

Report

Disintegration
under defined composting conditions
in a pilot-scale test
(ISO 16929 : 2019)

of

TAPIOPLAST

Customer: Siam Modified Starch Co., Ltd.

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MTEC1170/63 - 1 Additional report to the test report no. MTEC1170/63

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Test sample : TAPIOPLAST (BDT022/63)

Date received : 22 May 2020

Sample description : TPS sheet (thickness 3.390 mm)

Results:

The degree of disintegration and compost analysis of the test material, TAPIOPLAST, in a pilot-scale aerobic composting test under defined composting conditions, was determined according to ISO 16929 : 2019, subtopic 6.1.1.4 (a) 1 % by weight of (50 x 50 mm²) sheet of test sample was mixed with the biowaste before submitted to the disintegration test. The test was conducted in duplicate. The composting took place in an environment wherein temperature, aeration and humidity are closely monitored and controlled. At the end of the composting test, the resulting compost was sieved and the degree of disintegration was evaluated. The percentage of disintegration is reported as the percent of the retrieved test material, particles >2 mm, compared to initial test material input on the basis of the respective total dry solids. The result of percentage of disintegration of TAPIOPLAST was 100 % under controlled composting in pilot-scale test as showed Table 1.

Table 1 Amount of test material before and after composting and calculated disintegration degree (%D).

Composting Bin	Initial mass (g) M_i	Final mass (g) M_f	D (%)
TAPIOPLAST - 1	508.25	N/A*	100
TAPIOPLAST - 2	500.93	N/A*	100
Average	504.59	0.00	100

The quality of the resulting compost was determined using “Rottegrad” Dewar test. It was found that the resulting compost from the disintegration test of TAPIOPLAST as good quality as the blank compost. The blank compost and TAPIOPLAST compost showed a Rottegrad of V, T_{max} was in the range of 20 ± 2 °C, which demonstrated that the composts were stable and mature. The characteristic of the resulting composts were compiled in Table 6.

Table 2 Validity criteria

1. The maximum temperature during composting remains below +75 °C during the first week and below +65 °C thereafter;	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
2. The temperature remains above +60 °C for at least 1 week;	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
3. The temperature remains above +40 °C for at least 4 consecutive week;	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
4. the pH increases to above 7.0 during the test and does not fall below 5.0	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No
5. The biowaste compost of blank control has a maturity (Rottegrad) of IV to V after 12 weeks.*	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No

* The result of a maturity (Rottegrad) of blank compost was "Rottegrad V" (or $T_{\max} \leq 30$ °C after 2-5 days.

According to ISO 16929 : 2019, these four requirements were fulfilled. Therefore, the test is considered valid.

Test method:

The test was conducted in conformance with WI-MT-BDT-504-01-15 (Work instruction for determination of the degree of disintegration of the materials under defined composting conditions in a pilot-scale test which based on ISO 16929 : 2019 : Plastics – Determination of the degree of disintegration of plastic materials under defined composting condition in a pilot-scale test.

Purpose and principle of test method:

For determining the degree of disintegration and the quality of the compost of the test material under conditions simulating an intensive aerobic composting process, 1 % by weight of (50 x 50 mm²) sheet of test sample was added. The test material was exposed to an organic waste, which was obtained from input material of an artificial biowaste. The composting takes place in an environment wherein temperature, aeration and humidity were closely monitored and controlled at below 75 °C for the first week and above 60 °C at least 1 week. The temperature remained above +40 °C for at least 4 consecutive week. The test period was 12 weeks.

At the end of the composting process, the obtained compost was dried and sieved by means of a vibrating sieve over 10, 5 and 2 mm. Dry the cleaned retrieved sample particles at 40 ± 2 °C in vacuum oven until constant mass was reached. The percentage of disintegration is reported as the percent of the retrieved test material, particles >2 mm, compared to initial test material input the on the basis of the respective total dry solids.

Volume of composting bin: 200 liters PP bin.

