



Caffeinated Compost: The Case for Compostable Coffee Capsules

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Single-Serve Coffee Capsules: The Good, The Bad & The Ugly

**“I feel bad
sometimes
that I ever did it.”**

**John Sylvan
K-Cup Inventor**

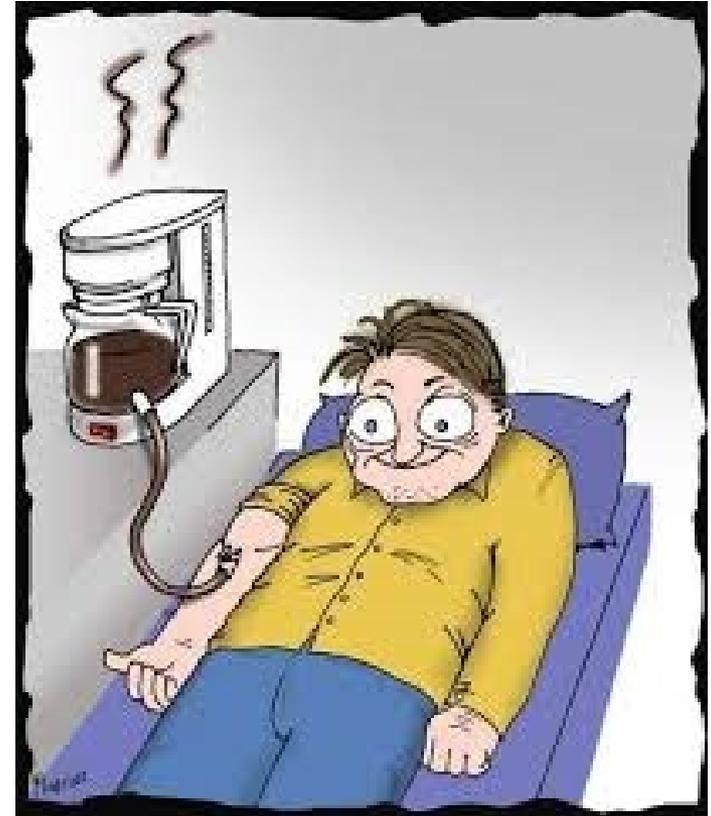
**Globally 56 billion
coffee capsules end
up in landfills annually**



