



OVERVIEW CERTIFICATIONS

Introduction

FluidSolids® is an innovative technology developed in Switzerland to produce home-compostable composite materials. As it uses residuals and waste streams, its environmental impact is minimal. FluidSolids® Biocomposites feature exceptional mechanical and environmental properties, making them suitable for use in countless industries.

This overview describes the certifications that are available for FluidSolids® with regards to quality, environment and food safety. For information with regards to mechanical and physical properties please refer to the datasheet, or get in touch with us.

Table of content

1	Introduction
2	Biodegradation in home compost
3	Biodegradation in industrial compost
4	Disintegration in biogas plant
5	Biodegradation in marine environment
5	Algea test in marine environment
6	Biobased content
7	Heavy metal content
8	Food safety
8	REACH compliance
9	CO2 reduction
9	Total environmental impact





OVERVIEW CERTIFICATIONS

Biodegradation in Home compost

The tested FluidSolids® concentrations fulfilled the requirements for the proof of aerobic biodegradation according to the norm DIN EN 13432, in a much shorter timeframe than the maximum allowed 12 months.

- Original report date: January 20, 2021
- Laboratory: Centre of Environmental Biotechnology, ZHAW Zürich
- Issued by: FluidSolids® AG, Zürich

Aerobic biodegradation test according to DIN EN 13432
Aerobic biodegradation of FluidSolids in home compost environment

Norm
In order to be classified as a biodegradable plastic according to the norm DIN EN 13432, the proof of aerobic biodegradation must be fulfilled. In the case of biodegradation in a home composting environment (+20°C) a minimum of 90% degradation within a maximum timeframe of 12 months is required by international certification schemes.

Laboratory
The tests were carried out by the Centre of Environmental Biotechnology, University of Applied Sciences Zürich (ZHAW), Switzerland.

Method
The applied measurement of aerobic degradation was carried out according to the normed method OECD 301F, Manometric Respiratory Test, in line with the requirements of the Norm EN13432. The measurement described is a quantitative measurement of the Oxygen (O₂) consumption and CO₂ production during biodegradation. Granulates consisting of the FluidSolids matrix and additives were mixed with compost inoculum in concentrations of 1, 2.5 and 5% and incubated over a time frame of 12 weeks with a constant temperature of 20°C-25°C in a dark environment.

Results
The samples 5%, 2.5% and 1% FS granulates reached 60% ThCO₂ on day 15, 12 and 9 respectively, within a degradation time window of 10, 7 and 4 days after start of the biodegradation. The samples 2.5% reached 90% degradation after 30 days. The sample 1% reached 99% degradation after 17 days. Sample 5% reached a total degradation of 75% after 33 days. After finalizing the testing, the matrix granulates were no longer to distinguish from the compost media.

Figure 1. Aerobic degradation behavior of FluidSolids granulates over a timeframe of 80 days.

Conclusion
The tested FS concentrations of 1% and 2.5% in home compost inoculum biodegraded within 17 days and 30 days respectively and fulfilled the requirement in a much shorter timeframe than the maximum allowed 12 months by home compost certification schemes. Based on the results it is expected that products made of FluidSolids materials have a high potential to pass the 90% degradation requirement for home composting. (Note: According to EN 13432 untreated natural fibers are exempt from testing of Biodegradation and therefore also exempt from the described test.)

Zürich, 20./01/2021

FluidSolids® AG | Hohlstrasse 408 | CH-8048 Zürich | +41 444 00 55 00 | info@fluidsolids.com | www.fluidsolids.com

Dr. Francesca Tancini
Chemist / R&D Department

Beat Karner
CEO

The tested FluidSolids® samples disintegrated within 4 weeks and fulfilled the requirement of the norm DIN EN 13432 for home composting in a much shorter time frame than the maximum allowed 26 weeks.

- Original report date: January 20, 2021
- Laboratory: Organic Waste System (OWS), Gent, Belgium
- Issued by: FluidSolids® AG, Zürich

Disintegration test according to DIN EN 13432
Qualitative evaluation of disintegration in home compost environment

Norm
In order to be classified as a biodegradable plastic according to the norm DIN EN 13432, the proof of disintegration must be fully filled. In the case of biodegradation in a home composting environment (+28°C) a minimum of 90% disintegration within a maximum of 26 weeks is required.

