Recycled Materials for Public Storm Pipe

Infrastructure Challenge:

America's GPA: D+

Estimated Investment Needed by 2020: $3.6 Trillion

Infrastructure Grades for 2013:
- Energy: D+
- Schools: D
- Public Parks & Recreation: C-
- Transit: D

Sustainable & Resilient Solutions:

Closing Infrastructure Gap

Infrastructure Needs vs. Available Funding

ASCE Grand Challenge

Time

$
ADS’ Commitment to Sustainability

Sustainable Product Evolution

HDPE Material Recycled Annually

Eight (8) Recycling Locations

Sustainable Product Evolution

[Graph showing percentage change in high performing pipe from FY 2005 to FY 2017]

https://www.ads-pipe.com/
The Perfect Outlet

• Drainage pipe is the ideal outlet for recycled HDPE
  • Colored flake can be used since end product is black
  • Blending allows for use of materials with a wide range of properties
  • Odors remaining in the plastics are not a concern
  • Short service life products are removed from a closed tight loop recycling chain and put it into service for 50-100 years
Project Goals

- Blending Multiple Resins
- Processing Blend
- Original Source Resin
- Finished Pipe Product

Material Property Variability
Nomenclature

- Post-Consumer HDPE
  - General public recycling
  - Milk jug, detergent containers, food & product packaging
  - Includes commercial and industrial products that have served its purpose

- Post-Industrial HDPE
  - Flake
  - Salt & Pepper Blending
  - Pellets & Pelletizing
Nomenclature

- Post-Consumer HDPE
- Post-Industrial HDPE
  - Excess or rejected bottles, crates, drums dunnage
- Flake
- Salt & Pepper Blending
- Pellets & Pelletizing
Nomenclature

- Post-Consumer HDPE
- Post-Industrial HDPE
- Flake
  - Original production, shredded plastic; washed
- Salt & Pepper Blending
- Pellets & Pelletizing
Nomenclature

• Post-Consumer HDPE
• Post-Industrial HDPE
• Flake
• Salt & Pepper Blending
  • Mechanical blending of 2+ components
• Pellets & Pelletizing
Nomenclature

- Post-Consumer HDPE
- Post-Industrial HDPE
- Flake
- Salt & Pepper Blending
- Pellets & Pelletizing
  - Melt, blend, filter process
  - Extruded into thin, cylindrical pellets

Recycled HDPE Pellets
Experiment

Raw Materials → Sample → Salt & Pepper Blend → Sample → Pelletize → Sample → Pipe Production, 95.5% Recycled, 4.5% Additive Package → Sample

Pipe Production, 80.5% Recycled, 15% High Molecular Weight HDPE, 4.5% Additive Package → Sample
Experiment

- 45,000lbs total material
  - 45% “Z” (post-industrial flake)
  - 25% “6” (post-consumer flake)
  - 15% “X” (post-industrial blow molding flake)
  - 10% “V” (post-industrial film)
  - 5% “Y” (post-industrial pellet)
- 95.5% recycled content, 4.5% additive to meet ASTM F2648 requirements
- 80.5% recycled content, 15% high molecular weight HDPE, 4.5% additive to meet AASHTO M294 requirements
Tested Properties

• Notched Constant Ligament Stress, per ASTM F2136
  • Initiated crack, time to failure
  • Stress crack resistance

<table>
<thead>
<tr>
<th>Standard Specification</th>
<th>Melt Index [ASTM D1238]</th>
<th>NCLS [ASTM F2136], hrs</th>
<th>UCLS [ASTM F3181], hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM F2648 Private land drainage</td>
<td>&lt;0.15</td>
<td>Avg &gt;16, Min &gt;12</td>
<td>N/A</td>
</tr>
<tr>
<td>AASHTO M294 Surface and subsurface drainage</td>
<td>&lt;0.15</td>
<td>Avg ≥24</td>
<td>Avg &gt;34, Min &gt;18</td>
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Finished pipe requirements; not raw material.
Tested Properties

- Un-notched Constant Ligament Stress, per ASTM F3181
  - Crack propagation, time to failure
  - Presence of contaminant

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Finished pipe requirements; not raw material
Results

NCLS
1. Raw material wide distribution
2. Mechanical blending some homogenization
3. Pelletizing (melt-filter) further homogenization
4. Pipe product extrusion
   1. Addition of virgin HDPE increased failure time

Dotted line is minimum average failure time per AASHTO M294
Dashed line is minimum average failure time per ASTM F2648
Arrows at top of chart indicate results exceeding the scale shown
Results

UCLS
1. Raw material wide distribution
2. Mechanical blending some homogenization
3. Pelletizing (melt-filter) some homogenization
4. Pipe product extrusion

Dotted line is minimum average failure time per AASHTO M294
Arrows at top of chart indicate results exceeding the scale shown
Significance of Pelletizing to Variability
Conclusions

• Raw material testing alone does not predict final product performance
• Mechanical blending facilitates homogenizing the blend
• Statistically significant reduction in variability with pelletizing salt & pepper (mechanical) blend
• Significant increase in stress crack resistance with 15% high molecular weight HDPE addition to meet AASHTO M294
• Recycled-content HDPE for corrugated pipe production is viable and will meet performance & service life requirements
Special Thanks!

Co-authors from ADS and Battelle for completing the joint research
ADS plant production and laboratory personnel

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