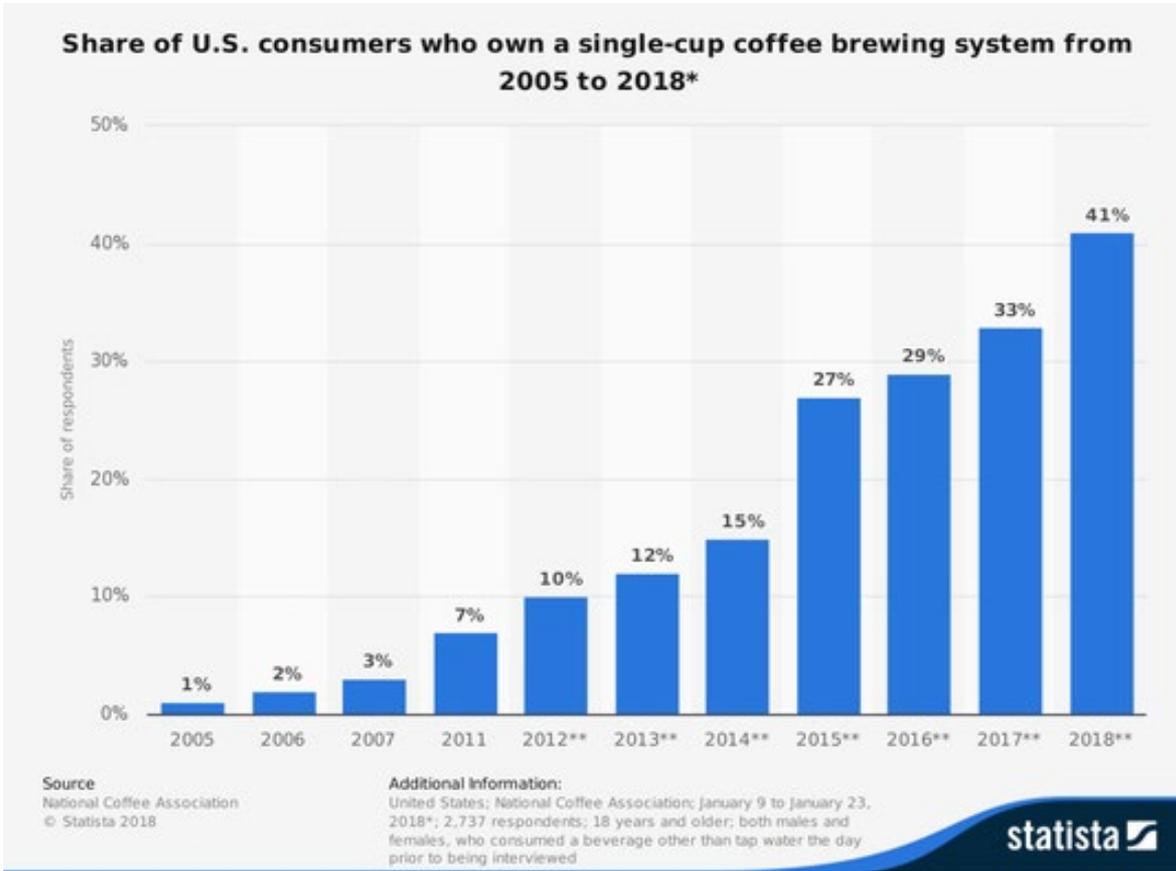
Coffee Consumption Stats

- Europe – Largest coffee market representing 30% of global consumption.
- Coffee capsules and pods – Fastest growing segment in the North American coffee market.
- Consumers report improved coffee taste, ease of use and product personalization as purchasing reasons for single-serve coffee capsules.
- Single-serve capsules represents one of the most attractive markets in the packaging industry.

Global Coffee Pod and Capsule Market to Reach \$29.2 Billion Globally by 2025 at 8.5% compound annual growth rate (CAGR)



Coffee Consumption Stats



- Over 41% of U.S. households own a single-serve coffee machine and the number is growing.
- The number of orders placed for coffee capsules grew by 53% over the past 12 months and accounted for more than half of all coffee orders online.

Still there is an end-of-life challenge



"We couldn't recycle them, so this entire 3-season room is made of coffee pods."

Recycling?...It's not easy

- The complexity of the packaging (multi-material), combined with the dregs of coffee grounds, makes them difficult to process at MRFs.
- Capsules are often too small to capture.
- Recyclers don't want capsules in their streams as they could impact the quality of the products they send to their end-markets.
- Requesting consumers to separate the capsule elements before recycling is inconvenient and typically doesn't happen.
- Even if recycled, the valuable organic nutrients contained in the coffee are lost.

The Case for Compostable Coffee Capsules



- Compostable coffee capsules require no separation of components by the consumer.
- They are 100% bio-based and compostable.
- Two-thirds to three-quarters of the weight of a spent single-use coffee capsule is the grounds.
- Coffee grounds are high in nitrogen contributing to healthy soils, healthy microorganisms and healthy plants.

Coffee Capsules:

- Coffee capsules are the plastic containers with an aluminum foil seal, which encapsulates the ground coffee.
- Nespresso coffee capsules are typically made from aluminum.

Coffee Pods:

- Coffee pods look similar to a teabag, except for that they are round in shape.
- The Club Coffee pod incorporates a rigid rim (coffee chaff/PLA blend) and paper lid over a PLA mesh which holds the ground coffee.
- Club Coffee pods are compostable, BPI-certified, and compatible with most single-serve brewing machines including most Keurig systems.