Table 3 Characteristics of the test material

Characteristics	Test material
Name	TAPIOPLAST (BDT022/63)
Description (thickness, mm)	TPS sheet (3.390 mm)
Total dry solids* (TS, % by weight)	97.27
Moisture content* (% by weight)	2.73
Volatile solids* (VS, % on TS)	99.73
Total organic carbon** (TOC, % on TS)	41.91
Total Kjeldahl Nitrogen** (% on TS)	0.02
Addition	1% (wet weight) of 50 x 50 mm ² test sample

* Average of result test of three replications

** Average of result test of two replications

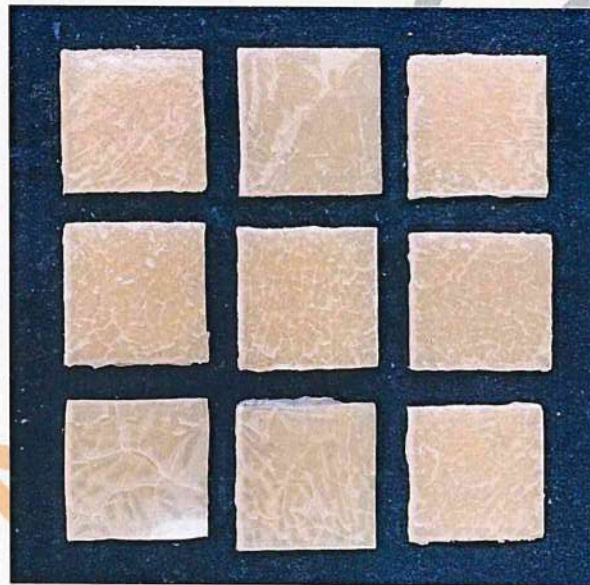


Figure 1 Visual appearance TAPIOPLAST as received

Number of test series:

- a) Two 200 litres bins for the blank; biowaste control only.
- b) Two 200 litres bins for TAPIOPLAST mix with biowaste.

The fresh biowaste was derived from the organic fraction of municipal solid waste from composting plant at Nonthaburi province, after a source separated collection. The test sample was mixed with the biowaste. Each composting bin was conducted with the same amount of biowaste (wet mass about 50 kg) and test sample (1 % by weight of 50 x 50 mm²) sheet. The amounts of the biowaste and test sample were compiled in Table 4. The composting bins were incubated in a pilot scale composting unit for 12 weeks. The composting took place in an environment wherein temperature, aeration and humidity are closely monitored and controlled. The mixture in each composting bin was regularly turned by hand to break down lumps and to remix water, micro-organism and substrate. This turning was done once a week during the first 4 weeks and then every two weeks until the end of the test. The mixture was inspected visually during turning with regard to structure and general appearance of the test sample. After turning, a small portion of each mixture in each tested bin was submitted to measure the pH and moisture content

Table 4 Amount of the biowaste and test material

Composition	Blank		Test material	
	Blank-1	Blank-2	TAPIOPLAST -1	TAPIOPLAST -2
Fruit and vegetable waste* (kg, wet weight)	25.0	25.0	25.0	25.0
Rabbit feed** (kg, wet weight)	7.5	7.5	7.5	7.5
Mature compost*** (kg, wet weight)	5.0	5.0	5.0	5.0
A bulky agent**** (kg, wet weight)	12.5	12.5	12.5	12.5
TAPIOPLAST (g)	-	-	508.25	500.93
Water (liters)	15	15	15	15

* Received from composting plant, Nonthaburi province, Bangkok.

** Purchased from C.P. DIET 086 manufactured by Perfect Companion Co., Ltd.

*** The age of the compost was 3 months

**** Wood chips and coconut bark, particle size 10-50 mm.

The conditions in the composting bins were controlled as follow:

- The temperature was controlled below 75 °C during the first week and below + 65 °C thereafter, above 60 °C for at least 1 week. The temperature remains above 40 °C for at least 4 consecutive week. The test period was 12 weeks.

- The oxygen concentration inside the composting material was controlled above 10% using compressed air. It was checked at least every working day during the first month of the test and once a week afterwards using gas analyzer

The degree of disintegration (D) can be calculated according to Eq. (1).

$$D = ((M_i - M_f)/M_i) \times 100 \dots \dots \dots (1)$$

Where

M_i is the initial dry mass of the test material

M_f is the dry mass of the residual test material recover by sieving

Results and conclusions:

Characteristics of the biowaste:

The fresh biowaste was prepared from 25 kg (around 50% by wet weight of biowaste) of freshly mixed fruit and vegetable waste, 7.5 kg (around 15% by wet weight of biowaste) of rabbit feed, 5 kg (around 10% by wet weight of biowaste) of mature compost and 12.5 kg (around 25% by wet weight of biowaste) of bulky agent. Sufficient water was added to attain good moisture content. According to ISO 16929 : 2019, the biowaste should have the moisture content, the volatile solids content of more than 50% and the pH above 5. The characteristics of the prepared biowaste at start were reported in Table 5.

