A Comparison of Clamshell Food Packaging Made from Ingeo and r-PET

Recycled PET

Ingeo

Life Cycle Analysis performed by the IFEU Institute in Heidelberg, Germany
IFEU Institute - Heidelberg, Germany

Background Information

- Institute for Energy and Environmental Research
- Founded 25 years ago
- About 35 employees
- Expertise covers environmental implications of
  - transport, energy supply and renewable energy sources
  - LCA, air pollution control, sustainable development
  - Environmental impact assessment and environmental management.
- Clients in the public as well as commercial and NGO sectors.
- Projects in EU, USA, China, India, Indonesia, Latin America, Russia and the Marshall Islands.
- Examples of Clients: the World Bank, the European Commission, German Ministries on the Federal and State level, regional and local governments, national and international foundations, industry associations, companies (e.g. Daimler-Chrysler, BMW, Deutsche Telekom, Deutsche Shell, BASF) and environmental organizations (e.g. Greenpeace, Friends of the Earth).
- www.ifeu.org
### Objective
Compare the environmental performance of clamshells made of Ingeo bioplastic with clamshells made of varying levels of recycled PET (r-PET).

### Variables Assessed

<table>
<thead>
<tr>
<th>Variables Assessed</th>
<th>Recycled PET</th>
<th>Ingeo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Material Type</td>
<td>• 0 %, 50 %, 100 % PET</td>
<td>• Ingeo 2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ingeo 2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ingeo 2009</td>
</tr>
<tr>
<td>2. Clamshell Weight</td>
<td>• 19.9 g</td>
<td>• 19.9 g (functionally overdesigned)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 15.0 g (functionally identical)</td>
</tr>
<tr>
<td>3. End-of-Life treatment</td>
<td>• Landfill</td>
<td>• Landfill</td>
</tr>
<tr>
<td></td>
<td>• Incineration</td>
<td>• Incineration</td>
</tr>
<tr>
<td>4. Location</td>
<td>• EU vs US power grid</td>
<td>• EU vs US power grid</td>
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<tr>
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<td>• EU vs US landfill practices</td>
<td>• EU vs US landfill practices</td>
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</tbody>
</table>
A North American Example: 
Sam’s Club reduced resin use with Ingeo compared to rPET

Mastronardi tomato clamshell

When made in rPET:
- 55 grams
- 16 mil

When made in Ingeo:
- 44 grams
- 14 mil

20% Actual Weight Reduction due to Ingeo Lightness & Stiffness
An EU Example:
Vitembal / Iper / London BioPackaging reduced resin use with Ingeo compared to rPET

<table>
<thead>
<tr>
<th>PET (g)</th>
<th>Ingeo (g)</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV2*</td>
<td>12.6</td>
<td>10.1</td>
</tr>
<tr>
<td>MV3</td>
<td>14.9</td>
<td>10.5</td>
</tr>
<tr>
<td>MV5</td>
<td>16.6</td>
<td>13.1</td>
</tr>
<tr>
<td>MV7</td>
<td>25.2</td>
<td>17.8</td>
</tr>
</tbody>
</table>

20-30% Actual Weight Reduction due to Ingeo Lightness & Stiffness

*Vitembal France November 14, 2008
Simplified flow diagrams of Ingeo & PET clamshell life cycles

Ingeo clamshell life cycle:

100% virgin Ingeo

Virgin Ingeo Production

Clamshell Production

EOL Clamshell (incineration or landfill)

(All transportation steps are included)

PET clamshell life cycle:

Virgin PET Production

Clamshell Production

EOL Clamshell (incineration or landfill)
Ingeo clamshell life cycle:
100% virgin Ingeo

Virgin Ingeo Production

Clamshell Production

EOL Clamshell (incineration or landfill)

PET clamshell life cycle:
0%, 50%, and 100% rPET

Virgin PET Production

PET Bottle Production

PET Recycling

EOL of Bottle

Clamshell Production

EOL Clamshell (incineration or landfill)

(All transportation steps are included)
What’s really happening when rPET is used for clamshells?

Although the extent to which it is actually practiced is limited, it does achieve cradle-to-cradle & reuse of raw materials in more durable applications.

Bottle-to-Bottle recycling of PET
Bottle-to-Fiber recycling of PET

Landfill or Incineration

Cradle-to-cradle concept is interrupted and terminated - replaced by one-way
IFEU’s LCA Results

First, a context of how we’ve improved the Ingeo eco-profile over time . . .

…where we’ve been since 2005 and where we are today
Improving Ingeo Eco-Profile: Cradle to Pellet CO2 Profile

Virgin Ingeo

Ingeo 2005: 2.02 kg CO2 eq. / kg Ingeo
Ingeo 2009 CIT: 1.3 kg CO2 eq. / kg Ingeo

Virgin PET: 3.49 kg CO2 eq. / kg PET

Plastics Europe:
Results for climate change

North America End-of-Life: Clamshell Landfilled After Use

As expected, higher r-PET use reduces the environmental burden

[CO2 eq / 1000 clamshells]

- 0% rPET: 84.4
- 50% rPET: 71.5
- 100% rPET: 58.6

19.9g PET clamshell

As expected, higher r-PET use reduces the environmental burden
Conclusions:

Even **without** our recent (2009) eco-profile improvements, virgin Ingeo has a lower GHG footprint than 100% rPET.

Differences in impact increase significantly if rPET content is less than 100%.
Results for non-renewable primary energy

North America End-of-Life: Clamshell Landfilled After Use

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Conclusions: Comparing rPET and Ingeo

• NatureWorks Supports Recycling
  – we agree that the use of rPET is a better way of doing business as usual
  – and bottle-to-bottle is a more sustainable route for rPET than bottle-to-clamshells

• The Big Picture
  – Ingeo can help packaging move away from oil dependence. (World Energy Outlook, IEA)

• Environmental Footprint
  – Virgin Ingeo already offers a better one today

• Comparing “Apples with Oranges”
  – (rPET vs Ingeo → rPET vs rIngeo).
Conclusions: Comparing rPET and Ingeo

- **The 4-R’s**
  - Packaging is guided by the three R’s: reduce; reuse; recycle; Ingeo brings in the fourth R - **Renewable**
  - A significant weight reduction is possible

- **Feedstock Recovery**
  - Ingeo offers additional waste management options
    - Hydrolysis back to lactic acid
    - Industrial compost

- **Ingeo is a 100% virgin material**
  - What about rPET supply reliability & availability?
  - Not all rPET is suitable for food contact
  - Material specification and QC. How to distinguish PET from rPET?
  - Is it post-consumer or just post-industrial rPET?