

Summary of requirements and test results in accordance with ASTM D6954-04

Tier 1	Testing	Requirements / Reporting	Completed (yes / no)	Report number or reference
<p>Rate and extent of molecular weight loss</p> <ul style="list-style-type: none"> • Accelerated testing is ok • Conditions and temperatures need to be indicative of application waste environment. • Tier 1 requires either accelerated testing or long-term testing over a range of relative humidity or amount of moisture. Accelerated testing must be performed under conditions and temperatures that are acceptably typical of the specific application and disposal environments Under consideration 	<p>Aging in the lab via either:</p> <p>ASTM D5208 - photooxidation - UV exposure - litter etc</p> <p>or</p> <p>ASTM D5510 - heat exposure - litter / landfill etc</p> <p>Both use ASTM D3826 - elongation to show embrittlement.</p> <p>Notes:</p> <ol style="list-style-type: none"> 1. temperatures to be within range of 20C to 70C and at least 1 sample to have been tested no further than 20C from typical disposal conditions. 2. Needs to be done at 3 different temperatures. 3. D5208 section 8.5.2 calls for product to disintegrate within 250 hours using Cycle A of the standard for material to be considered photo-degradable 	<p>Need to report the following:-</p> <ol style="list-style-type: none"> 1. Exposure time = time to reach < 5% elongation to break using D3826, AND for film to reach average molecular weight of 5000 or less. 2. Gel formation = weight fraction of total samples. (less than 5% wt gel would seem acceptable to D6954-04) 	<p>Yes</p> <p>Yes</p> <p>Yes</p>	<p>KMIe6230-1a Dr. Jakubowicz</p> <p>Reference: Page 2 of 5</p> <p>Thermo-oxidative degradation</p> <p>And: Page 2 of 5</p> <p>Graph: Oven ageing in air under composting conditions</p> <p>The effects of thermo-oxidation were evaluated using SEC (size exclusion chromatography) measurements. The measurements give the information about molecular weight (Mw) of the materials. „... Mw values of both materials drop under 5000 after 2 weeks...“</p> <p>Ass. Prof.Dr. Jakubowicz SP Swedish National Testing and R&D Institute Boros Sweden</p>

		As to 2: Gel formation = weight fraction of total samples. (less than 5% wt gel	Yes	<p>And:</p> <p>CLARIANT :</p> <p>0835-11\0835-11.plw</p> <p>„...Mw after 6 weeks outdoor exposure of Mw: 1253...“</p> <p>Reference: Page 4 of 4</p> <p>SP Report PX29051-1</p> <p>Gel content < 0,5%</p>
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Tier 2	Testing	Requirements / Reporting	Completed (yes / no)	Report number or reference
<p>Biodegradation tests</p> <p>The purpose of Tier 2 is to estimate the biodegrad- ability of all the fragmented products from Tier 1 under laboratory scale conditions appropriate to the application using current Test Methods D 5988 and D 5338. The entire material from the Tier 1 exposure is subjected to biodegradation testing. The percent biodegradation shall be calculated and reported as stated in the above referenced standards. The</p>	<p>Need to test to show material biodrades - selection of test method dependant on application waste environment:</p> <p>ASTM D5988 - equivalent to ISO 17556 - Aerobic biodegradation in soil - probably applicable for litter and agricultural applications.</p> <p>ASTM D5338 - equivalent to ISO 14852 - Aerobic biodegradation - aqueous or composting - applicable for composting applications.</p>	<p>Need to report as per the standards the time to reach thresholds and time profile of CO2 evolution.</p> <p>For single polymers need to show 60% CO2 conversion before ending test and less than 10% gel wt.</p> <p>or</p> <p>For blended polymers etc need to show 90% CO2 conversion before ending test.</p> <p>or</p>	<p>Yes</p> <p>Yes</p>	<p>Dr. Kaiser Nr. 422809</p> <p>Reference: Page 4 of 12</p> <p>Results: Mineralization in the soil columns</p> <p>% of CO₂ production; corrected values under the assumption that glucose is completely mineralized to carbon dioxide and biomass</p>

<p>results from Tier 1 and Tier 2 shall be combined and used for comparison and ranking purposes between polymers of interest.</p>	<p>ASTM D5526 - no ISO equivalent - Anaerobic biodegradation - accelerated landfill - applicable to landfill applications.</p> <p>ASTM Standard D 6400-99 (Standard specification for compostable plastics)</p>	<p>Alternatively for any polymer show 90% CO2 conversion before ending test and conclude no excessive gel formation.</p>	<p>Yes</p>	<p>EMPA Swiss National Research & Testing Institute, St. Gallen CH</p> <p>Reference: Page 11 of 12</p> <p>This goal has been reached... „..mineralization rate after 180 days of incubation was.. 62 %..“ And:</p> <p>KMle6230-1a Dr. Jakubowicz</p> <p>Reference: Page 2 of 5 Mineralisation of the AddiFlex modified material in soil columns at 60 °C monitored by measurements of the produced CO2</p>
<p>Tier 3</p>	<p>Testing</p>	<p>Requirements / Reporting</p>	<p>Completed (yes / no)</p>	<p>Report number or reference</p>
<p>Toxicity tests - Aquatic & Terrestrial</p> <p>Tier 3 involves considerations of the ecological impacts in the final disposal medium such as soil, as in all biodegradation testing methods,</p>	<p>Preparation of samples is via D5951 Aquatic testing is via D3987</p>	<p>Need to report as follows:</p> <p>1. Plant growth test as per OECD guideline 208.</p>	<p>Yes acc EN 13432 and OECD 208</p>	<p>Nr. 422809 Dr. Kaiser</p> <p>Reference: Page 8 of 12</p> <p>Plant growth test „..Ecotoxic effects was determined....“</p>

<p>which is basically a comparison of the test medium before and following oxidation and biodegradation.</p> <p>Toxicity: Analysis of heavy metals</p>	<p>Heavy metals done on test materials before degradation tests are done.</p>	<p>Acc. EN 13432 / DIN 54900</p>	<p>Yes</p>	<p>Germination – rate % was: 101,1% resp. 107,6%</p> <p>Reference: Page 5 of 12</p> <p>„..All analysed heavy metals in the polymer foil AddiFlex were below the tolerated values..“</p> <p>EMPA Swiss National Research & Testing Institute, St. Gallen, CH</p>
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Additional testing:

Disintegration and material tests on a polypropylene-based plastic film.

Report Nr. F221840:D

By:

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Biodegradability, disintegration and material tests on five different plastic films

Report Nr. F221840:C

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Influence of Addiflex® HE 01010 FF NO on the photooxidation and thermooxidation of HDPE films

Report Nr. *N/Réf : JL SB 2004 – 141*

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Envejecimiento Térmico y a la Luz UV de Películas de Polietileno con aditivo Addiflex

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