NATIONAL ASSOCIATION OF PRINTING INK MANUFACTURERS
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Printing Ink and Substrate Compostability

Purpose

This document is designed to provide an understanding of the regulatory and technical issues related to compostability of printed substrate with a particular focus on the impact/contribution of dried printing ink on the rate of compostability of cellulosic and bio-based polymeric substrate.

Overview

The U.S. ink industry strongly encourages recycling and reuse of printed substrate as a means to improve the sustainability of the graphic arts industries. Composting and landfilling are frequently utilized as post-use options when recycling a substrate is not possible or practical. This document will cover issues related to composting or landfilling printed substrate.

It is important to note that both processes (landfilling and composting) result in some form of chemical decomposition. Composting differs from landfilling by optimizing/improving the rate of decomposition by creating an aerobic (oxygen rich) environment.

Definitions:

Composting/Compostability

- U.S. Federal Regulatory Coverage: No Federal regulatory definition, tests or standards. Guidance available from the Federal Trade Commission.

- Industry Consensus Definitions: According to ASTM 6400-19 — Composting is a managed process that controls the biological decomposition and transformation of biodegradable materials into a humus-like substance called compost: the aerobic mesophilic and thermophilic degradation of organic matter to make compost; the transformation of biologically decomposable material through a controlled process of bio-oxidation that proceeds through mesophilic and thermophilic phases and results in the production of carbon dioxide, water, minerals, and stabilized organic matter (compost or humus)

- Other (Non-U.S.) countries and industry consensus standards may have relevant definitions.

Background

Printing ink is designed and formulated to be stable (weather resistant, water resistant, lightfast) under its intended conditions of use. Printing ink is primarily a mixture of organic compounds (solvents, resins, vehicles, colorants, etc.). Inorganic substances are sometimes used as “driers” in some types of lithographic inks and inorganic (metal based) pigments are also used. Inorganic substances are widely accepted as non-biodegradable or compostable.

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There are numerous types of printing inks including energy curable, water-based, oil-based, solvent-based and others. Each is applied to the substrate using an ink-specific/substrate-specific print process and employing different drying or curing mechanisms.

U.S Government Guidance and Industry Consensus Standards Related to Substrate Compostability

U.S. Federal Trade Commission (FTC) Green Guides (FR Listing) - Green Guides

The FTC *Green Guides* were published in the Federal Register on October 11, 2012. FTC has indicated that it intends to review the Green Guides in 2022 (FR July 2, 2021). The FTC *Green Guides* provide guidance via examples of FTC's position on the acceptability of "environmentally friendly" or "green" marketing claims.

The current FTC *Green Guide* provides the following guidance on the meaning of degradability and compostability:

Degradability
The product's or package's ability to degrade in the environment where it is customarily disposed.

Compostability
all the materials in the item will break down into, or otherwise become part of, usable compost (e.g., soil-conditioning material, mulch) in a safe and timely manner
(i.e., in approximately the same time as the materials with which it is composted) in an appropriate composting facility, or in a home compost pile or device.

Industry Consensus Standards (non-inclusive)

Consensus and regulatory (both US and non-US) definitions and related test methods covering compostability of printed substrate do not exist. However, there are internationally recognized organizations that publish consensus-based, technical standards applicable to measurement/quantification of compostability and biodegradability. These include but are not limited to:

- American Society for Testing and Materials:
  - ASTM D6400-19 Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities (6.3.2 Organic constituents which are present at concentrations of less than 1 % do not need to demonstrate biodegradability. However, the sum of such unproven constituents shall not exceed 5 %)
  - D6868 -21 Standard Specification for Labeling of End Items that Incorporate Plastics and Polymers as Coatings or Additives with Paper and Other Substrates Designed to be Aerobically Composted in Municipal or Industrial Facilities (6.3.2.2 - 1% by weight exclusion)

- Organisation for Economic Co-operation and Development (OECD EN13432:2000) Requirements for packaging recoverable through composting and biodegradation - (Section A4 Annex B – exclusion for each constituents 1% or less or the total content of constituents 5% or less).
- Biodegradable Products institute (BPI) Commercial Compostability Certification Scheme - 2.2 (Section 6.A.a.iii.2 exclusion 1% by dry weight of final product; AND the total of these ingredients does not exceed 5% by dry weight[1].)

Testing

The ASTM consensus standards outlined (D6400 and D6800) above contain the most commonly referenced/used compostability test methods. Each test requires 180 days to complete in addition to data analysis and reporting. Costs per test vary but range between $6000 and $7500. It is important to note that both of these test methods are substrate-based methods. Accordingly, to respond to compostability inquiries regarding a specific printed article separate tests would be necessary for each substrate and each ink system used.

Metals

The consensus testing standards outlined above contain limitations on the concentrations of metals in the tested substrates. They can be found here:

ASTM 6400 and 6800 – Sections 5.1.3 and 6.4.1

EN13432 – A.1.2 Table A-1

Printing Ink-Specific Technical Properties and Calculations

This section provides technical properties for dried ink and substrate useful for weight-based determinations/calculations. The test methods noted above provide for certain exclusions based on percent weight of components:

This table (Table 2.1 from the Printing Ink Manual[2]) shows ink film thickness

[1] AND by June 2026 the total of these ingredients does not exceed 5% by dry weight.

