TECHNICAL REPORT 22311632 - November 20th 2023

"OK biodegradable WATER"

TECHNICAL REPORT FOR THE CERTIFICATION OF PRODUCT

CONFORMING TO CRITERIA DEFINED BY:

Program "OK biodegradable WATER"

with reference: Doc Ref: OK11-e, Edition: C, Application Date: 2013-03-01

Test material	
Sample Code	22311632
Producer identification	PVA PRO JSC
Material identification	1.1.1. In form of Resin or Granulates; 1.1.2. In form of Film
Commercial name of the product	AQUAFLEX - AQUAFLEX FILM 61 µm
Arrival date	August 24th 2023
Color	Light yellow granulates, light yellow and transparent film
Thickness	Film (61 µm): 62 ± 5 µm µm
Grammage	Film (61 µm): 99,8 ± 4,2 g/m^2
Visual aspect	Granulates and Film
Starting date for tests	September 1st 2023

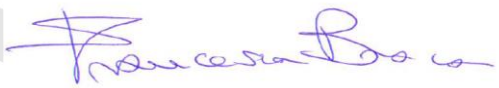
November 20th, 2023

LABORATORY ANALYSES SUPERVISOR

BIODEGRADABILITY & COMPOSTABILITY

CHEMICAL DEPT.

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1. INTRODUCTION

This technical note describes the results obtained on the following sample:

Table 1. Test material information and identification.

Test material	
Sample Code	22311632
Producer identification	PVA PRO JSC
Material identification	1.1.1. In form of Resin or Granulates; 1.1.2. In form of Film
Commercial name of the product	AQUAFLEX - AQUAFLEX FILM 61 µm
Arrival date	August 24th 2023
Color	Light yellow granulates, light yellow and transparent film
Thickness	Film (61 µm): 62 ± 5 µm µm
Grammage	Film (61 µm): 99,8 ± 4,2 g/m^2
Visual aspect	Granulates and Film
Starting date for tests	September 1st 2023

According to the following Regulation and Programs:

- *Program "OK biodegradable WATER", Doc Ref: OK11-e, Edition: C, Application Date: 2013-03-01;*
- *TÜV Austria TS-OK-15e;*
- *TÜV Austria TS-OK-16e;*

to verify the compliance to the **requirements for recoverable plastic material through degradation in aqueous medium** according to the above-mentioned scheme.

In particular, this technical report describes the overall results obtained by carrying on the experimental steps for the assessment of the conformity to the requirements as following listed:

1) Chemical characterization according to EN13432
2) Biodegradation test with OK biodegradable WATER conditions, temperature between 20 - 25 °C
3) Solubility and dispersibility

as informed by the Producer (PVA PRO JSC).

2. IDENTIFICATION OF THE PRODUCT

The previous Table 1 summarises the main information for the description of the test material, in Figure 1, the pictures of the test material are presented.



Figure 1. Pictures of the sample.

- Material identification: 1.1.1. In form of Resin or Granulates; 1.1.2. In form of Film
- Commercial name of the product: AQUAFLEX - AQUAFLEX FILM 61 µm
- Product description: Granulates and Film
- Material producer: PVA PRO JSC
- Production site: 89 Vinh Hoi, Q4, Ho Chi Minh City, VN
- Material formulation: the exact formulation is provided by PVA PRO JSC to TÜV Austria, directly.
- Color: Light yellow granulates, light yellow and transparent film
- Average thickness: 62 ± 5 µm µm
- Average grammage = 99,8 ± 4,2 g/m^2
- Other relevant information: none

According to the results related to the determination of the volatile solids content (expressed in percentage on dry matter, % dm, reference value > 50% dm), the sample complies with the requirements of EN 13432, as reported in ANNEX 1 - Test report n. 22311632/1.

Volatile solids content = 96,04 % w/w dm

2.1. Heavy metals and fluorine concentrations

The results related to the quantification of the heavy metals and fluorine concentrations of the sample are reported in Table 2 and ANNEX 1 - Test Report n. 22311632/1: **the test material complies with the requirements of EN 13432 for all the parameters and the specific limit for Cobalt (table II of the Trade Memorandum T-4-93)**. Further heavy metals requirements are not defined by local Regulations as the Producer (PVA PRO JSC) informed the laboratory.

Table 2. Heavy metals and fluorine concentrations compared to EN 13432 limits.

		22311632/1	EN 13432:2000
As	mg/kg dm	0,279	5
Cd	mg/kg dm	0,284	0,5
Co	mg/kg dm	0,279	38*
Cr tot	mg/kg dm	0,386	50
Hg	mg/kg dm	< 0,1	0,5
Mo	mg/kg dm	0,547	1
Ni	mg/kg dm	0,572	25
Pb	mg/kg dm	0,452	50
Cu	mg/kg dm	1,78	50
Se	mg/kg dm	0,353	0,75
Zn	mg/kg dm	26,8	150
F	mg/kg dm	< 25	100

*Cobalt limit: table II of the Trade Memorandum T-4-93.

2.2. FTIR spectrum

Infrared spectroscopic analysis (FTIR) is performed for the characterization of the main organic component. The determination is carried out by using the ATR (Total Attenuated Reflectance) technique on the material as it is. The spectrum is registered with 32 acquisitions and the result spectrum of the sample is shown in Figure 2.

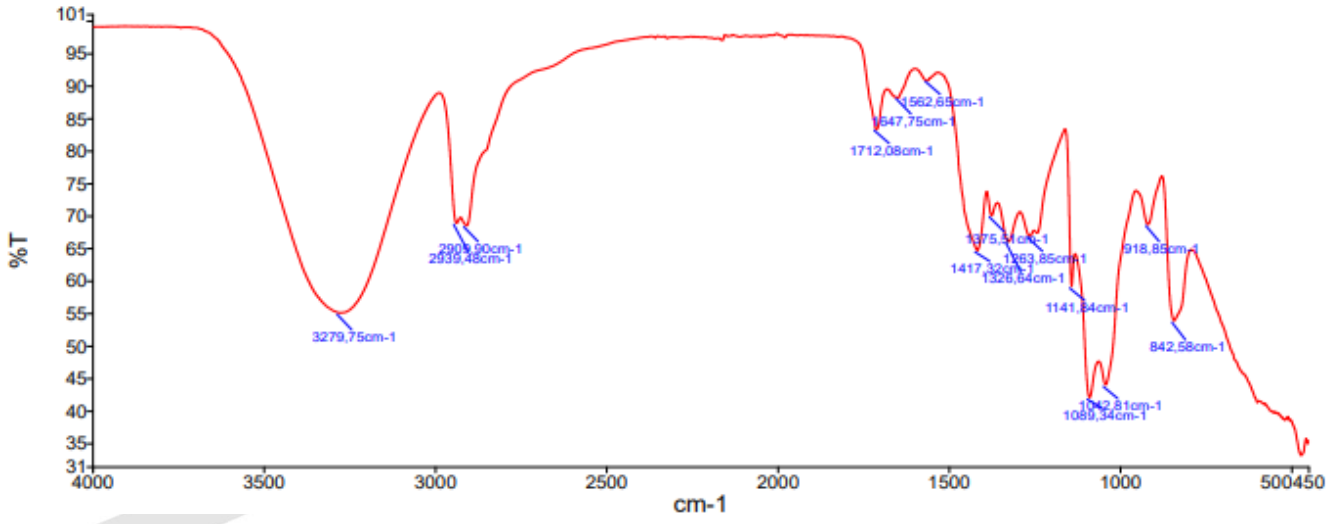


Figure 2. FTIR Spectrum of test material.