Laboratory
The tests were carried out by the Laboratory Organic Waste System (OWS), Belgium.

Method
The evaluation described is a qualitative evaluation of the disintegration by means of visual perception. The applied test method is based on ISO 20200, which is part of the DIN EN 13432 Norm for the definition of the disintegration test.

Two FluidSolids materials (Reference 1 and 3) were tested and compared to a standard PLA (Ingeo 2251 D). The disintegration behavior was tested on a FluidSolids product part "FluidSolids Hanger Small" with a thickness of ± 2.0mm. The disintegration of the samples was tested in fresh bio waste over a time frame of 11 weeks with a constant temperature of ±28°C.

Results
The disintegration of FS - Reference 1 and 3 has proceeded very swiftly (see Figure 1 and 2). Already after 4 weeks of composting both test items had completely disappeared and no test material could be retrieved from the composting reactors. The disintegration of PLA Ingeo 2251 D (± 2.0 mm) was clearly insufficient. After 11 weeks all test item pieces still remained completely intact. The test was stopped after 11 weeks instead of the allowed 26 weeks.

Figure 1. Test item FS - Ref. 1 (top) and Ref. 3 (bottom) at start and after 2 weeks of composting.

Conclusion
The tested FS samples Reference 1 and 3 disintegrated within 4 weeks and fulfilled the requirement of the norm DIN EN 13432 for home composting in a much shorter time frame than the maximum allowed 26 weeks.

Zürich, 20./01/2021

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OVERVIEW CERTIFICATIONS

Biodegradation in Industrial compost

The tested FluidSolids® samples disintegrated within 4 days and fulfilled the requirement of the norm DIN EN 13432 for industrial composting in a much shorter time frame than allowed.

- Original report date: January 19, 2021
- Laboratory: Organic Waste System (OWS), Gent, Belgium
- Issued by: FluidSolids® AG, Zürich

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BIOCOMPOSITES

Disintegration test according to DIN EN 13432
Qualitative evaluation of disintegration in industrial compost environment

Norm
In order to be classified as a biodegradable plastic according to the norm DIN EN 13432, the proof of disintegration must be full filled. In the case of biodegradation in an industrial composting environment (±55°C) a minimum of 90% disintegration within a maximum of 12 weeks is required.

Laboratory
The tests were carried out by the Laboratory Organic Waste System (OWS), Belgium.

Method
The evaluation described is a qualitative evaluation of the disintegration by means of visual perception. The applied test method is based on ISO 16629, which is part of the DIN EN 13432 Norm for the definition of the disintegration test.

Three FluidSolids materials (Reference 1-3) were tested and compared to a standard PLA (Ingeo 3251D). The disintegration behavior was tested on a FluidSolids product part "FluidSolids Hanger Small" with a thickness of ± 2.0mm. The samples are shown in Fig1 below.
The disintegration of the samples was tested in fresh biowaste. The biowaste and the samples were composted for 4 weeks with a temperature profile between 79°C (week 1) and 59°C (week 4).

Figure 1. Test items (left to right): FS - Ref. 3, PLA Ingeo 3251D, FS - Ref. 1 and FS - Ref. 2

Results
The degradation of the FluidSolids materials Reference 1-3 proceeded extremely swiftly. Already after 4 days of composting the samples had disappeared completely. No test material could be retrieved from the test bin. The disintegration of the PLA reference proceeded well, where the specimen had disappeared completely after 4 weeks of composting. The test was stopped after 4 weeks instead of the allowed 12 weeks.

Conclusion
The tested FS samples disintegrated within 4 days and fulfilled the requirement of the norm DIN EN 13432 for industrial composting in a much shorter time frame than allowed. Based on the results it is expected that even higher wall thicknesses have the potential to pass the 90% disintegration requirement for industrial composting.

Zürich, 19.01/2021
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The tested FluidSolids® materials biodegraded and disintegrated well within 10 weeks.