[2] The Printing Ink Manual - Published by Blueprint 5th Edition 1993 ISBN 0 948905 81 6

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Table 2.1 Main characteristics of the printing processes [1]

Print process	Ink film thickness (μ)	Typical halftone screen ruling (lines/cm)	Substrate types	Typical applications
Offset litho				
Sheet-fed	<2	47–80	Wide range of paper and board, plastic sheet and metal	All general print, business forms, technical documentation, promotional, magazines, credit cards
UV drying		60	Carton board	Packaging
Web-fed				
Heat-set	<2	52–69	Wide range of coated and uncoated paper	Magazines and similar format products
Cold-set	<2	25–40	Newsprint	Newspapers
Flexography				
Narrow web	0.75–2	60	Paper and plastic film	Labels, flexible packaging
Wide web	0.75–2	33	Newsprint	Newspapers
	0.75–2	52	Wide range of plastic film, paper, corrugated cardboard	Boxes and many other types of packaging, sacks
Gravure				
Large web	<6	60–80	Coated or uncoated paper	Magazines and similar products, mail order catalogues, woodgrain patterns
Smaller web	<6	60–80	Coated or uncoated paper, plastic films, board	Packaging (esp. flexible), cigarette cartons, postage stamps
Sheet	<6	150–200	Paper	Fine art reproductions

[1] R.H. Leach, R.J. Pierce, E.P. Hickman, M.J. Mackenzie, H.G. Smith, "Printing Ink Manual – 5th Edition, (Great Britain: Blueprint an Imprint of Chapman & Hall 1993), 76.

- Offset/flexo dried ink thickness = 2 microns (from the Printing Ink Manual p. 76 above)
- 2 microns = 0.00008 inches Volume (in cubic inches of 1 square inch) at height of 0.00008*u*
  0.00008 cubic inches or 0.00131 ml (assumes 100% coverage)

Assumption

1 g/ml ink density (the density should be adjusted with the removal of any volatiles or other volatiles

0.00131 ml = 0.00131 g or 1.31 mg ink/square inch or 2.03 g/m²

Typical Substrates – Cellulosic[3]

Tissue: 20 g/m2 to 75 g/m2

Unbleached paperboard: 130 g/m2 to 450 g/m2

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https://faculty.cnr.ncsu.edu/richardvenditti/wp-content/uploads/sites/24/2018/10/PaperGrades-Venditti.pdf

Bleached paperboard: 134 g/m2, typically from 200 g/m2 to 500 g/m2.
Kraft Paper: 50 g/m2 to 134 g/m2
Coated wood-free: 70 g/m2 to 170 g/m2
Coated groundwood: 45-130 g/m2
Uncoated groundwood: • 24-75 g/m2 with newsprint 40-50 g/m2

Typical Substrates – Film (Compostable Films (NatureFlex NM)[4]
NM 90 thickness (mil) 0.92
MN 120 thickness (mil) 1.18
NM 90 weight (g/m2): 32.3 g/m2
NM 120 weight (g/m2): 42.9 g/m2

Dried Ink Weight%/Substrate

Cellulosic Substrate	**g/m2 (range)**	**Total Dried Ink %**
Tissue	20 g/m2 to 75 g/m2	10.15 - 2.71
Unbleached paperboard	130 g/m2 to 450 g/m2	1.5 - 0.45
Bleached paperboard	200 g/m2 to 500 g/m2	1.0 - 0.41
Kraft Paper	50 g/m2 to 134 g/m2	4.1 - 1.51
Coated wood-free	70 g/m2 to 170 g/m2	2.9 - 1.2
Coated groundwood	45 g/m2 -130 g/m2	4.5 - 1.56
Uncoated groundwood	24 g/m2 -75 g/m2	8.45 - 2.7
Film/Polymeric*		
NM 90 (90 mil)	32.3 g/m2	6.3
NM 120 (120 mil)	42.9 g/m2	4.7
* NatureFlex NM Films		

Summary

Although portions of some paper, paperboard and printing inks are biodegradable, they also contain components that are not. The wood fiber in paper is biodegradable, but paper contains many additives such as clay, calcium carbonate, titanium dioxide, synthetic binders, and paper machine runnability agents. The amount and type of these additives is highly dependent on the grade of paper, i.e. newsprint, copy paper, coated gloss, etc.

In addition, certain metal-based pigments (e.g. copper, aluminum, etc.) may inhibit the rate of biodegradation.

Printing inks, even those based on vegetable oil and other bioderived, renewable materials contain components that are not fully or easily compostable, such as pigments, dyes, waxes, resins, etc. The

[4] see attached technical data sheets C:\Users\gfuchs\NAPIM Dropbox\NAPIM_Documents\Biodegradability\2021\Printing Ink and RecyclabilityFinalOct-2021.docx

amount of these materials are dependent on the type of printing ink, i.e. heatset, gravure, flexographic, coldset, oxidizing, etc

In both cases, the amount of non-compostable content is relatively low with low toxicity characteristics.

The absence of a consensus, technical standard or regulatory standard on compostability generally precludes the definitive or conclusive designation of an article (e.g. printed substrate, etc.) or substance (e.g. printing ink, etc.) as compostable or biodegradable.