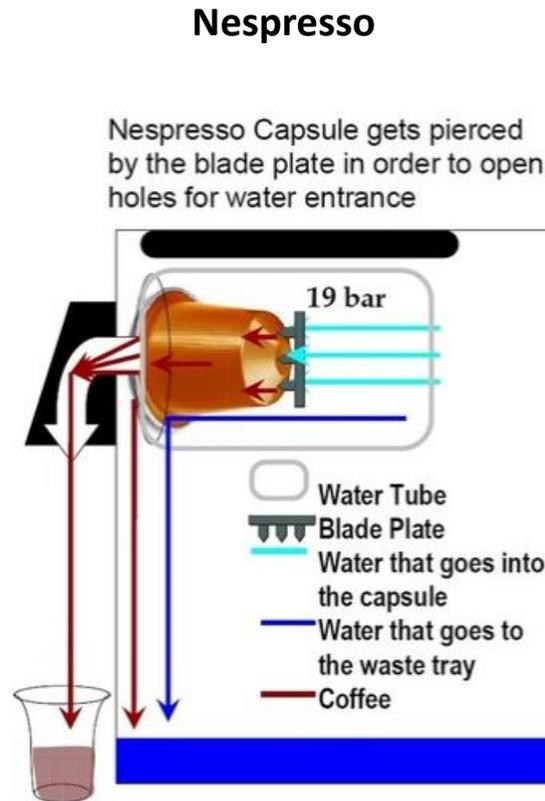
What is the difference between coffee capsules and coffee pods?



High-Pressure Systems vs. Low-Pressure Systems

HIGH-PRESSURE

- Typically, high-pressure systems don't need a filter.
- During the brewing process, several needles punch the top of the capsule (lid) and the bottom of the capsule.
- The capsule is designed to keep the pressure high while the water flows through it.



High-Pressure Systems Favored in Europe

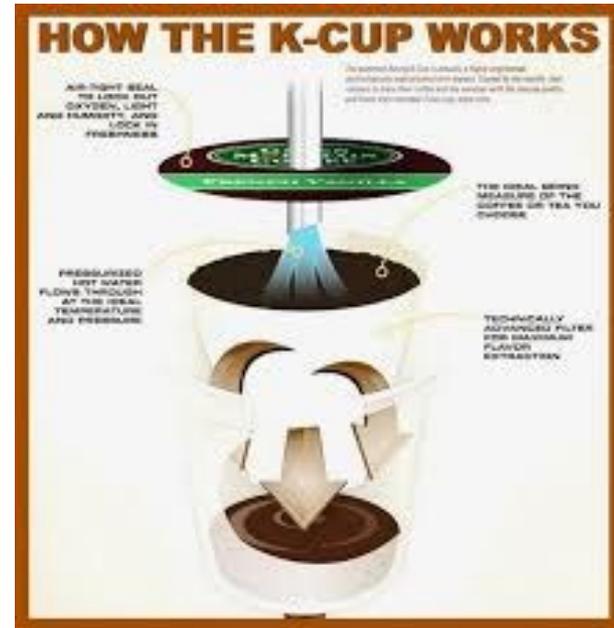
- Nespresso
- Nestle
- Lavazza
- Caffitaly

High-Pressure Systems vs. Low-Pressure Systems

LOW-PRESSURE

- Typically low-pressure systems need a filter.
- The chamber in which the capsule sits contains two hollow needles: one punctures the cup's foil top and fills it with the hot water, while the other punctures the cup's plastic bottom so the brewed coffee can make its way to your cup.
- The filter allows for optimal flavor extraction while the foil-sealed lid, keeps the coffee air tight and blocks out oxygen and humidity similar to what a high-pressure system does.

Keurig K-Cup



Low-Pressure Systems Favored in North America

- Keurig Dr. Pepper

Coffee Capsule Composting: The Italian Study

Project Participants

- NatureWorks
- Consorzio Italiano Compostatori (CIC)



Project Objectives

- Test Ingeo™ single-serve coffee capsules in an industrial composting facility to determine the disintegration rate of the capsules over an 83 day time period.