- Original report date: January 22, 2021
- Tests carried out by: Industrial Composting Facility in Zurich
- Issued by: FluidSolids® AG, Zürich

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Applied Aerobic degradation test according to EN 13432
Qualitative evaluation of aerobic degradation in a industrial composting plant

Norm
In order to be classified as a biodegradable plastic according to the norm DIN EN 13432, the proof of biodegradation and disintegration must be full filled. In the case of biodegradation in an industrial composting environment (±55°C) a minimum of 90% biodegradation and disintegration within a maximum of 12 weeks is required.
This test describes the degradation behavior of FluidSolids in a real life industrial composting scenario.

Laboratory
The test was carried out by an industrial composting facility in Zürich, Switzerland.

Method
Three FluidSolids standard materials (black, white and naturl) were tested in form of two commercial FluidSolids products each ("FS-Hanger Small", "FS-Hanger Large", wall thickness ± 2.0mm). The biodegradation and disintegration of the samples was tested in a industrial, thermophilic environment over a processing time of 10 weeks. The samples were wrapped in a nylon mesh (mesh size 0.5mm) and buried in the composting mass. The degree of degradation was measured in reduction of dry weight on a weekly schedule.

Figure 1. FS-Hanger small sample preparation (top), after one week of degradation (bottom)

Results
The aerobic digestion of the FluidSolids materials proceeded very good. Within a 10 Week composting cycle the samples showed an average degradation of 80%. The remaining residuals were brittle crumbs, which were difficult to distinguish from the composting mass. The test was stopped after 10 weeks according to the composting plant processing schedule.

Conclusion
The tested FS materials biodegraded and disintegrated well within 10 weeks. The steep degradation curve allows for the assumption that the 90% degradation and disintegration requirement for industrial composting according to EN 13432 would be passed within the time frame of 12 weeks.

Zürich, 22.01/2021
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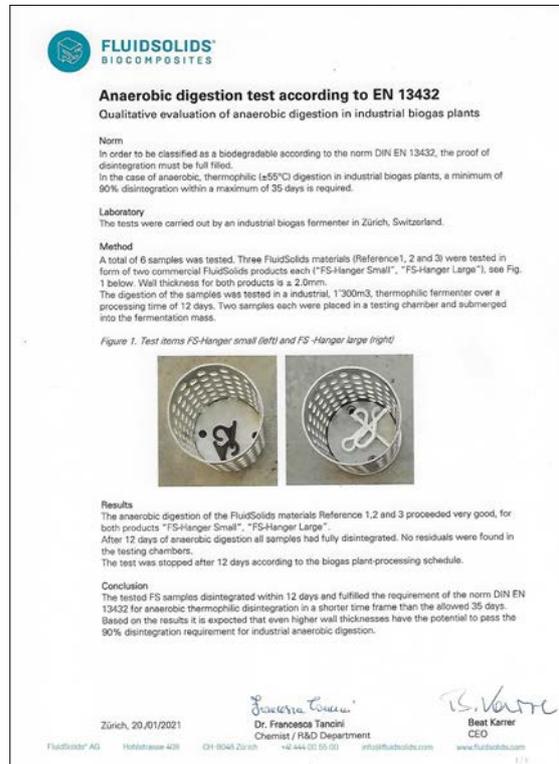


OVERVIEW CERTIFICATIONS

Disintegration in Biogas plant

The tested FluidSolids® samples disintegrated within 12 days and fulfilled the requirement of the norm DIN EN 13432 for anaerobic thermophilic disintegration in a much shorter time frame than allowed.

- Tests carried out by: Industrial Biogas Fermenter in Zurich
- Original report date: January 20, 2021
- Issued by: FluidSolids® AG, Zürich





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Biodegradation in marine water

The tested FluidSolids® samples biodegraded to a degree of 60% within a timeframe of 60 days and fulfilled the requirements given by the ISO 16221 framework.

- Original report date: January 20, 2021
- Tests carried out by: Centre of Environmental Biotechnology, ZHAW Zürich
- Issued by: FluidSolids® AG, Zürich



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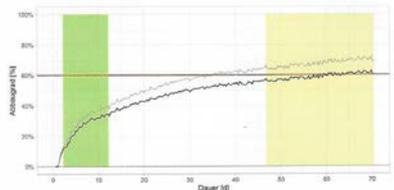
Marine degradation test according to ISO 16221
Quantitative evaluation of degradation in marine environment

Norm
The proof of biodegradation in marine environments of FluidSolids material was tested according to the international norm ISO 16221. The ISO-Norm framework, for the measurement of degradation in water medium, constrains their degree of degradation to a minimum of 60% within a timeframe of 28 to 60 days.