Table 5 Characteristics of the biowaste at the beginning of the disintegration test

Characteristics	Biowaste
Total dry solid* (TS, % by weight)	23.04
Moisture content* (% by weight)	76.96
Volatile solid* (VS, % on TS)	90.00
Ash content* (% on TS)	10.00
pH*	6.26
Conductivity (mS/cm)	3.19
Total organic carbon** (% on TS)	41.11
Total Kjeldahl Nitrogen** (% on TS)	2.48
C/N	16.58

* Average of result test of three replications

** Average of result test of two replication

Temperature, oxygen concentration, pH and moisture content of the mixture:

The temperature in each tested bin was controlled above 60°C for about 2 weeks. After that the temperature in each tested bin was controlled in the range of 40-60°C until finish testing as shown in Figure 2.

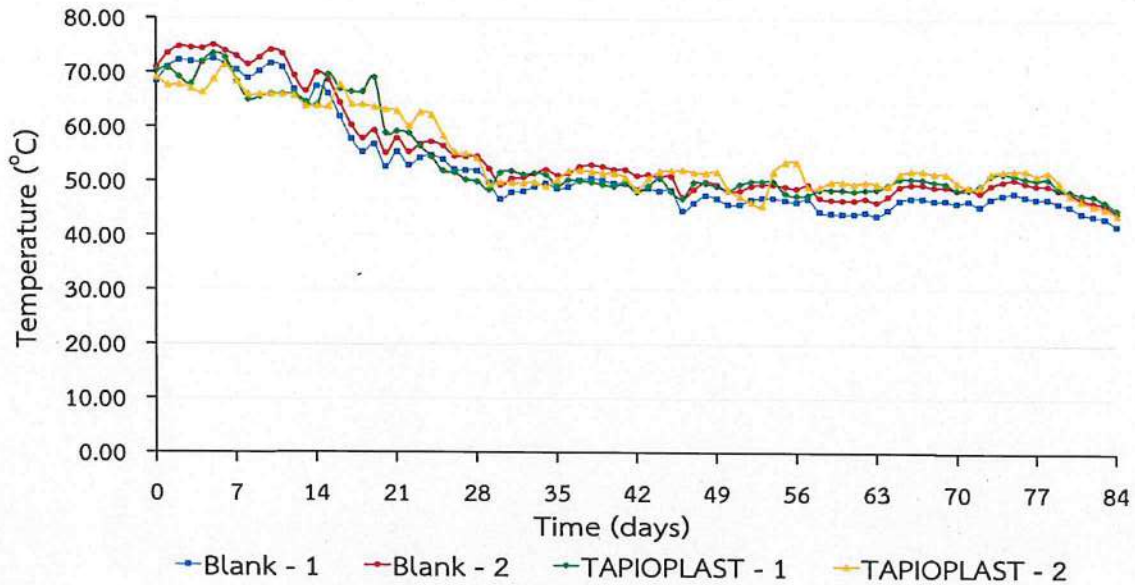


Figure 2 Temperature profile during the disintegration test

The O₂ concentration in the tested bins was controlled above 10% using compressed air.

Figure 3 showed the O₂ concentration in the exhaust air during the test.