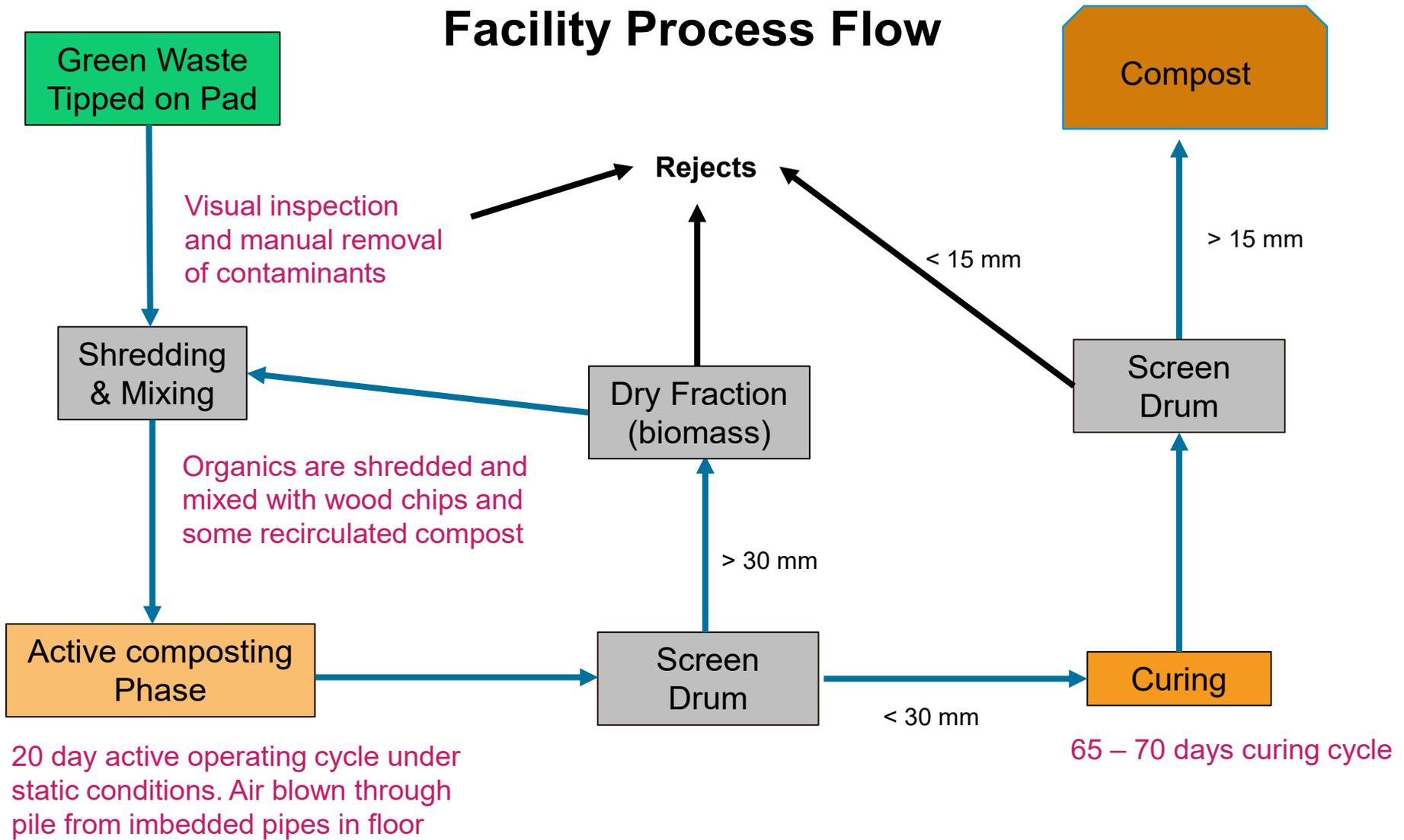


Facility Description

- Processes 28,500 tons/year of organics – 99% green waste, 1% other
- Produces up to 7,000 tons/year of compost



Facility Process Flow



Project Methodology



- Mesh testing bags with a mesh-size of 1 mm (~0.04 inches) were used for monitoring the disintegration process.
- Bags were filled with a mixture of approximately 2/3 shredded green-waste and 1/3 finished compost.
- A limited amount of the Ingeo coffee capsules (up to 1% by weight) was added to the bags.
- A total of six bags were prepared
 - 3 containing unused Ingeo coffee capsules
 - 3 containing used (brewed) coffee capsules.