Laboratory
The tests were carried out by the Centre of Environmental Biotechnology, University of Applied Sciences Zürich (ZHAW), Switzerland.

Method
The applied test method is based on the guidance of ISO 16221, with the normed measuring method defined by DEC03 01F. The measurement described is a quantitative measurement of the Oxygen (O₂) consumption and CO₂ production during biodegradation. The degradation behavior of the FluidSolids Material was investigated on one standard formulation Reference-1. The formulation consists of roughly 45%-60% fibers, a binder matrix and an additive package. The FluidSolids formulation was tested in reference to a well degradable material Sodium acetate.

Figure 1: Degradation behavior of FS – Ref. 1 (black curve) in a marine environment.



Results
The degradation of the FluidSolids material Reference 1 in a marine environment started after 2 days of testing. 60% degradation is reached after a timeframe of 60 days. (see Fig. 1, black curve). The grey curve in Fig. 1 describes the calculated behavior of FluidSolids in correlation to the well degradable reference material Sodium acetate. The remaining 40% non-degraded material (after 60 days) is strongly believed to be allocated to the slowly degrading natural fiber content.

Conclusion
The tested FS sample biodegraded to a degree of 60% within a timeframe of 60 days and fulfilled the requirements given by the ISO-Norm framework.

Zürich, 20.01.2021

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Algae test in marine environment

The tested FluidSolids® samples showed no negative effect on the tested marine algae growth according to norm ISO 10253.

- Original report date: January 20, 2021
- Tests carried out by: Centre of Environmental Biotechnology, ZHAW Zürich
- Issued by: FluidSolids® AG, Zürich



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Algae growth inhibition test according to ISO 10253
Evaluation of toxicity effects of FluidSolids in marine environments.

Norm
An assessment of the toxicity effects of degraded FluidSolids material was carried out in terms of an algae inhibition growth test according to ISO 10253. For this purpose the samples were inoculated with the diatom *Phaeocodylum striatum*, whose growth was logged for 21 days. A toxic effect of a material on the algae growth is determined as a growth inhibition in comparison to a positive control measurement. Algae growth is measured by counting an increase in algae cells.

Laboratory
The tests were carried out by the Centre of Environmental Biotechnology, University of Applied Sciences Zürich (ZHAW), Switzerland.

Method
The applied test method is based on the guidance of ISO 10253. In this test setup the algae number is logged in comparison to a positive control specimen (marine water with no biodegradable material included). The algae number is evaluated by counting the algae number with a microscope method. The testing time frame was extended from 72 hours to 21 days. The ecotoxicity behavior of the FluidSolids Material was investigated on a standard formulation. The formulation consists of roughly 45%-60% fibers, a binder matrix and an additive package. All specimens, except for the negative control specimen, were treated with algae cultures to reach a cell density of approximately 10'000 algae per milliliter. The incubation phase was carried out in an exposed incubation chamber at 20°C. The FluidSolids formulation was tested in reference to a well degradable material Sodium acetate and a non-marine degradable PLA.

Figure 1: Coloring of the specimens after the timeframe of 21 days. From left to right: negative control, positive control, PLA, FluidSolids Biocomposite, Reference, Sodium acetate.



Results
The algae growth was compared with the positive control. When adding together the algae growth over the 21 days it was seen that the reference sample showed a slight decrease (-25%), whereas both the PLA sample (+94%) and the FluidSolids sample (+260%) showed an increase, in algae numbers.

Conclusion
The tested FS sample showed no negative effect on the tested marine algae growth according to norm ISO 10253. According to the results described above FluidSolids is confident that its material has no negative effect on the growth of algae cells and that the requirements given by international certification schemes for biodegradability in marine environments can be reached.

Zürich, 20.01.2021

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Biobased content

Test item FluidSolids Standard Natur is 100% biobased.