3. BIODEGRADABILITY TEST IN AN AQUEOUS MEDIUM

Biodegradability is carried on according to UNI EN ISO 14852:2021 (except for test duration) and Program OK 11-i official method at temperature range between 20 – 25°C. In the Test Reports:

- n. 22311632/1 for TEST MATERIAL CHARACTERIZATION (see ANNEX 1),
- n. 22311632/7 for BIODEGRADABILITY TEST - OK WATER (see ANNEX 2)

the results of the analysis are reported. The test started on September 21st 2023 and ended on November 16th 2023.

3.1. Information on inoculum and reference material (cellulose)

The used inoculum (no pre-exposed) was collected at the domestic wastewater treatment plant (San Jacopo, Pisa) on September 20th 2023. The inoculum and the nutritive solution used for the biodegradation test in aqueous medium were characterized for the main parameters (Table 3).

The reference material is microcrystalline cellulose, average dimension of the particles is 20 µm, produced by ALDRICH, distributed by SIGMA ALDRICH SRL, Code number 310697-500G, Lot number MKCL9441, Expiration date September 28th 2023. The characterizations of this reference material are provided in Table 3 and Test Report n. 22311632/2, ANNEX 2.

Table 3. Characterizations for biodegradation test.

Substrate -Inoculum (Sludge) + Nutritive solution	
ARCHA REAGENT CODE (Sludge)	R02317001 (C2023004582)
Arrival date (Sludge)	20/09/2023

Parameter	C (% dm)	N (% dm)	Dry matter (%)	S.S (mg/L)	N (mg/L)	C (mg/L)
Nutritive solution	-	-	-	-	3,97	15,4
Inoculum (sludge)	-	-	-	2190		
Reference material (Cellulose)	41,4	-	97,7	-	-	-
Test material	50,5	0,05	99,4	-	-	-

3.2. Preparation of the biodegradability test

In Table 4, the main information about the amount of inoculum, nutritive solution and test material needed to start the biodegradation test and the compliance with the content of suspended solids are presented.

Table 4. Vessels preparation to start the biodegradation test.

Vessel	Blank 1	Blank 2	Blank 3	Reference 4	Reference 5	Test 6	Test 7	Test 8
Inoculum volume (ml)	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0
Total volume (nutritive solution+inculum) ml	300,0	300,0	300,0	300,0	300,0	300,0	300,0	300,0
Actual material weight as it is (mg)	-	-	-	99,1	100,3	97,2	97,5	97,4
Suspended Solids (mg)	21,9	21,9	21,9	21,9	21,9	21,9	21,9	21,9
Compliance (30 mg/L ≤ S.S ≤ 1000 mg/L)	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant

3.3. *Main characteristics of the equipment*

The equipment for biodegradation test in aqueous medium is listed below:

- Climatic chamber (Set-point Temperature at 23 ± 1°C)
- Glass bottles (500 mL as volume)
- Magnetic stirrer
- Air supply system, consisting of compressor, filtration and purification system and flow regulation
- Carbon dioxide determination system: continuous infrared analyzer
- Flowmeter
- Pipes for the passage of gases, to connect the biodegradation vessels to the air supply and to the carbon dioxide determination system
- Datalogger for temperature
- Analytical balance
- Mixer
- pH-meter
- Pipettes and micropipettes various volumes



Figure 3. Picture of the vessels in the climatic chamber for the biodegradation test in aqueous medium.

3.4. Test temperature range for the biodegradation test in aqueous medium

The biodegradability test in aqueous medium was carried on at fixed temperature (23 ± 1°C) in the climatic chamber, with temperature monitoring: in Figure 4, the acquired data for temperature monitoring during the biodegradability test are presented.

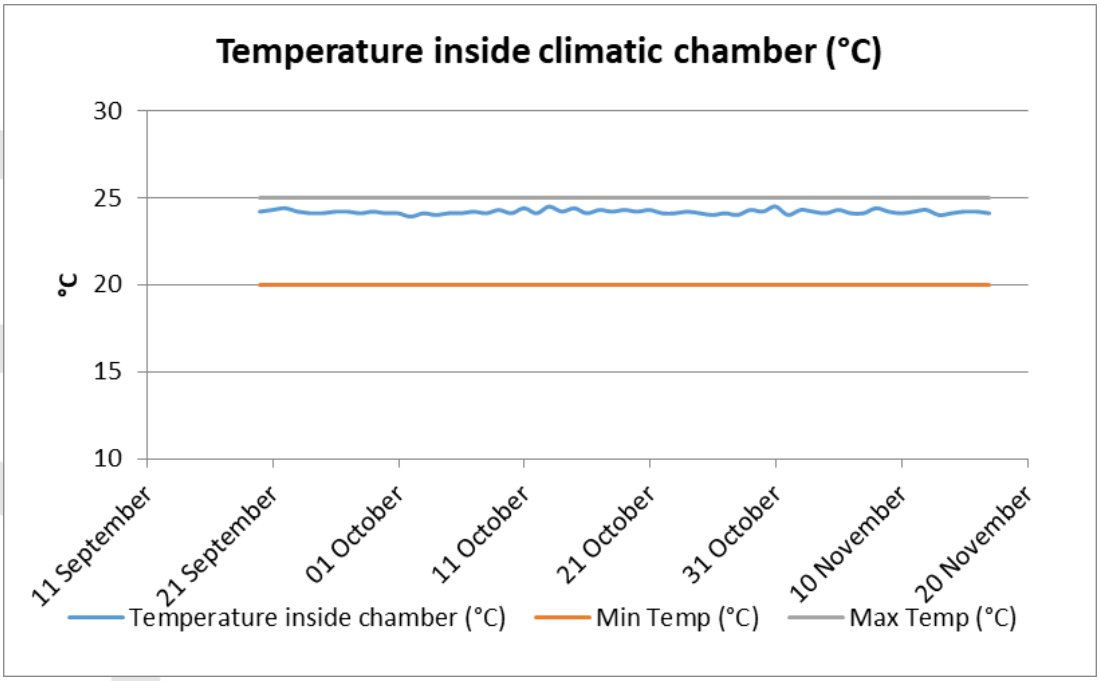


Figure 4. Temperature monitoring during biodegradability test in climatic chamber (23°C, temperature setting).

3.5. Experimental results for biodegradation test

The most meaningful results are presented:

- CO_2 cumulative production for single vessel of blank inoculum, reference material and tested sample, see Figure 5,
- CO_2 evolved for single vessel of blank, reference material and tested sample (not subtracted by the blank compost and not cumulative, as raw data), see Table 5,
- Biodegradability percentages by each vessel for reference and test materials, in graphical and tabular form (Figure 6 and Figure 7, Table 6), absolute values;
- Average biodegradability percentages for reference and test materials among vessels, in graphical and tabular form (Figure 8, Table 6), absolute values.