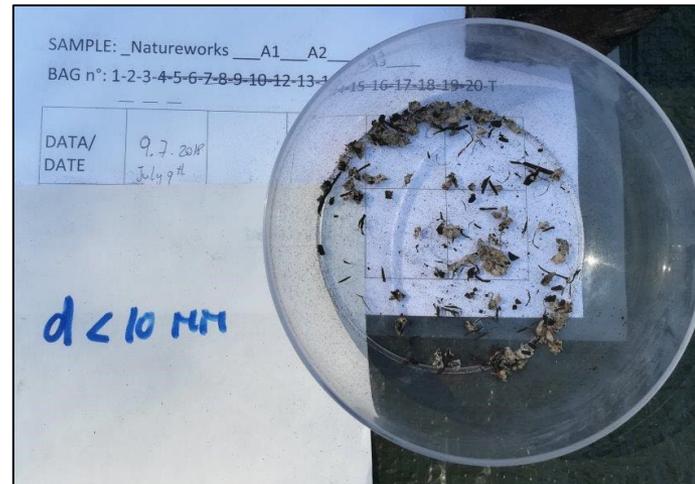
Project Methodology

- Bags are buried inside a static, aerated compost windrow, operated at 149⁰ F for 10 days and then at 140⁰ F for another 10 days.
- Moisture levels are maintained at 46%.
- Curing windrows are maintained at between 122 – 131⁰ F for a curing period of between 65 and 70 days.
- Bags are recovered from the windrows (both active and curing) at regular intervals to monitor the disintegration process.
- Once inspected and documented, the content of each bag is mixed, watered and placed back inside the windrow.



Project Methodology

- After a total of 83 days¹, all bags are removed, emptied and the contents are manually sorted to detect visible, non-degraded coffee capsules.
 - Fragments with a diameter ≥ 10 mm (~ 0.4 inches)
 - Fragments with a diameter between 2 mm and 10 mm (~ 0.08 to 0.4 inches)



¹ Duration was chosen based on the EN13432 standard for assessing the amount of disintegration of compostable plastics.

Coffee Capsule Disintegration Testing Results

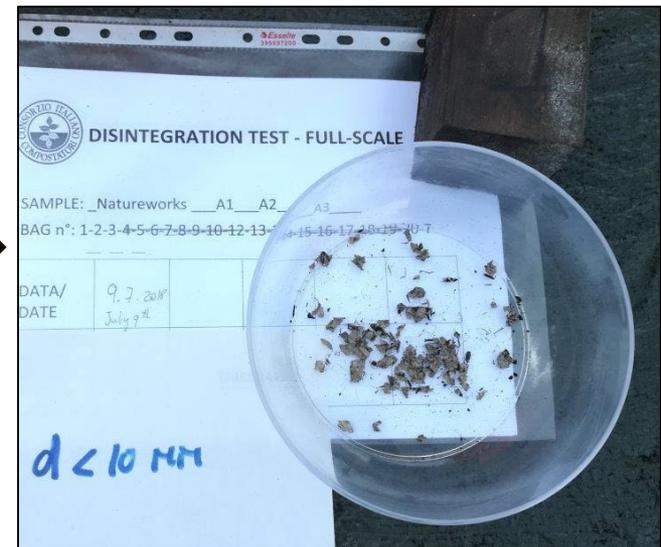
Bag	Material ¹	Evidence of Non-Degraded Fragments	Weight of Coffee Capsules			Amount of Disintegration (%)	
			Starting Weight (grams)	> 10 mm fraction (grams)	Between 2 and 10 mm fraction (grams)	Per Bag	Average
1	Coffee Capsules (N)	Yes	99.0	0.0	0.4	98.6	98.0%
2	Coffee Capsules (N)	Yes		0.0	1.6	97.4	
3	Coffee Capsules (N)	Yes		0.0	1.0	98.0	
8	Coffee Capsules (U)	No	28.8	0.0	0.0	100.0	100.0%
9	Coffee Capsules (U)	No		0.0	0.0	100.0	
10	Coffee Capsules (U)	No		0.0	0.0	100.0	

¹ N= New unused capsule U= Used (brewed) capsule

- In addition to the above table, a more detailed analysis of the results also show that the Ingeo capsule itself generally broke down after 23 days with only the paper lids requiring extra time to disintegrate.

Study Conclusions

- At the end of the process, prior to screening, no fragments were detectable by visual inspection and barely visible after sieving to 10 mm.
- After sieving between 2 and 10 mm, non-disintegrated fragments were found only in the bags testing the unused coffee capsules.



Study Conclusions

- This suggests the composting process works more effectively for items that have been brewed in a coffee machine.
- Regardless, both new and used coffee capsules disintegrated at a 98% and 100% level, respectively complying with the 90% set by the EU standard EN13432 for compostable biopolymers.



Naturally advanced materials made from locally abundant and sustainable natural resources

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