The certification institute TÜV AUSTRIA Belgium prescribes a double minimum requirement for OK biobased certification.

- Original report date: February 9, 2021
- Report number: RA.CLD-I_Rev00
- Issued by: Organic Waste System (OWS), Gent, Belgium

2 Introduction

2.1 Total carbon (TC)

The total carbon content is determined as described in 'M_017. Determination of Total Organic Carbon – Total Carbon After Dry Combustion and Inorganic Carbon After Acidation' by using a high temperature (950°C to 1200°C) combustion method. The formed CO₂ is measured with IR detection. The released CO₂ is determined by IR detection. The results are given in percent on wet weight.

2.2 Biobased carbon content (BCC)

The biobased content is determined by combustion at 900°C for 2 to 4 hours and measuring of the ¹³C/¹²C and ¹³C/¹⁴C isotopic ratios using accelerator mass spectrometry as described by the European norm EN 16640 *Bio-based products – Bio-based carbon content – Determination of the bio-based carbon content using the radiocarbon method* (2017). The biobased carbon content is given in percent on total carbon. The biobased carbon content analysis was performed by BETA Analytic, an ISO 17025 accredited laboratory with head office in Miami, Florida, USA.

3 Results

The total carbon content (TC) and the biobased carbon content (BCC) on TC of the test item are shown in Table 1. The biobased carbon content on TC of the test item is also shown in Figure 2. An average total carbon content of 46.0% was measured for FluidSolids Standard Natur, while an average biobased carbon content of 100% on TC was measured.

Table 1. Total carbon content and biobased carbon content of the test item

Characteristics	FluidSolids Standard Natur
Total carbon (TC, %)	46.0* (45.8 / 46.0 / 46.2)
Biobased carbon (% on TC)	100* (100 / 100 / 100)

* Result of repeat determination

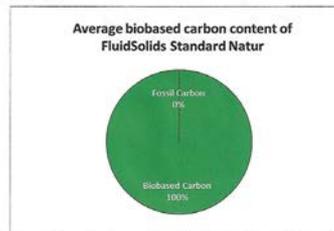


Figure 2. Average biobased carbon content of FluidSolids Standard Natur (on total carbon)

RA.CLD-I_Rev00
Feb-09-2021



4/5
F_210_Rev01

4 Conclusion

The certification institute TÜV AUSTRIA Belgium prescribes a double minimum requirement for OK biobased certification:

- (1) A specified minimum total carbon (TC) content of 30%;
- (2) A minimum proportion of biobased carbon of 20%.

Test item FluidSolids Standard Natur has a total carbon content above 30%, while a biobased carbon content of 100% on TC was obtained. Based on the results of this test, it can be concluded that FluidSolids Standard Natur is, in our opinion, eligible for OK Biobased (TUV AUSTRIA Belgium) certification showing four stars: more than 80% biobased.

Gent, February 9th, 2021

Flemming Cornielje
Study Director

Bruno De Wilde
Lab Manager

RA.CLD-I_Rev00
Feb-09-2021



5/5
F_210_Rev01



OVERVIEW CERTIFICATIONS

Heavy metal content

In FluidSolids® Standard formulation all tested substances were below the allowed limit. The examination was conducted according to EN 13432:2000-12

- Original report date: December 18, 2020
- Order number: 19240/1
- Issued by: ISEGA Forschungs- und Untersuchungsgesellschaft mbH, Aschaffenburg



ISEGA
Forschungs- und Untersuchungsgesellschaft mbH Aschaffenburg

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Aschaffenburg, 18 Dec. 2020
From: Zu-sp
Authorized by: Dr. Zang

REPORT

Order No.: 19240/1 page 1 of 2 pages

Client: FluidSolids AG
Hohlstrasse 408
8048 Zürich
SWITZERLAND

Date of order: 27 November 2020

Receipt of sample material: 2 December 2020

Origin of sample material: Sent by the client

Purpose: Analysis of a granules for compostability –
Chemical characterization


 (Dr. Derra)
 Managing Director


 (Dr. Zang)
 Geo-ecologist, Head of
 Compostability Testing
 Department

The present report refers exclusively to the samples as laid out therein. Information and statistical data on the results can be obtained on request.