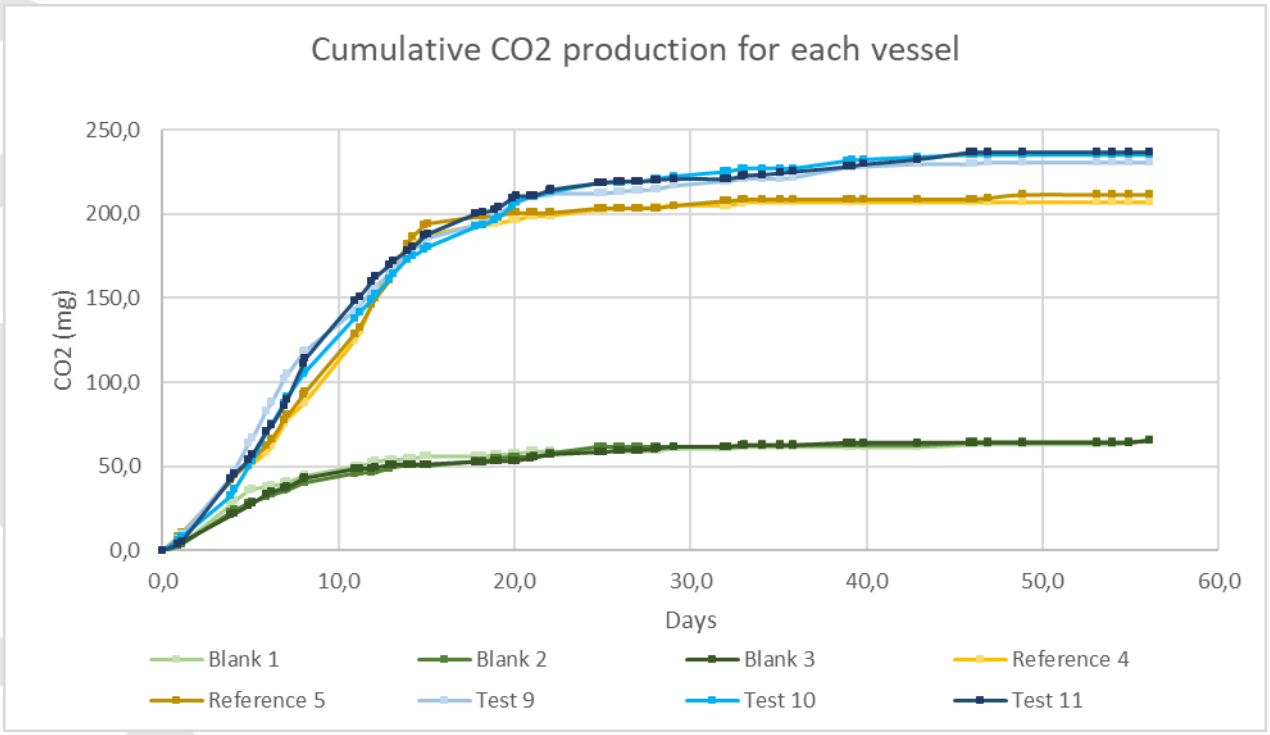


Figure 5. Accumulated measured CO_2 production for single vessel.

Table 5. Accumulated measured CO_2 production by each vessel for blank, reference and test materials and calculated average values.

TIME (days)	Blank 1	Blank 2	Blank 3	Average Blank	Reference 4	Reference 5	Average Reference	Test 6	Test 7	Test 8	Average Test
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,94	2,74	2,71	3,56	3,00	4,94	8,22	6,58	6,23	5,48	7,90	6,54
1,13	4,21	4,06	5,07	4,45	7,39	10,64	9,01	9,08	9,20	10,73	9,67
3,92	27,41	22,91	21,00	23,77	43,60	41,53	42,56	56,92	77,89	61,27	65,36
4,15	29,43	24,13	21,98	25,18	45,71	44,50	45,10	60,44	82,21	66,00	69,55
4,95	36,04	28,39	26,66	30,36	50,89	52,87	51,88	71,59	94,98	80,23	82,27
5,13	36,63	28,98	27,87	31,16	51,76	54,31	53,03	73,70	97,28	82,62	84,53
5,91	38,12	32,00	33,49	34,54	58,38	62,41	60,40	81,25	104,06	88,01	91,10
6,15	38,59	33,19	34,91	35,57	62,16	66,17	64,16	83,18	106,59	88,84	92,87
6,92	40,06	35,43	37,14	37,54	75,26	77,61	76,44	89,31	116,34	92,28	99,31
7,14	40,68	36,17	37,68	38,18	78,22	80,27	79,24	91,59	118,97	93,47	101,34
7,99	44,39	40,26	42,61	42,42	87,13	92,51	89,82	108,26	130,75	98,42	112,48
8,08	44,66	40,57	43,02	42,75	88,30	94,12	91,21	110,23	132,05	99,28	113,85
10,87	49,97	45,96	48,34	48,09	124,74	128,65	126,69	128,81	158,60	115,21	134,21
11,16	50,52	46,23	48,76	48,50	129,82	132,76	131,29	131,56	162,44	118,25	137,42
11,86	52,19	46,57	48,76	49,17	146,62	146,11	146,36	141,23	172,84	130,04	148,04
12,11	53,17	46,82	49,13	49,70	151,98	149,90	150,94	143,08	175,19	132,76	150,34
12,88	54,25	49,02	50,95	51,41	163,76	160,76	162,26	149,62	181,70	140,72	157,35

13,11	54,25	49,82	51,18	51,75	167,27	165,26	166,26	152,80	184,18	144,09	160,36
13,92	54,64	50,60	51,18	52,14	179,25	182,14	180,69	164,14	192,66	156,20	171,00
14,15	54,98	50,60	51,18	52,25	181,95	186,41	184,18	166,88	194,37	158,52	173,26
14,86	56,01	50,60	51,18	52,59	187,04	193,55	190,29	171,64	199,49	160,59	177,24
15,10	56,12	50,60	51,29	52,67	187,61	194,35	190,98	172,67	201,44	161,04	178,38
17,85	56,12	53,21	52,62	53,98	192,85	198,27	195,56	183,12	215,94	172,80	190,62
18,16	56,27	53,51	52,62	54,13	193,30	198,27	195,78	184,32	216,68	174,00	191,67
18,86	56,95	54,53	52,95	54,81	193,98	198,61	196,29	187,76	217,36	176,41	193,84
19,08	57,16	55,06	53,06	55,09	194,51	199,13	196,82	189,15	217,56	178,12	194,95
19,85	57,53	55,79	53,06	55,46	196,00	200,62	198,31	194,48	219,04	186,41	199,98
20,08	57,74	55,79	53,28	55,60	196,43	200,62	198,53	195,63	219,26	188,19	201,03
20,92	58,94	55,79	54,89	56,54	198,43	200,62	199,53	200,10	220,07	190,61	203,59
21,09	59,03	55,96	55,23	56,74	198,60	200,62	199,61	200,86	220,32	190,94	204,04
21,96	59,03	57,62	56,90	57,85	198,60	200,62	199,61	204,20	221,15	193,41	206,25
22,12	59,03	58,00	57,13	58,05	198,83	200,78	199,80	204,66	221,30	193,72	206,56
24,83	59,03	61,88	58,44	59,78	202,71	203,40	203,05	208,54	226,55	200,27	211,79
25,08	59,03	61,88	58,56	59,82	202,71	203,40	203,05	209,02	226,91	200,63	212,19
25,92	59,03	61,88	59,37	60,09	203,11	203,40	203,26	210,22	227,71	201,83	213,25
26,15	59,03	61,88	59,48	60,13	203,22	203,40	203,31	210,55	228,05	202,15	213,58
26,95	59,03	61,88	59,48	60,13	203,22	203,40	203,31	211,71	228,43	203,72	214,62
27,13	59,12	61,88	59,48	60,16	203,22	203,40	203,31	211,79	228,52	204,24	214,85
27,96	59,52	61,88	60,28	60,56	203,63	203,40	203,51	213,00	230,12	205,05	216,06
28,09	59,65	61,88	60,54	60,69	203,83	203,46	203,65	213,26	230,65	205,24	216,38
29,14	60,66	61,88	61,55	61,36	204,85	204,99	204,92	215,81	233,17	207,75	218,91
31,92	60,66	61,88	61,55	61,36	204,85	207,71	206,28	222,56	237,14	211,72	223,81
32,08	60,66	61,88	61,55	61,36	204,85	207,71	206,28	222,88	237,38	211,80	224,02
32,90	61,43	62,65	62,32	62,14	206,40	208,49	207,45	224,04	237,38	213,73	225,05
33,12	61,65	62,86	62,53	62,35	206,82	208,71	207,77	224,15	237,38	214,59	225,37
34,13	61,65	62,86	62,53	62,35	206,82	208,71	207,77	225,60	237,38	216,06	226,35
35,15	61,65	62,86	62,53	62,35	206,82	208,71	207,77	227,58	237,38	217,52	227,49
35,84	61,65	62,86	62,53	62,35	206,82	208,71	207,77	228,92	237,38	218,85	228,38
38,94	61,65	62,86	64,03	62,85	206,82	208,71	207,77	231,88	237,38	224,99	231,41
39,16	61,65	62,86	64,13	62,88	206,82	208,71	207,77	231,88	237,48	225,30	231,55
39,85	61,65	62,86	64,13	62,88	206,82	208,71	207,77	231,88	237,81	225,30	231,66
42,88	61,65	62,86	64,13	62,88	206,82	208,71	207,77	231,88	237,81	226,74	232,14
45,88	63,09	64,29	64,13	63,84	206,82	208,71	207,77	231,88	237,81	228,17	232,62
46,11	63,21	64,40	64,13	63,91	206,82	208,71	207,77	231,88	237,81	228,17	232,62
46,93	63,21	64,40	64,13	63,91	206,82	209,49	208,16	232,67	238,61	228,96	233,41
48,92	63,21	64,40	64,13	63,91	206,82	211,38	209,10	234,59	240,55	230,88	235,34
53,12	63,21	64,40	64,13	63,91	206,82	211,38	209,10	234,59	240,55	230,88	235,34
53,96	63,21	64,40	64,13	63,91	206,82	211,38	209,10	234,59	240,55	230,88	235,34
54,93	64,13	64,40	64,13	64,22	206,82	211,38	209,10	234,59	240,55	230,88	235,34
56,13	66,41	65,55	65,29	65,75	206,82	211,38	209,10	234,59	240,55	230,88	235,34

