Driving the development of the Bioeconomy

Bio-Succinic Acid’s Coming of Age

Marcel Lubben

BIO World Congress on Industrial Biotechnology
July 2018, Philadelphia
- 50/50 JV of DSM & Roquette
- Produces & sells Biosuccinim®, a versatile bio-based diacid building block
- Develops performance-enhanced bio-materials with partners
- Best-in-class technology: low pH yeast fermentation

HQ in The Netherlands

10 kt plant in Italy

Process R&D and Application Support in The Netherlands
Biosuccinium® main markets

Bio-based materials
• Sports & Leisure
• Coatings & Paints

Bio-based chemicals
• Coolants
• De-icing
• Corrosion inhibitors
• Solvents

Compostable plastics
• Packaging
• Food Service Ware
• Coffee Capsules

100% natural ingredients
• Cosmetics
• Personal Care
“Plastics have become the ubiquitous workhorse material of the modern economy — combining unrivalled functional properties with low cost” *

With 20-fold growth in last 50 years and expected to double again in the next 20 years

* The New Plastics Economy, Ellen Mc Arthur Foundation, 2018
Issues with plastics

~ 99% of current plastics are fossil-based -> climate change

32% of plastic escapes collection -> impacting vital natural systems
Addressing the issues of plastics

Biobased Economy
- Bio-based plastics
- Decouple from fossil feedstock and use biomass or CO2

Circular Economy
- Re-use, recycle
- Circular design
Bio-based and circular economy go hand in hand

1. a) collection & re-use or
   b) collection & separation & recycle

2. composting (e.g. in presence of food waste)

3. virgin bio-based plastics

Credits to the leading work of the Ellen Mc Arthur Foundation in “The New Plastics Economy, 2018”
Looking forward: expectations for bio-based materials will continue to increase

1. Replacing oil-based products
2. Adding new functionality
3. Circularity and circular design
Biosuccinium® is made by fermentation using renewable resources (corn starch hydrolysate)
Biosuccinium® is produced at commercial scale

- Commercial scale (10 kt)
- Qualified by customers in many applications
- Continuous improvement & version control
- Ongoing evolution of Biosuccinium® offering
- Choice of grades
- Choice of packaging
Introduction of Biosuccinium®-based materials goes hand-in-hand with offering performance benefits

Trekking Shoe (Vaude)
Outdoor brand value

Coffee capsules
Addressing upcoming regulations

Coffee cups
Compostable – sustainable end of life option

Emulsifiers (Bonderalia)
100% natural product

Paint (Mäder)
Antimicrobial and depolluting function
Use of Biosuccinium® in PET bottles
Collaboration with PET resin producers + water bottler

Current PET bottle

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEG</td>
<td></td>
</tr>
<tr>
<td>PTA</td>
<td></td>
</tr>
<tr>
<td>IPA</td>
<td>1-5%</td>
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Future PET bottle

<table>
<thead>
<tr>
<th>Component</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>MEG</td>
<td>Bio-MEG</td>
</tr>
<tr>
<td>PTA</td>
<td>Bio-PTA</td>
</tr>
</tbody>
</table>

Green PET bottle

<table>
<thead>
<tr>
<th>Component</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td>IPA</td>
<td>Biosuccinium</td>
</tr>
</tbody>
</table>

- Highly volatile pricing
- Fossil-based
- Renewable, bio-based
- Stable price, independent from oil
- Commercially available
- Same or superior performance, drop-in
Commercial efforts pay off

CAGR +47%

# of new clients
# of repeat clients
Conclusion & discussion

What has worked for Reverdia:
- Co-development with customers and value-chain selling
- Cutting edge technology
- Support from shareholders
- Customer-obsessed BD staff
- Credible communication

Lessons learned:
- Don’t invest too early in large-scale capacity
- Focus on markets where “green solutions with performance benefits” can be created

Going forward:
- The bio-based industry at large has established a promising niche play but how to take it to the next level:
  - Leverage brand-owner momentum
  - Price on carbon
  - Integrate bio-based and circular economy
Thank you

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