Qualifizierung: Dr. Ralph Derra, Head of the Aschaffenburg MBH 5228
Die Sachprüfung von Verpackungsmaterialien und Verpackungen sowie die Verantwortung für Lebensmittelverpackungen - auch in Zusammenarbeit mit
Nährstoffanforderung, Biodegradierbarkeit und Kompostierbarkeit



Deutscher
Anforderungsnormenrat
DIN 14340-01-01
D-PL-14160-01-01

Page 2 of 2 pages
Date: 18 December 2020

ISEGA Forschungs- und Untersuchungsgesellschaft mbH Aschaffenburg
Order no. 19240/1

Chemical characterization of the sample material

Examination period: 2 December 2020 to 17 December 2020

Sample material

The following sample material was at hand:

sample 1: granules

Carrying out of the tests

The examination was conducted according to EN 13432:2000-12 (Packaging - Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging)

Tab. 1: Quantitative characterization of the sample material

parameter	sample 1	limit (EN 13432)
dry content [% OS] (DIN EN ISO 638:2009-01)*	88	-
residue on ignition [% DW] (DIN 38409-H1:1987-01)*	0,9	50
fluorine [†] [mg/kg DW] (DIN ISO 10304-1:2009-07)*	< 50	100
zinc [†] [mg/kg DW] (DIN EN ISO 11885:2009-09)*	5,7	150
copper [†] [mg/kg DW] (DIN EN ISO 11885:2009-09)*	< 2	50
nickel [†] [mg/kg DW] (DIN EN ISO 11885:2009-09)*	< 2	25
cadmium [†] [mg/kg DW] (DIN EN ISO 17294-2:2017-01)*	< 0,2	0,5
lead [†] [mg/kg DW] (DIN EN ISO 11885:2009-09)*	< 5	50
mercury [†] [mg/kg DW] (DIN EN ISO 12946:2012-08)*	< 0,25	0,5
chromium [†] [mg/kg DW] (DIN EN ISO 11885:2009-09)*	< 2	50
molybdenum [†] [mg/kg DW] (DIN EN ISO 17294-2:2017-01)*	< 0,5	1
selenium [†] [mg/kg DW] (DIN EN ISO 17294-2:2017-01)*	< 0,5	0,75
arsenic [†] [mg/kg DW] (DIN EN ISO 11885:2009-09)*	< 2	5

*after oxidative digestion
†after microwave digestion

* < " lower than limit of quantification
" OS " original substance
" DW " dry weight

The accreditation applies to the methods marked with * in the test report (Register no. D-PL-14160-01-01 and D-PL-14160-01-02). ISEGA is a DIN CERTCO-approved testing laboratory (Register no. PL046).

END OF REPORT



OVERVIEW CERTIFICATIONS

Food safety

The analysis results showed very good compliance of the tested FluidSolids® formulation with dry and powdery foods according to PN-EN 1186-1:2005 Materials and articles in contact with foodstuffs - plastics - part 1.

- Original report date: January 29, 2021
- Laboratory: J.S. Hamilton Poland
- Report number: 304698/20/FCMW
- Issued by: FluidSolids® AG, Zürich

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Food migration test of FluidSolids - Dry Foods
Food migration analysis of FluidSolids according to PN-EN 1186-1:2005

Norm
Migration behavior analysis of FluidSolids materials in contact with dry food simulants was carried out according to PN-EN 1186-1:2005 MATERIALS AND ARTICLES IN CONTACT WITH FOODSTUFFS - PLASTICS - PART 1. The analysis for dry foods was carried out with Tenax simulant in order to evaluate food contact behavior of FluidSolids materials.

Laboratory
The analysis was carried out by an accredited laboratory: J.S. Hamilton Poland Sp. Testing Laboratory (Gdynia, Poland).

Method
A standard FluidSolids formulation without color pigments additives was tested in terms of this evaluation. The food contact simulant used was Tenax for dry and powdery foods, testing conditions were 10 days at 40°C.

Results
The measurement of migration in Tenax showed a result of 1.1 mg/dm². Criteria for compliance is set at < 10 mg/dm².