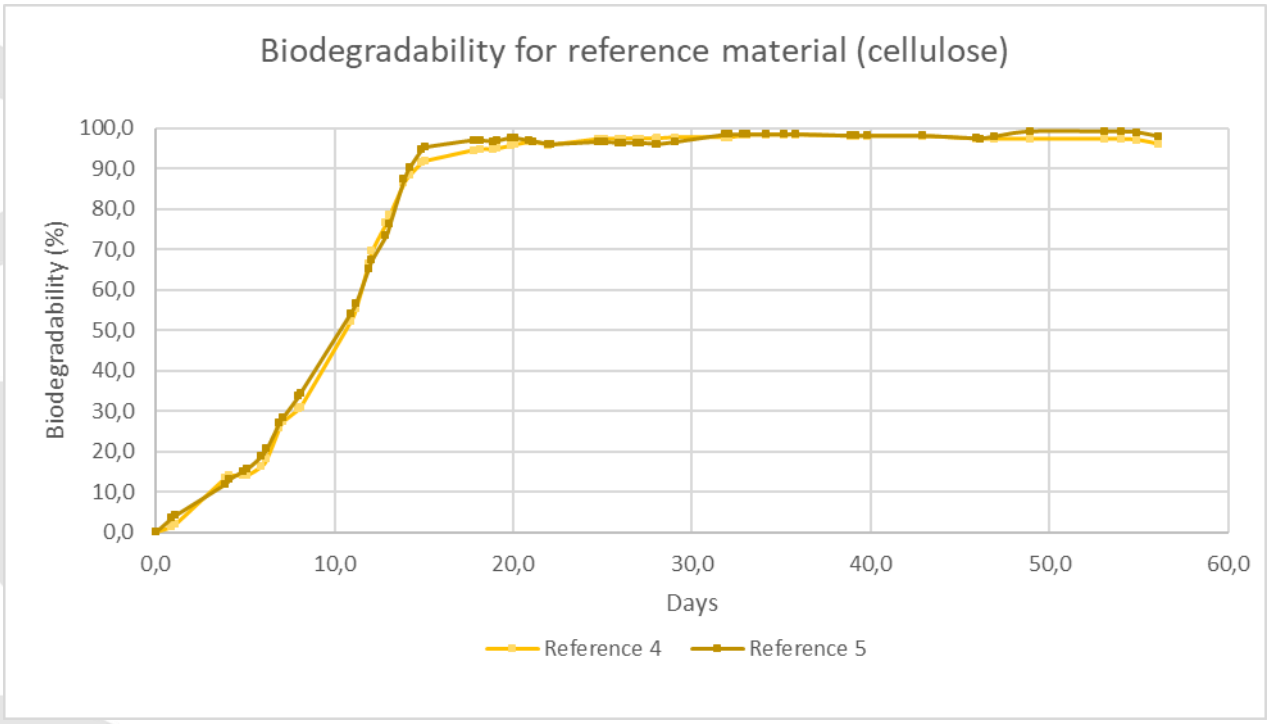


Figure 6. Biodegradation degree of reference material (each vessel).

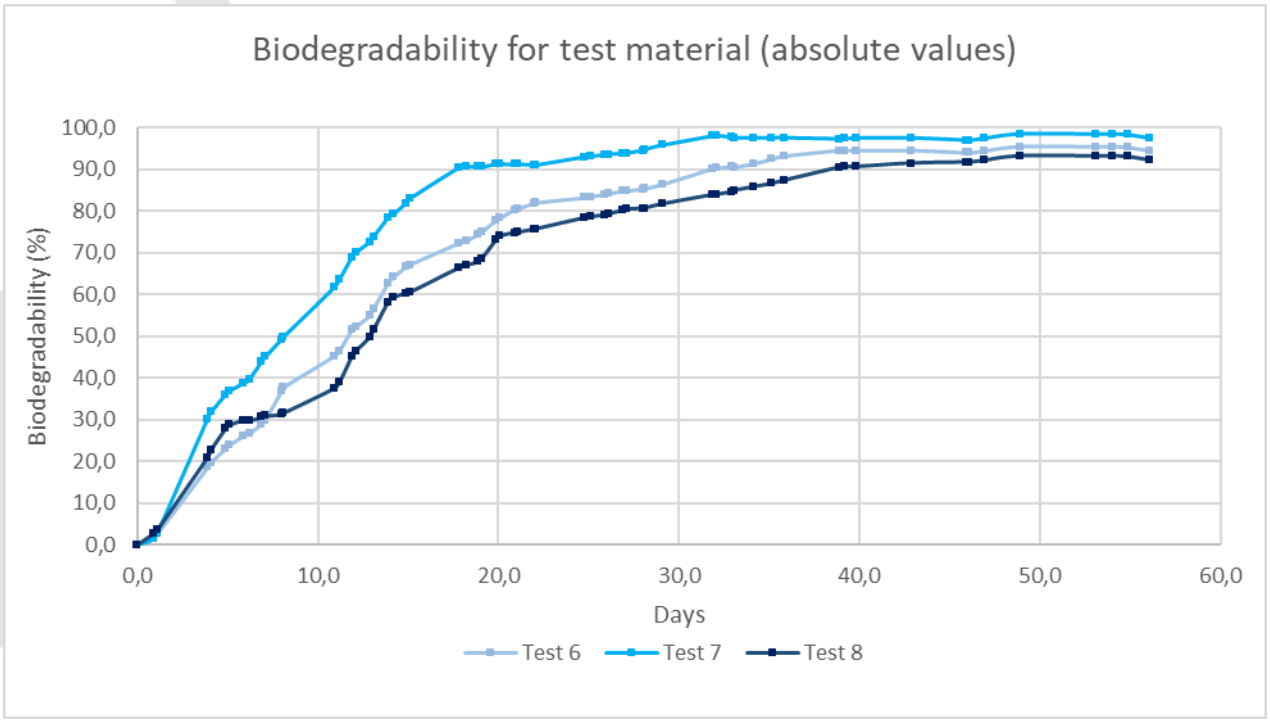


Figure 7. Biodegradation degrees (as absolute values) of test material (each vessel).

Table 6. Biodegradability percentages by each vessel for reference and test materials and calculated average values (as absolute).

