	4.20	2.00	2.97	7.70	3.50	5.20	5.47	6.45%	0.73%	3.05%	3.41%
104	47.50	8.80	9.90	22.07	29.40	35.30	35.50	33.40	10.00%	18.05%	18.32%	15.45%
Total	133.40	133.40	113.20	126.67	204.30	199.00	204.30	202.53	105.86%	98.64%	105.86%	103.45%

Validity parameter: After 45 days the rate of biodegradation of the reference material has to be 70% or higher. This requirement has been fulfilled

$(CO_2)_B$ = Measured cumulative CO₂ production by blank

$(CO_2)_R$ = Measured cumulative CO₂ production by reference material

$(CO_2)_{Bmean}$ = $[(CO_2)_{B1} + (CO_2)_{B2} + (CO_2)_{B3}] / 3$

D = $[(CO_2)_R - (CO_2)_{Bmean}] / ThCO_2$

D_{mean} = $(D_{R1} + D_{R2} + D_{R3}) / 3$

The rate of biodegradation of the reference material is 103.45% after 104 days.

The rate of biodegradation of the test material, compared to the reference material (reference is set to 100%) is 91.4%.

The peaks in the diagrams "CO₂ production over time" are caused by not measuring the amount of CO₂ on weekends, therefore the amount on Mondays also contains the amount absorbed during the weekend and is higher than on other weekdays.

During the first 64 days, for adjusting humidity in the composting vessels water was carefully added to the vessel once a week. The concentration of oxygen was checked every day during the first week of the test and once a week afterwards. For aerobic conditions the concentration of oxygen shall be higher than 6%. The concentration shall not fall below 18% during the test.

Due to the unexpected COVID-19 epidemic, the measurement of CO₂ during Day 64 to Day 104 can't be done daily. On Day 104, according to moisture content of the compost, pH of compost, and the data we get from the measurement, the test was considered to be valid.

-End-