Method	Simulant	Test Conditions	Compliant Y / N
PN-EN 1186-13:2007	Tenax	10d/40°C	Yes

Conclusion
FluidSolids is well suitable for contact with dry foods as tested by J.S. Hamilton Poland Sp according to the international method PN-EN 1186-1:2005 MATERIALS AND ARTICLES IN CONTACT WITH FOODSTUFFS - PLASTICS - PART 1. The analysis results showed very good compliance of the tested FluidSolids formulation with dry and powdery foods. The measurement with Tenax simulant showed a migration result well below the allowed criteria of 10 mg/dm² for plastic substrates.

Zürich, 29/01/2021

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REACH compliance

FluidSolids® Standard Black formulation is REACH compliant and does not contain substances above 0.1% weight of a Substance of Very High Concern (SVHC) listed in Annex XIV as of January 30, 2019.

- Original report date: February 01, 2021
- Laboratory: Self declaration
- Issued by: FluidSolids® AG, Zürich

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FluidSolids AG, Hohlstrasse 408, 8048 Zürich
FluidSolids AG
Hohlstrasse 408
CH-8048 Zürich
Switzerland

Zürich, 01/02/2021

DECLARATION OF CONFORMANCE REACH - SVHC

Dear Valued Customer,

FluidSolids AG certifies that the Material Basic Black (F3694-S2aK1S11o-C1c) is compliant with the European Union Regulation (EC) 1907/2006 governing the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) and does not contain substances above 0.1% weight of a Substance of Very High Concern (SVHC) listed in Annex XIV as of January 30, 2019.

We are committed to taking all necessary steps to ensure our products comply with the REACH requirements. Should you have any questions regarding the content of this letter or any REACH related issues, please do not hesitate to contact FluidSolids R&D Department.

Sincerely,

Beat Karner
CEO

Dr. Francesca Tancini
Chemist / R&D Department

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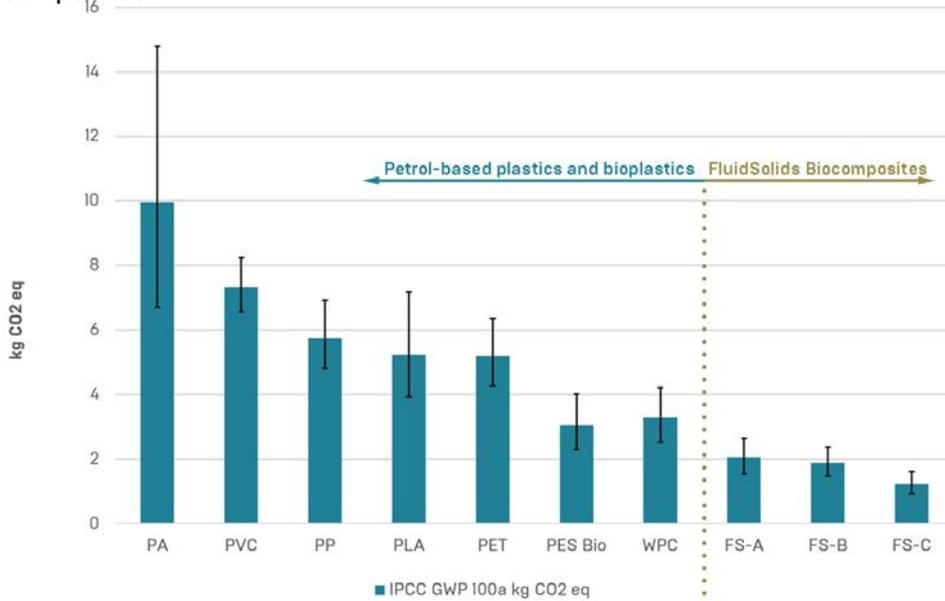


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CO2 reduction

FluidSolids® Biocomposites show a significantly lower climate warming potential than the analysed conventional plastics and composites.

- Original report date: February 1, 2018
- Issued by: myclimate, Zürich
- External Review: Ernst Basler & Partner



Total environmental impact

In terms of total environmental impact, FluidSolids® Biocomposites perform better than the analyzed comparative plastics and WPC.

- Original report date: February 1, 2018
- Issued by: myclimate, Zürich
- External Review: Ernst Basler & Partner