TIME (days)	Reference 4	Reference 5	Average Reference	Test 6	Test 7	Test 8	Average Test
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0,94	1,32	3,51	2,41	1,80	1,38	2,73	1,97
1,13	2,00	4,16	3,08	2,59	2,65	3,50	2,91
3,92	13,49	11,94	12,71	18,52	30,15	20,91	23,20
4,15	13,97	12,99	13,48	19,70	31,77	22,76	24,75
4,95	13,97	15,13	14,55	23,04	36,00	27,81	28,95
5,13	14,01	15,56	14,79	23,77	36,84	28,70	29,77
5,91	16,22	18,74	17,48	26,10	38,73	29,82	31,55
6,15	18,09	20,57	19,33	26,61	39,57	29,71	31,96
6,92	25,66	26,94	26,30	28,93	43,90	30,53	34,45
7,14	27,25	28,30	27,77	29,85	45,02	30,84	35,23
7,99	30,42	33,68	32,05	36,80	49,21	31,23	39,08
8,08	30,99	34,53	32,76	37,71	49,75	31,52	39,66
10,87	52,15	54,15	53,15	45,11	61,57	37,43	48,04
11,16	55,32	56,64	55,98	46,42	63,48	38,90	49,60
11,86	66,30	65,16	65,73	51,45	68,90	45,10	55,15
12,11	69,59	67,35	68,47	52,18	69,91	46,32	56,14
12,88	76,44	73,51	74,98	54,89	72,59	49,81	59,10
13,11	78,60	76,31	77,45	56,47	73,78	51,50	60,58
13,92	86,49	87,39	86,94	62,59	78,29	58,04	66,31
14,15	88,25	90,19	89,22	64,06	79,18	59,27	67,50
14,86	91,47	94,76	93,11	66,53	81,84	60,23	69,53
15,10	91,81	95,24	93,53	67,06	82,88	60,44	70,13
17,85	94,49	96,99	95,74	72,17	90,23	66,26	76,22
18,16	94,69	96,89	95,79	72,75	90,56	66,85	76,72
18,86	94,69	96,67	95,68	74,30	90,56	67,82	77,56
19,08	94,86	96,83	95,85	74,92	90,52	68,62	78,02
19,85	95,62	97,59	96,61	77,69	91,14	73,03	80,62
20,08	95,82	97,49	96,66	78,25	91,18	73,95	81,13
20,92	96,54	96,86	96,70	80,23	91,11	74,77	82,03
21,09	96,52	96,73	96,62	80,54	91,14	74,85	82,18
21,96	95,77	95,98	95,87	81,79	90,98	75,60	82,79
22,12	95,78	95,95	95,87	81,93	90,95	75,66	82,85
24,83	97,25	96,55	96,90	83,13	92,91	78,35	84,80
25,08	97,22	96,52	96,87	83,38	93,09	78,53	85,00
25,92	97,31	96,34	96,82	83,90	93,39	79,04	85,44
26,15	97,36	96,31	96,84	84,06	93,55	79,21	85,61
26,95	97,36	96,31	96,84	84,71	93,77	80,08	86,19
27,13	97,34	96,29	96,82	84,74	93,80	80,35	86,30
27,96	97,34	96,02	96,68	85,19	94,47	80,58	86,75

28,09	97,39	95,98	96,69	85,26	94,69	80,62	86,86
29,14	97,63	96,56	97,09	86,31	95,72	81,64	87,89
31,92	97,63	98,38	98,01	90,09	97,93	83,86	90,62
32,08	97,63	98,38	98,01	90,26	98,06	83,90	90,74
32,90	98,16	98,39	98,27	90,48	97,63	84,55	90,89
33,12	98,30	98,39	98,35	90,42	97,51	84,91	90,95
34,13	98,30	98,39	98,35	91,23	97,51	85,73	91,49
35,15	98,30	98,39	98,35	92,34	97,51	86,54	92,13
35,84	98,30	98,39	98,35	93,09	97,51	87,29	92,63
38,94	97,96	98,06	98,01	94,46	97,24	90,43	94,04
39,16	97,94	98,03	97,99	94,45	97,27	90,58	94,10
39,85	97,94	98,03	97,99	94,45	97,46	90,58	94,16
42,88	97,94	98,03	97,99	94,45	97,46	91,39	94,43
45,88	97,29	97,39	97,34	93,91	96,92	91,65	94,16
46,11	97,23	97,34	97,29	93,87	96,88	91,61	94,12
46,93	97,23	97,86	97,55	94,31	97,33	92,05	94,56
48,92	97,23	99,13	98,18	95,38	98,41	93,12	95,64
53,12	97,23	99,13	98,18	95,38	98,41	93,12	95,64
53,96	97,23	99,13	98,18	95,38	98,41	93,12	95,64
54,93	97,02	98,93	97,98	95,21	98,24	92,94	95,46
56,13	95,99	97,90	96,94	94,36	97,39	92,09	94,61

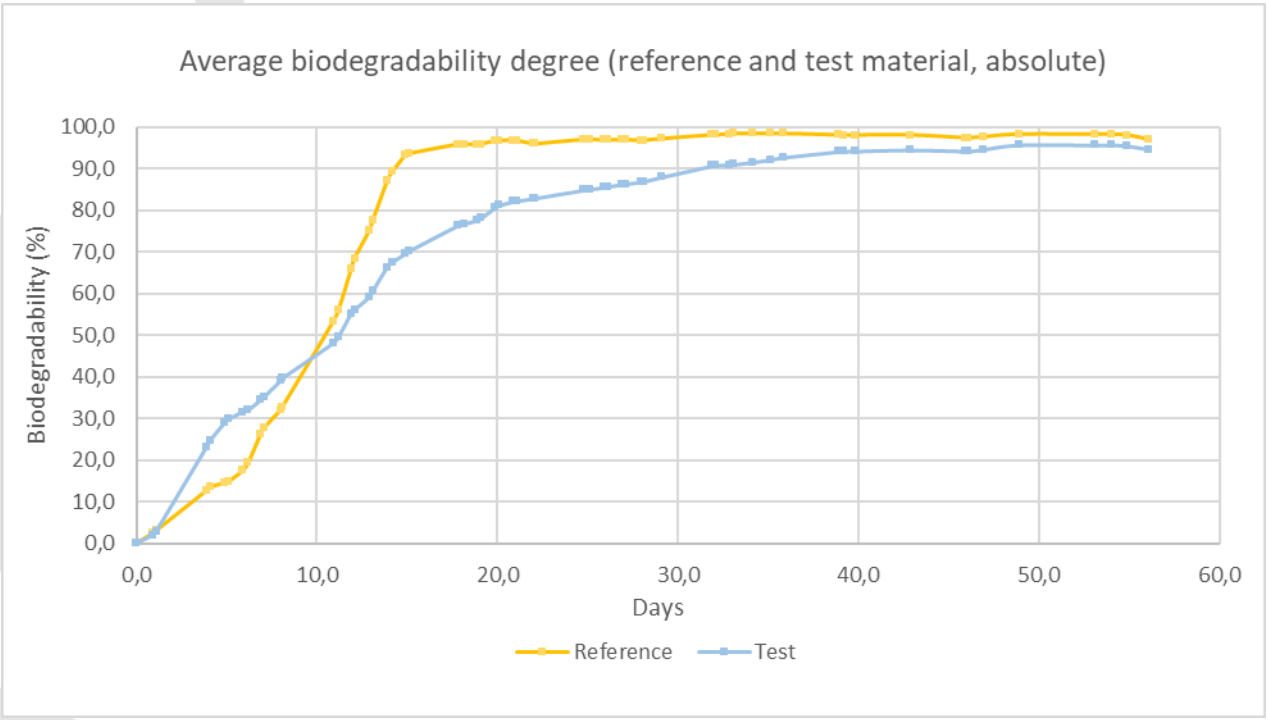


Figure 8. Average biodegradation degrees for reference and test materials (as absolute values).