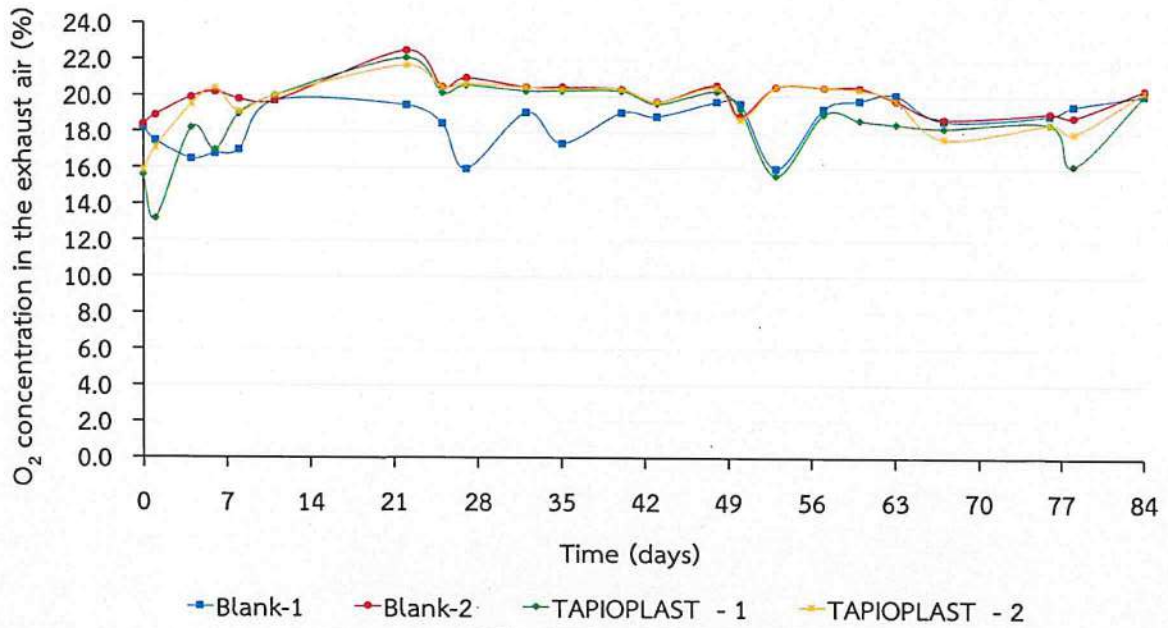


Figure 3 O₂ concentrations in the exhaust air during the disintegration test.

Figure 4 showed pH of the mixture in each tested bin during the composting test. The pH value of the biowaste at the beginning of the test was 6.26. It was found that pH of the mixture in all tested bin were changed in ranges of 6.15 – 9.12 during the test.

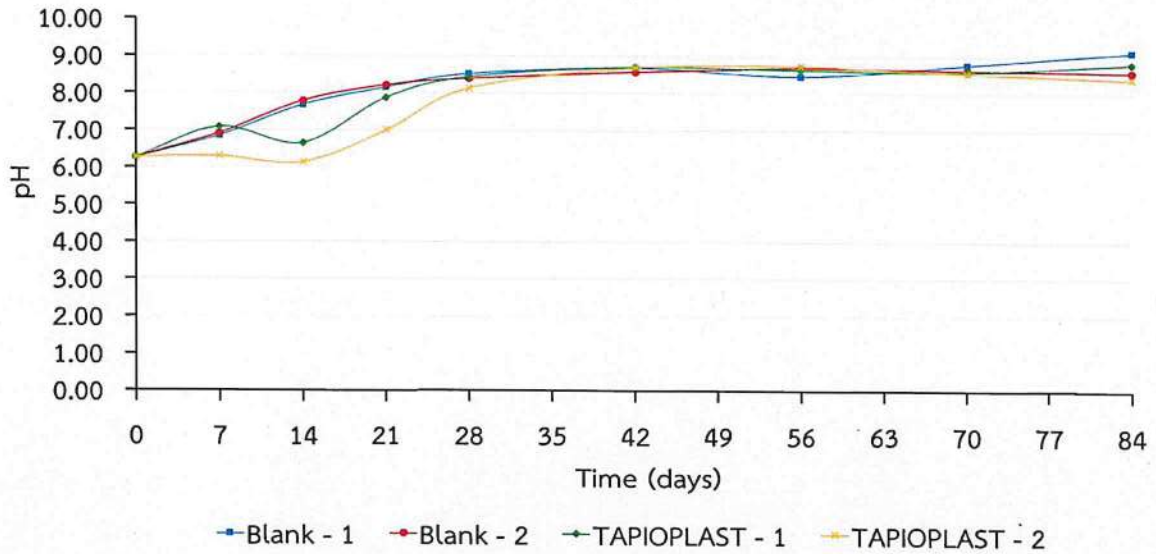


Figure 4 pH of the mixture during the disintegration test.

Figure 5 showed the humidity variation of the mixture in each tested bin during the composting test. The humidity value of the biowaste at start was 76.96. It was found that the humidity of the mixtures in all tested bin were changed in ranges 63.59 – 76.96 during the test.

