Quantifying the Biobased Content of Materials Using ASTM-D6866

ASTM-D6866-08

Standard Test Method for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples using Radiocarbon Analysis
What is “Biobased”?  

Premise: Use less petroleum

US Department of Agriculture’s definition:

- ASTM-D6866 results are to be consistent with this definition
- Mass of component is factored out
- A single value is applicable across industries
- Carbonates of natural mineral origin are to be excluded

Renewably Sourced Carbon

Total Organic Carbon

Verification of Biogenic Carbon / Carbon-neutral CO₂

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Nature has embedded a
“carbon tracer”
related to the carbon source
Radiocarbon
(\textsuperscript{14}C, carbon-14)

It’s a naturally occurring isotope.
It’s in all recent plant and animals
It’s absent in petrochemicals.
ASTM D6866 measures it.
Radiocarbon is a ubiquitous in all living things.

But it doesn’t stick around.

It decays away at a known rate such that after being removed from a respiring system, it’s all gone by 50,000 years.

Ergo….petroleum, petrochemicals, coal, and natural gas don’t have any radiocarbon whereas biomass and plant feedstocks do.
The Radiocarbon Cycle

Nitrogen + cosmic radiation

$^{14}$C Decays
(T$^{\frac{1}{2}}$ ~ 5700 yrs)

$^{14}$CO$_2$

On-going Plant Respiration

Animals eat the plants

Animals eat animals

People eat the animals

People eat the plants

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ASTM-D6866 is a standardization of radiocarbon dating methods used by archaeologists to determine the age of fossils.

Methods that have been in use for 60 years
(mature technology)
Regardless of the percentage of total carbon in the product...

If it were 100% petroleum derived...

If it were 50% corn-based & 50% petroleum derived...

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and being a mature industry . . .

- Expertise
- Laboratories
- Well known sources of error
- Supply Lines
- Venders
- Instrumentation
- Raw materials

Complete pre-existing infrastructure
Two practical methods of analysis

Method B
AMS
(Amplifier Mass Spectroscopy)

Routine by the 1980s

Plastic
↓
CO₂
↓
Reduced to Graphite
AMS

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Two practical methods of analysis

Method C
Benzene Synthesis

Routine by 1960s

Plastic
→
CO₂
→
Lithium Carbide
→
Acetylene
→
Benzene
→
LSC

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Total Combined Error based on USDA Program Testing Data is ~ 2-3 % absolute (Methods B and C)

Analytical error on 14C /12C ratio = 0.1 – 0.6 % RDS

**ASTM-D6866 cites +/- 3 % absolute error on each result**

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Reporting

An “Easy” Visual

Easy Inter-comparison

Instinctively Obvious

Verification of Biogenic Carbon / Carbon-neutral CO₂
Considerations in using ASTM-D6866

things to remember

All carbon components must be either fossil or contemporary (respiring carbon w/in last 10 years)

The reported result will be unique to the actual material analyzed

Ensure a representative sample is analyzed

Consider the homogeneity of your product
Considerations in using ASTM-D6866
things to remember

If carbonates of natural mineral origin account for > 3% of the total carbon in the product, it must be subtracted out of the “Biobased Content”. This is going to require a 2\textsuperscript{nd} analysis of the same material

Just about anything with carbon in it can be analyzed

Difficult materials: high alkalinity, high acidity, high sulfur, high water content – let the lab know

Knowing the % biobased content of each component, the % carbon within each component, and the fraction of the component within the product, you can predict the biobased content
Considerations in using ASTM-D6866 things to remember

MARKETING PERSPECTIVE

50% biobased also means 50% less petroleum carbon. – consider this in the marketing of your biobased products

“This product contains 50% less petroleum carbon than our previous formulas”

- Immediately understood by the public
- Positive public image and reception
- Brings value to your assemblers, distributors and retailers

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Considerations in using ASTM-D6866
things to remember

LEGAL PERSPECTIVE – PRODUCT DEFENSE

An ASTM-D6866 analysis is routine, but complex – it is a “one of measurement”

If you are doing R&D or product development, generally one measurement is fine.

If you are submitting materials to the USDA’s BioPreferred Program or other certification, we recommend 2 per material for better credibility and averaging.

If you are doing any kind of product discovery, product market protection, or purpose otherwise that may entail commercial or legal repercussions, we recommend 3-4 analyses per material.
The manufacturer submitted 3 samples

Radiocarbon Dating Results were . . .

- Product A → 69 % Biobased
- Product B → 78 % Biobased
- Product C → 70 % Biobased

After the analyses, the manufacturer informed the lab that A, B, & C were all the same product and an error must be present in the result for Product B.

ASTM-D6866 determined the biobased content & revealed a quality control issue.
**USDA BioPreferred Program**

**Two Programs:**

- **Federal Procurement**
  - Mandatory purchasing of biobased products by government agencies
  - Biobased minimums enforced for each product category
  - ASTM D6866 used to determine if products meet minimums

- **BioPreferred Label**
  - Starting early 2010
  - Consumer product label
  - 51% or higher (unless category has minimum in procurement program)
  - Biobased % listed on label
  - ASTM D6866 used to determine %

More information: [www.biopreferred.gov](http://www.biopreferred.gov)

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