3.6. Requirements for the biodegradation test in aqueous medium

The biodegradation test met all the requirements for its validation, according to the validity criteria, as detailed list below and in Table 7:

1. the degree of biodegradation of the reference material is > 60% at the end of the test (98,0% as average experimental value);
2. the differences between the percentage biodegradation of the reference material in the different vessels is less than 20% at the end of the test;
3. the amount of CO_2 in (mg) that has evolved from the blank at the end of the test does not exceed three times the content of suspended solids loaded with the addition of the inoculum (mg);
4. the amount of CO_2 evolved from the three blanks is within ± 20% of the mean value at the end of the test.

Table 7. Compliance with all requirements for the validity of the biodegradation test in aqueous medium.

Vessel	Blank 1	Blank 2	Blank 3	Reference 4	Reference 5	Test 6	Test 7	Test 8
Inoculum volume (ml)	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0
Total volume (nutritive solution+inculum) ml	300,0	300,0	300,0	300,0	300,0	300,0	300,0	300,0
Actual material weight as it is (mg)	-	-	-	99,1	100,3	97,2	97,5	97,4
Suspended Solids (mg)	21,9	21,9	21,9	21,9	21,9	21,9	21,9	21,9
Compliance (30 mg/L ≤ S.S ≤ 1000 mg/L)	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant
Actual dry material weight (mg)	-	-	-	96,8	98,0	96,6	96,9	96,8
Carbon content in the final mixture (mg/L)	-	-	-	149,0	150,6	178,1	178,6	178,4
Compliance (30 mg/L ≤ C ≤ 2000 mg/L)	-	-	-	Compliant	Compliant	Compliant	Compliant	Compliant
C/N ratio	-	-	-	37,5	37,9	43,1	43,2	43,2
Compliance (35 < C/N < 45)	-	-	-	Compliant	Compliant	Compliant	Compliant	Compliant
Theoretical CO2 for test material (mg)	-	-	-	147,0	148,8	178,9	179,5	179,3
	Blank 1	Blank 2	Blank 3	Reference 4	Reference 5	Test 6	Test 7	Test 8
Final pH	7,19	7,18	7,2	7,19	7,2	7,18	7,26	7,21
CO2 (mg) after 56 days	64,13	64,40	64,13	-	-			
Compliance [mg CO2 56 gg < 3 x mg S.S]	Compliant	Compliant	Compliant	-	-	-	-	-
Compliance [mg CO2 56 gg = average value ± 20%]	Compliant	Compliant	Compliant	-	-			
Final D (%) after 56 days	-	-	-	97,0	98,9	95,2	98,2	92,9
Compliance [D > 60%] after 56 days	-	-	-	Compliant	Compliant	-	-	-
D average (%)	-	-	-	98,0		95,5		
D relative (%)	-	-	-	-		**97,4**		

3.7. Conclusion on the biodegradation test in aqueous medium

The test material complies with the requirements of Program “OK biodegradable WATER” with reference: Doc Ref: OK11-e, Edition: C, Application Date: 2013-03-01 for the biodegradability degree in aqueous medium, providing:

- relative biodegradation degree is 97,4 % after 56 days (total test duration),
- lag phase duration is < 1 day,
- biodegradation phase duration is 39 days.

4. SOLUBLE FRACTION (S) OR THE DISPERSIBLE FRACTION (D)

The soluble or dispersible fractions are quantified according to UNI EN 14897:2007. The test is performed by using both cold and hot water as experimental conditions on samples with dimensions 25mm x 25mm and total mass 1 gram, approximately, after drying at 50 ± 2 °C to constant weight. The test is carried out in triplicate.

1 L of tap water is introduced into a 2 L beaker and placed on the stirring plate (equipped with a temperature probe for regulation) and started stirring at 150 rpm. After weighing the sample, the sample is introduced into the beaker and the suspension is kept stirring for 16 hours at 25 ± 2 °C to evaluate the solubility and dispersibility in cold water and in hot water (at 60 ± 2 °C) to evaluate the solubility and dispersibility in hot water. Also the blank of water is performed to evaluate the residue present in the water used.

After this period, the suspension can be subjected to the determination of the water-soluble fraction (S) or to the determination of the water-dispersible fraction (D). This depends on the level of dissolution achieved by the sample after this period.

The initial and the final pH of the water is measured and reported in this report and the temperature is monitored during the test, to detect any effects due to the heat of dissolution of the sample. If a significant increase in temperature is observed, the sample should be introduced progressively into the water: this is not the case for the current test material.

For the determination of the water soluble fraction (S): at the end of the 16 hours, the solution is cooled and filtered immediately on a 0.45 µm filter (previously calibrated), by using the vacuum filtration system and finally, the filter is weighted, after drying it at 50 ± 2 °C to constant mass.

For the determination of the fraction dispersible in water (D): at the end of the 16 hours, the solution is cooled and immediately sieved by gravity through a 10 mm sieve (previously calibrated). The sieve is weighted, after drying at 50 ± 2 °C to constant mass.

4.1. Main characteristics of the equipment

The equipment for soluble and dispersible fraction determination is listed below:

- Drying oven
- Beaker, 2 L volume
- Magnetic stirrer (equipped with speed control and reaching 150 rpm) equipped with a temperature probe
- Vacuum filtration system with 0.45 µm nylon filters
- 10 mm sieve with a maximum diameter of 10 cm
- Analytical balance with precision 1 mg
- pH meter
- Temperature data logger

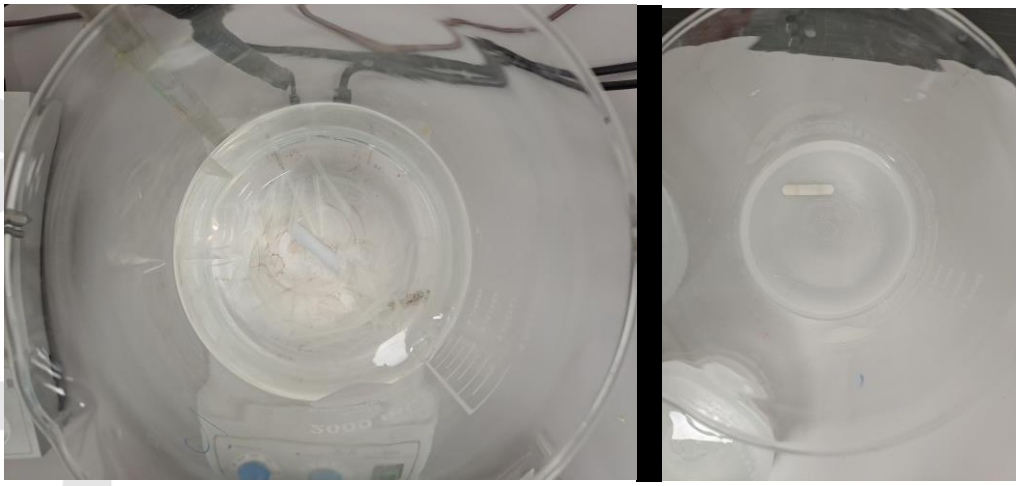


Figure 9. Picture of the dispersible and soluble fraction test, at the begin (on the left) and at the end (on the right) of the test.

4.2. Experimental results for determination of the soluble fraction in water (S)

The obtained results for the determination of the soluble fraction in water are provided in the Table 8.

Table 8. Results for the determination of the soluble fraction in water.

