Aqueous Polyolefin Dispersion for Packaging Boards and Papers

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Outline

• Polyolefin dispersions processing and fundamental properties
• Materials and Results
  - Adhesion priming
  - Barrier improvement
  - Performance balance
• Summary and Conclusions
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Processing Plastic Pellets

- Plastic Pellets
- Printing/Coating
- Spray coating
- Dipping
- Frothed Foams
Processing Waterborne Polyolefin Dispersions

- Printing/Coating
- Spray coating
- Dipping
- Frothed Foams
Aqueous Polyolefin Dispersions (POD)

Positive performance characteristics of polyolefins:

- Heat sealability
- Low temperature flexibility
- Water & chemical resistance

Application benefits of water-borne systems:

- Adhesion to polar substrates
- Acceptance of inorganic fillers
- Low viscosity application
How are PODs different from other dispersions?

- Dispersion of polymers which are not self-dispersing
- High molecular weight polymers
- Thermoplastic and elastomer formulations
- Low viscosity
- High solids
- Solvent-free solution
Aqueous POD benefits

**Waterborne Application vs. Extrusion**

- Thinner coatings
- Use existing waterborne application equipment
- Higher line speeds
- Penetrate porous/fibrous webs
- Coat complex geometry
- Coat in pattern

**Properties of PODs**

- Water resistance
- Oil & grease resistance
- Heat sealability
- Elasticity/flexibility
- Adhesion to polyolefins
- Adhesion to polar substrates
Continuous Mechanical Dispersion Process

Liquid or Molten Polymers → Continuous High Shear Mixer → HIPE System:
- Water continuous phase
- Rhombohedral particles
  - High viscosity
  - 90+% Solids
→ Spherical Particles < 75% Solids

Optional Surfactant

Initial Water → Dilution Water

Ref: U.S. Patents: 5,539,021; 5,959,027; 5,688,842; 5,959,027; 6,087,440
HIPE = High Internal Phase Emulsion
POD Characteristics

- Avg. particle size: ~ 1 µm
- Solids content (wt%): 40 to 55%
- pH: 8.0-10.5
- Viscosity (Brookfield @ 25°C): < 500 cps
Properties of PODs

• Water resistance
• Oil & grease resistance
• Heat sealability
• Elasticity/flexibility
• Adhesion to polyolefins
• Adhesion to polar substrates
Materials and Results
## Product description

<table>
<thead>
<tr>
<th>Product designation</th>
<th>Target performance</th>
<th>Polymer composition</th>
<th>Functional groups</th>
<th>Polymer melting point [°C]</th>
<th>Polymer glass transition point [°C]</th>
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</thead>
<tbody>
<tr>
<td>POD Primer</td>
<td>Primer</td>
<td>Ethylene-Copolymer</td>
<td>Medium</td>
<td>63</td>
<td>-53</td>
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<tr>
<td>POD Standard</td>
<td>Standard</td>
<td>Ethylene-Copolymer</td>
<td>Low</td>
<td>63</td>
<td>-53</td>
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<tr>
<td>POD BI</td>
<td>Barrier Improvement</td>
<td>Ethylene-Copolymer</td>
<td>Low</td>
<td>63</td>
<td>-53</td>
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<tr>
<td>POD BR</td>
<td>Blocking Reduction</td>
<td>Propylene-copolymer</td>
<td>Medium</td>
<td>80</td>
<td>-26</td>
</tr>
</tbody>
</table>
Adhesion priming

- POD priming improves adhesion already at 0.8 g/m²
- Enables higher extrusion coating line speeds
Water Vapor Barrier Improvement

WVTR (90% RH, 38C)

• Reduction of polar content improves significantly water vapor barrier
Water barrier improvement

H$_2$O absorption (Cobb 2 min)

- Reduction of polar content improves significantly water barrier
# Improved dispersions

<table>
<thead>
<tr>
<th>Test results</th>
<th>POD BI Barier improved dispersion</th>
<th>POD BR Blocking reduced dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barrier test results</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WVTR (90%,RH 38C) [g/m²/24h]</td>
<td>54</td>
<td>185</td>
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<tr>
<td>WVTR (50%RH, 23C) [g/m²/24h]</td>
<td>13</td>
<td>9.5</td>
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<tr>
<td>Cobb 2 min [g/m²] [g/m²/24h]</td>
<td>0.1</td>
<td>0.6</td>
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<td>Grease resistance (Kit test) folded sample</td>
<td>12</td>
<td>12</td>
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<tr>
<td><strong>Blocking test results</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocking rating / fiber tear % (45°C, 1500 psi)</td>
<td>3 / 0%</td>
<td>3 / 0%</td>
</tr>
<tr>
<td>Blocking rating / fiber tear % (60°C, 1500 psi)</td>
<td>5 / 83%</td>
<td>4 / 0%</td>
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<tr>
<td><strong>Heat seal performance</strong></td>
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<td></td>
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<tr>
<td>Heat seal initiation temperature (°C)</td>
<td>&lt;70</td>
<td>&lt;100</td>
</tr>
</tbody>
</table>
Summary and Conclusions
Summary

• Polyolefin dispersion have potential to:
  - Reduce steps to build existing structures and create new structures.
  - Coating with online paper or paperboard machine
    • Thinner coatings at higher line speeds
    • Use existing coating techniques
  - Enable sustainable solutions
    • Fluorochemical free
    • Emits low VOCs
    • Lower material use
Conclusions

• Benefits demonstrated in:
  - Adhesion primer between paper and extruded polyolefin
  - Dispersions with improved water and water vapor resistance
  - Oil and grease barrier with balance of water vapor barrier

→ Polyolefin Dispersions have broad application potential

  - Low in-reel blocking with 100% polymer and heat sealing can be achieved

→ Enables on-line coating in paper or board machine
Thank you!