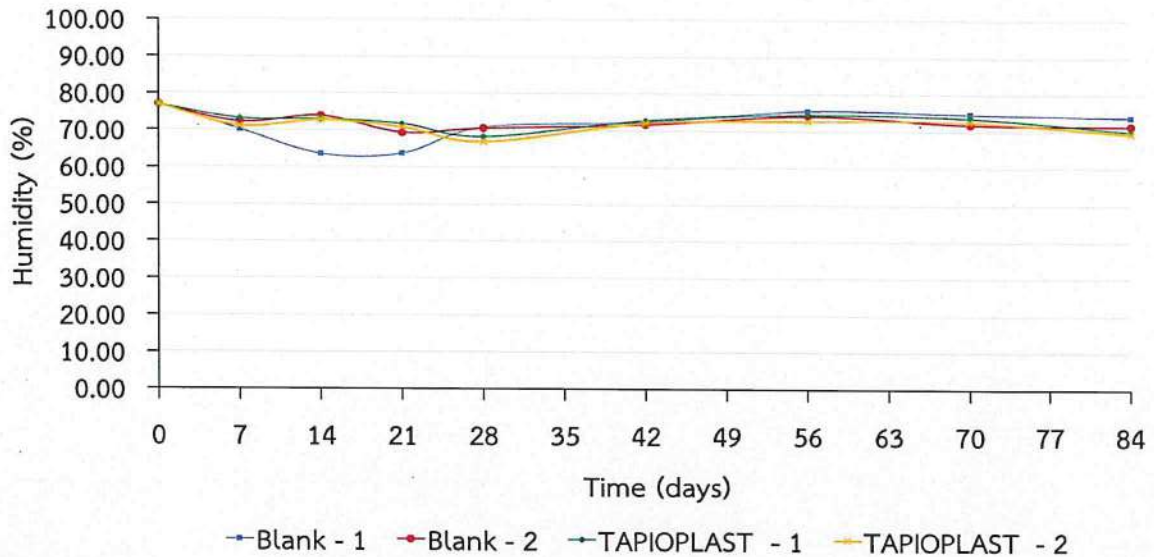


Figure 5 The humidity value of the mixture during the disintegration test.

The mixture in the composting bin was regularly turned by hand weekly during the first four weeks and then every two weeks until the end of the test. At the same time, the visual appearance was visually inspected. Figure 6-7 showed the appearance of the test mixture and TAPIOPLAST, respectively. Fragmentation of the sample was observed after 7 days. No residual material could be located through visual inspection after 14 days and the test sample seemed completely disappeared. Unpleasant odors were not detected throughout the test.



0 Day



7 Days



14 Days



21 Days



28 Days



42 Days



56 Days



70 Days



84 Days

Figure 6 Visual appearance of the mixture during the disintegration testing



Figure 7 Visual appearance of TAPIOPLAST during the disintegration testing

The degree of disintegration

At the end of the disintegration test, the whole content in each bin was dried and sieved. The resulting compost was sieved by means of a vibrating sieve over 10, 5 and 2 mm, respectively. The percentage of disintegration is reported as the percent of the retrieved test material, particles >2 mm, compared to initial test material input on the basis of the respective total dry solids. It was found that 100% disintegration was established for TAPIOPLAST.

Maturity level

The maturity level of the resulting compost was determined using the "Rottegrad" Dewar test. The blank compost and the sample compost showed the Rottegrad of V (or $T_{max} \leq 30$ °C after 2-5 days), which demonstrated that the composts were stable and mature as good quality composts.

Characteristics of the resulting compost

The homogeneous sample of the resulting compost <10 mm fraction was submitted for chemical characterizations and reported in Table 6.

Table 6 Characteristics of the resulting compost

Characteristics	Blank compost		Sample compost	
	Blank-1	Blank-2	TAPIOPLAST - 1	TAPIOPLAST - 2
Total dry solid* (TS, %)	26.12	28.59	29.93	30.55
Moisture content* (%)	73.88	71.41	70.07	69.45
Volatile solid* (VS, % on TS)	75.61	76.06	76.81	75.98
Ash content* (% on TS)	24.39	23.94	23.19	24.02
Total organic carbon** (% on TS)	33.52	34.75	33.65	33.46
Total Kjeldahl Nitrogen** (% on TS)	3.64	3.66	3.91	3.79
NO _x -N (% on TS)**	0.02	0.09	0.08	0.02
NH ₄ ⁺ -N (% on TS)**	0.00	0.00	0.01	0.00
pH*	9.12	8.58	8.81	8.39
Conductivity (E.C.,mS/cm)*	9.19	9.48	8.22	8.58
Rottegrad (T _{max} , °C)**	V	V	V	V
C/N	9.21	9.49	8.61	8.83

* Average of result test of three replications

** Average of result test of two replications

Conclusions:

TAPIOPLAST was tested for the degree of disintegration in a pilot-scale composting test. The test sample was added together with biowaste and aerobically composted for 12 weeks. The mixture was regularly turn by hand, weekly during the first four weeks and then every two weeks until the end of the test. During turning, the visual appearance of the mixture was carefully checked. At the end of the disintegration test, the whole content in the composting bin was dried and sieved. The resulting compost was sieved by means of a vibrating sieve over 10, 5 and 2 mm, respectively. The percentage of disintegration was reported as the percent of the retrieved test material, particles >2 mm, compared to initial test material input the on the basis of the respective total dry solids. 100% disintegration in the pilot-scale composting test was established for TAPIOPLAST .

End of Report

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