Hot test (60°C)	Blank (g)	Test 1 (g)	Test 2 (g)	Test 3 (g)
Tare of filter (dried at 50°C)	0,10109	0,10121	0,10106	0,10114
Sample (dried at 50°C)	-	1,52332	1,54071	1,53625
Gross (filter + sample, dried 50°C)	0,10118	0,15955	0,14976	0,15271
	Soluble fraction (S)	**0,942**	**0,951**	**0,948**
	Average value	0,947		
	Std dev.	0,005		

	Experimental pH	
	pH (time 0)	pH (final)
Test 1	6,97	7,02
Test 2	6,94	6,99
Test 3	6,95	7,04

Cold test (25°C)	Blank (g)	Test 1 (g)	Test 2 (g)	Test 3 (g)
Tare of filter (dried at 50°C)	0,10114	0,10152	0,10211	0,10183
Sample (dried at 50°C)	-	1,53821	1,54071	1,54028
Gross (filter + sample, dried 50°C)	0,10122	0,17198	0,17652	0,18036
	Soluble fraction (S)	**0,930**	**0,926**	**0,922**
	Average value	0,926		
	Std dev.	0,004		

	Experimental pH	
	pH (time 0)	pH (final)
Test 1	6,85	6,98
Test 2	6,82	6,95
Test 3	6,83	6,99

4.3. Conclusion on the determination of the soluble fraction in water (S)

The official UNI EN 14897:2007 standard defines that a plastic material is considered a hot or cold water soluble plastic if it produces a soluble fraction S ≥ 0.9 in hot or cold water.

Based on the obtained results for the soluble fraction:

- S (cold test) = 0,926
- S (hot test) = 0,947

the test material is soluble both in cold and in hot water.

5. QUANTITATIVE/QUALITATIVE DISINTEGRATION

No disintegration requirement has to be met, according to Program "OK biodegradable WATER" with reference: Doc Ref: OK11-e, Edition: C, Application Date: 2013-03-01.

6. ENVIRONMENTAL SAFETY (ECOTOXICITY)

No requirement regarding the compost quality and ecotoxicity has to be met according to Program "OK biodegradable WATER" with reference: Doc Ref: OK11-e, Edition: C, Application Date: 2013-03-01.

7. AVAILABLE DOCUMENTATION (FOR THIS SAMPLE)

MSDS of test material is not provided in this technical report. The Producer has provided it to TÜV Austria, directly.

8. NOT AVAILABLE DOCUMENTATION (FOR THIS SAMPLE)

For this specific analyzed material, dealing with the following documentation:

- In the case of several internal production sites: OCO nomination document (OCO: OK compost industrial manager), description of the traceability system and agreement of the manufacturers for each production site.
  NOT FORESEEN
- In the case of several external production sites (third-party companies): description of the traceability system and contract of the manufacturers for each production site
  NOT FORESEEN
- In case of sublicense certification: authorization of the original certificate holder
  NOT FORESEEN
- In case of use of recycled sources: adequate documentation of origin, recycling flows and production of recycled sources
  NOT FORESEEN

A representative sample of test material to be certified will be sent by PVA PRO JSC as Producer to TÜV Austria for the certification procedure.

9. CHECK LIST FOR THE FINAL ASSESSMENT OF THE COMPLIANCE WITH PROGRAM "OK BIODEGRADABLE WATER" WITH REFERENCE: DOC REF: OK11-E, EDITION: C, APPLICATION DATE: 2013-03-01

Overall result of the evaluation		
Code number	Acceptance	Rejected
22311632	x	

	Parameters		Official method to verify the compliance	*Judgement*	Test report n.
Characterization	Volatile solids		APHA Standard Methods 2540 G 1997	*COMPLIANT*	22311632/1
	Heavy metals	Cu, Zn, Ni, Cd, Pb, Hg, Cr, Mo, Se, As and Co	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016	*COMPLIANT*	22311632/1
	Fluorine		UNI EN 14582:2016 + UNI EN ISO 10304-1:2009	*COMPLIANT*	22311632/1
Biodegradability in aqueous medium			ISO 14852:2021	*COMPLIANT*	22311632/7
Soluble fraction (S) and the dispersible fraction (D) (EN 14987)			UNI EN 14987:2007	*COMPLIANT*	22311632/8

The material has previously been tested with a higher mass / surface ratio	NO
Minor changes have been made that do not affect the compliance with the EN 13432 standard	NO
Changes type	NO
Comment (if any)	NO
Signature of the person responsible for this evaluation	
Qualification of the person responsible for this assessment	Dr. Francesca Braca (LABORATORY ANALYSES SUPERVISOR)

Sample code: 22311632

ANNEXES

TEST REPORT

SAMPLE CODE

22311632

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C.F. P.IVA Iscr. Reg. Impr. di Pisa n. 01115340505 – Rep. Econ. Amm. di Pisa n° 101169 – Capitale Sociale 101.400 i.v.

Sample code: 22311632

ANNEX 1

TEST REPORT

SAMPLE CODE:

22311632/1

ARCHA S.r.l.
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PVA PRO JSC
Sede Legale
89 Vinh Hoi, Q4
00000 Ho Chi Minh City

1. General Data - Sample Description

Description: **AquaFlex (MATERIAL CHARACTERIZATION)**
Sample N°: 22311632/1 *Received on:* 24/08/2023
Type of material: PLASTIC MATERIALS *Appearance:* SOLID
Batch N°: -

2. Sampling Data

Site Address: Sede Legale, 89 Vinh Hoi, Q4 00000 Ho Chi Minh City

Sampling Date: 21/08/2023 *Sampling Report:*
Sampling:

3. Other Informations

Customer N°: 051985 *Order:* S23/0146

4. Warnings and Legends

The reproduction of the present Test Report is not allowed without authorization of ARCHA S.r.l.. The content of the present Report refers exclusively to the submitted samples and not to the batch that they want to represent. A portion of the sample is kept for 60 days if the nature and the quantity of the sample allow this. The data and the files are saved in laboratory for ten years. The report is made solely on the basis of the instructions and/or informations and materials supplied by the Applicant. If not indicated on report uncertainty data are available for every single test.
Unless otherwise stated, when they are present: "Description", "Batch N°", "Process conditions", "Sampling date" (if the sample was sampled by the Customer), are data provided by the Customer and the Laboratory disclaims all responsibility.
U = Expanded uncertainty of the test expressed with the same measurement unit as the result and calculated with a coverage factor k = 2.26 (k = 2 where indicated by the symbol §) corresponding to a probability level of approximately 95% or as a confidence interval calculated at a probability level of approximately 95% ; U.M. = Unit of Measurement.
(*) not accreditated by ACCREDIA

5. Additional Notes

None

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Ordine dei Chimici della Toscana
N. 1680 SEZIONE A

6. Test Results (Start measurements: 01/09/2023 - End measurements: 02/10/2023)

Test	UM	Result	LQ	U	Method Description
FEATURES AND INFORMATION		Note (1)			
THICKNESS	µm	Note (2)			* ASTM F2251-13
MASS / SURFACE RATIO	g/m²	Note (3)			* M.I. 2493 rev 0 2017
TOTAL ORGANIC CARBON	% w/w (d.m.)	50,5		± 7,2	UNI EN 15936:2022 Met B
TOTAL NITROGEN	% w/w (d.m.)	< LQ	0,05		UNI 10780:1998 App J1
TOTAL FLUORINE	mg/kg (d.m.)	< LQ	25		* UNI EN 14582:2016 + UNI EN ISO 10304-1:2009
VOLATILE SOLIDS	% w/w (d.m.)	96,04		± 0,91	* APHA Standard Methods 2540 G 1997
DRY MATTER	% w/w	99,42		± 0,33	* APHA Standard Methods 2540 G 1997
FT/IR SPECTROSCOPY		Note (4)			-
ACID DIGESTION	-	Note (5)			* UNI EN 13657:2004
ARSENIC	mg/kg (d.m.)	0,279		± 0,045	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
CADMIUM	mg/kg (d.m.)	0,284		± 0,045	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
COBALT	mg/kg (d.m.)	0,279		±	* UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
TOTAL CHROMIUM	mg/kg (d.m.)	0,386		± 0,061	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
COPPER	mg/kg (d.m.)	1,78		± 0,28	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
MERCURY	mg/kg (d.m.)	< LQ	0,1	±	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
MOLYBDENUM	mg/kg (d.m.)	0,547		± 0,087	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
NICKEL	mg/kg (d.m.)	0,572		± 0,09	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
LEAD	mg/kg (d.m.)	0,452		± 0,069	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
SELENIUM	mg/kg (d.m.)	0,353		± 0,054	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016
ZINC	mg/kg (d.m.)	26,8		± 4,1	UNI EN 13657:2004 + UNI EN ISO 17294-2:2016

(1) The test material is described in detail in the TECHNICAL REPORT 22311632, providing the composition, the main constituents, the additives.

(2) Micrometer: RS PRO Mod. 705-1229
Number of replicates for the quantification of the thickness: 10

Film 1 (61 µm): 62 ± 5 µm
Film 2 (30 µm): 32 ± 4 µm

(3) Number of replicates for the quantification of the mass/surface ratio: 10

Film 1 (61 µm): 99,8 ± 4,2 g/m2
Film 2 (30 µm): 42,5 ± 1,6 g/m2

(4) The IR spectrum is provided in the TECHNICAL REPORT 22311632

(5) Amount of sample: 0,5 ± 0,3 g
Pre-treatment: air drying, granulometric reduction and homogenization.
Digestion equipment: microwave digestor in closed vessel, temperature 180 °C gained within 13 minutes and keep constant for 2 minutes, with aqua regia.
Separation after digestion made by: filtration

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Dott. Yuri Pelosi
Ordine dei Chimici della Toscana
N. 1680 SEZIONE A

7. Opinions and interpretations (not accreditated by ACCREDIA)

None

End of Test Report

Rapporto di Prova firmato digitalmente
Dott. Yuri Pelosi
Ordine dei Chimici della Toscana
N. 1680 SEZIONE A

Sample code: 22311632

ANNEX 2

TEST REPORT

SAMPLE CODE:

22311632/7

ARCHA S.r.l.
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PVA PRO JSC
Sede Legale
89 Vinh Hoi, Q4
00000 Ho Chi Minh City

1. General Data - Sample Description

Description: **AquaFlex (BIODEGRADABILITY TEST - OK WATER)**
Sample N°: 22311632/7 *Received on:* 24/08/2023
Type of material: PLASTIC MATERIALS *Appearance:* SOLID
Batch N°: -

2. Sampling Data

Site Address: Sede Legale, 89 Vinh Hoi, Q4 00000 Ho Chi Minh City

Sampling Date: 21/08/2023 *Sampling Report:*
Sampling:

3. Other Informations

Customer N°: 051985 *Order:* S23/0146

4. Warnings and Legends

The reproduction of the present Test Report is not allowed without authorization of ARCHA S.r.l.. The content of the present Report refers exclusively to the submitted samples and not to the batch that they want to represent. A portion of the sample is kept for 60 days if the nature and the quantity of the sample allow this. The data and the files are saved in laboratory for ten years. The report is made solely on the basis of the instructions and/or informations and materials supplied by the Applicant. If not indicated on report uncertainty data are available for every single test.
Unless otherwise stated, when they are present: "Description", "Batch N°", "Process conditions", "Sampling date" (if the sample was sampled by the Customer), are data provided by the Customer and the Laboratory disclaims all responsibility.
U = Expanded uncertainty of the test expressed with the same measurement unit as the result and calculated with a coverage factor k = 2.26 (k = 2 where indicated by the symbol §) corresponding to a probability level of approximately 95% or as a confidence interval calculated at a probability level of approximately 95% ; U.M. = Unit of Measurement.

5. Additional Notes

None

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Dott. Yuri Pelosi
Ordine dei Chimici della Toscana
N. 1680 SEZIONE A

6. Test Results (Start measurements: 21/09/2023 - End measurements: 17/11/2023)

Test	UM	Result	LQ	U	Method Description
INOCULUM CHARACTERIZATION					
TOTAL SUSPENDED SOLIDS	mg/L	2190			UNI EN 872:2005
NUTRITIVE SOLUTION+ INOCULUM CHARACTERIZATION					
		-			
TOTAL ORGANIC CARBON	mg/L	15,4			UNI EN 1484:1999
TOTAL NITROGEN (TKN)	mg/L	3,97			APAT CNR IRSA 5030 Man 29 2003
CELLULOSE BIODEGRADABILITY TEST - ABSOLUTE AVERAGE VALUE					
BIODEGRADATION DEGREE	%	98,0		± 1,9 §	UNI EN ISO 14852:2021
MATERIAL BIODEGRADABILITY TEST - ABSOLUTE AVERAGE VALUE					
BIODEGRADATION DEGREE	%	95,5		± 2,0 §	UNI EN ISO 14852:2021
		-			
MATERIAL BIODEGRADABILITY TEST - RELATIVE VALUE					
BIODEGRADATION DEGREE	%	97,4		± 2,9 §	UNI EN ISO 14852:2021

The characterization data of reference (cellulose) lot number MKCL9441, expiration date September 28th 2023 are:
TOC = 45,4 % w/w (d.m.) determination on 20/03/2023
Dry residue = 98,19 % w/w determination on 17/03/2023

7. Opinions and interpretations

None

End of Test Report

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Dott. Yuri Pelosi
Ordine dei Chimici della Toscana
N. 1680 SEZIONE A

Sample code: 22311632

ANNEX 3

TEST REPORT

SAMPLE CODE:

22311632/8

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PVA PRO JSC
Sede Legale
89 Vinh Hoi, Q4
00000 Ho Chi Minh City

1. General Data - Sample Description

Description: **AquaFlex - Film (DISPERSIBILITY - SOLUBILITY TEST)**
Sample N°: 22311632/8 *Received on:* 24/08/2023
Type of material: PLASTIC MATERIALS *Appearance:* SOLID
Batch N°: -

2. Sampling Data

Site Address: Sede Legale, 89 Vinh Hoi, Q4 00000 Ho Chi Minh City

Sampling Date: 21/08/2023 *Sampling Report:*
Sampling:

3. Other Informations

Customer N°: 051985 *Order:* S23/0146

4. Warnings and Legends

The reproduction of the present Test Report is not allowed without authorization of ARCHA S.r.l.. The content of the present Report refers exclusively to the submitted samples and not to the batch that they want to represent. A portion of the sample is kept for 60 days if the nature and the quantity of the sample allow this. The data and the files are saved in laboratory for ten years. The report is made solely on the basis of the instructions and/or informations and materials supplied by the Applicant. If not indicated on report uncertainty data are available for every single test.
Unless otherwise stated, when they are present: "Description", "Batch N°", "Process conditions", "Sampling date" (if the sample was sampled by the Customer), are data provided by the Customer and the Laboratory disclaims all responsibility.
U = Expanded uncertainty of the test expressed with the same measurement unit as the result and calculated with a coverage factor k = 2.26 (k = 2 where indicated by the symbol §) corresponding to a probability level of approximately 95% or as a confidence interval calculated at a probability level of approximately 95% ; U.M. = Unit of Measurement.

5. Additional Notes

None

6. Test Results (Start measurements: 20/09/2023 - End measurements: 22/09/2023)

Test	UM	Result	LQ	U	Method Description
SPECIFIC INVESTIGATIONS	-	Note (1)			-

(1) Determination of soluble and dispersible fraction on film 61 µm (according to UNI EN 14987:2007)

Soluble fraction (S) in cold water
S = 0,926 ± 0,004
Soluble fraction (S) in hot water
S = 0,947 ± 0,005

Dispersible fraction in cold and hot water is D=1

7. Opinions and interpretations

Rapporto di Prova firmato digitalmente
Dott. Yuri Pelosi
Ordine dei Chimici della Toscana
N. 1680 SEZIONE A

None

End of Test Report

Rapporto di Prova firmato digitalmente
Dott. Yuri Pelosi
Ordine dei Chimici della Toscana
N. 1680 SEZIONE A