Multilayer Polyethylene Films For Food Service Packaging Applications
FlexPackCon 2017

October 2017
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NOVA Chemicals
The advent of more complex multilayer blown film co-extrusion lines and the development of a high barrier high density polyethylene resin (B.HDPE) has facilitated many new options in food packaging.

In this presentation, we will discuss:

- Trends in extrusion equipment
- The protein food market segment
- Changes in food service poultry packaging
- BONFIRESM Multilayer Property Predictor for packaging film design
Film Extrusion Equipment Trends

*North America Blown Film – New and Current Equipment 2016-2030

*Based on 5,000-6,000 blown film lines in existence in 2016.

Source: internal / external

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Film Extrusion Equipment Sales / Trends

Multilayer Blown Film Lines Trend
Long-term Outlook

Source: internal / external
Market Assessment Methodology

Data Sources and Analysis Process

• External Market Research
  – Market studies, conferences, tradeshows, and publications
• Internal research
• Primary Market Research
  – Industry expert interviews
• Analysis and focus area identification
Protein Food Market

Protein Market Segment Assessment

U.S. red meat and poultry production

Billion pounds

2015 USDA Data

- Chickens grown for eating (rather than laying eggs) are called broilers.
- Contrary to some myths, growth-enhancing additives such as hormones or steroids are not used in chicken.
Value Chain

Typical Operation of a Vertically Integrated Poultry Firm

- Primary Breeder Company
  - Breeder Chicks
  - Breeder Farm
  - Hatching Eggs
  - Hatchery
- Feed Mill
  - Mixed Feed Ration
- Further Processing
  - Byproducts
- Processing Plant
  - Rendering Plant
- Distributor
  - Retail
  - Grocery
  - Food Service Institution
  - Export
- Byproducts
  - Corn, soybean meal, other feed ingredients

KEY:
- Facilities owned by vertically integrated poultry firm
- Allied industry of the poultry industry
- Facilities owned by contract growers or integrator

Courtesy of the U.S. Poultry & Egg Association
Market Overview

Poultry

• 83% Chicken
• 15% Turkey
• 2% Other

• Main focus is on domestic market

Poultry Market (46 B lbs)

80-85% Domestic (38 B lbs) - Fresh and Frozen

55% Retail

45% Food Service

15-20% Export (8 B lbs) - Frozen

• About 8.5 billion broilers are produced in the US each year; the average broiler weighs about 6 pounds.
• If we went back to raising chickens the way we did in 1925, chickens' mortality rate would increase 490%, and the poultry industry's environmental footprint would be increased three-fold.
Market Overview

Retail and Foodservice

- About 25,000 family farmers have production contracts. Approximately 95% of chickens are produced on these farms.
- More than 40 billion pounds of chicken product was marketed, measured on a ready-to-cook basis.
Market Overview

Foodservice Packaging

- Ice Pack box
- Bulk Bag in box
- Gas Flushed CVP bags
- VFFS bags

The United States has the largest broiler chicken industry in the world, and about 19 percent of production was exported to other countries in 2015.

Americans consume more chicken than anyone else in the world – more than 90 pounds per capita in 2015.

did you know?
## Commercial Food Service Packaging Analysis

<table>
<thead>
<tr>
<th>Poultry Category</th>
<th>Secondary Package Format</th>
<th>Primary Package Format</th>
<th>Packaging Film Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken Parts</td>
<td>-</td>
<td>3 layer coex Pouch</td>
<td>HDPE/PE/LLDPE-Talc</td>
</tr>
<tr>
<td>Chicken Parts</td>
<td>-</td>
<td>7 layer coex Pouch</td>
<td>PA/EVA/Nylon/EVOH/Nylon/PE/PE-Si</td>
</tr>
<tr>
<td>Chicken Parts</td>
<td>3 layer coex Outer Bag</td>
<td>-</td>
<td>C8-LLDPE/LDPE/c8-LLDPE</td>
</tr>
<tr>
<td>Chicken Parts</td>
<td>-</td>
<td>9 layer barrier coex Inner Pouch</td>
<td>PA/EVA/EVA/PA/EVOH/PA/PE-tie/PE/LDPE-Si</td>
</tr>
</tbody>
</table>

- **Barrier Food Service Bag**
- **Non-Barrier Food Service Bag**
Cost Savings from Downdraguing: Poultry Bag

Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>C8 LLDPE</th>
<th>HDPE</th>
<th>Desired Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>4.0 mil</td>
<td>9.0¢/msi</td>
<td>Medium oxygen barrier</td>
</tr>
<tr>
<td></td>
<td>3.25 mil</td>
<td>8.0¢/msi</td>
<td>Seal-through contamination</td>
</tr>
<tr>
<td>2000</td>
<td>3.0 mil</td>
<td>7.6¢/msi</td>
<td>Dart and puncture resistance</td>
</tr>
<tr>
<td></td>
<td>2.75 mil</td>
<td>7.4¢/msi</td>
<td>Burn-through resistance</td>
</tr>
<tr>
<td>2010</td>
<td>2.75 mil</td>
<td>7.1¢/msi</td>
<td>VFFS capability</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following resins are referred to in the next slides:

<table>
<thead>
<tr>
<th>Name</th>
<th>Grade</th>
<th>Melt Index g/10 min</th>
<th>Density g/cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8 LLDPE</td>
<td>SCLAIR® FP120-C</td>
<td>1.0</td>
<td>0.920</td>
</tr>
<tr>
<td>HDPE</td>
<td>SCLAIR 19C</td>
<td>1.0</td>
<td>0.958</td>
</tr>
<tr>
<td>sLLDPE</td>
<td>SURPASS® FPs016-C</td>
<td>0.7</td>
<td>0.916</td>
</tr>
<tr>
<td>B.HDPE</td>
<td>SURPASS® HPs167-AB</td>
<td>1.2</td>
<td>0.967</td>
</tr>
</tbody>
</table>
Engineered Structure: I-Beam Effect (3 mil film)

Stiffer films feel thicker than softer films. Also, downguaging of films can be limited by film stiffness due to packing systems. Separation of HDPE will result in higher film stiffness: I-Beam Effect.

<table>
<thead>
<tr>
<th>Material</th>
<th>OTR (cc/100in2/day)</th>
<th>WVTR (g/100in2/day)</th>
<th>1% Secant (Mpa)</th>
<th>MD Tear (g)</th>
<th>Bending Stiffness (N-um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLDPE</td>
<td>184</td>
<td>0.43</td>
<td>175</td>
<td>1260</td>
<td>6.5</td>
</tr>
<tr>
<td>HDPE</td>
<td>68</td>
<td>0.16</td>
<td>568</td>
<td>241</td>
<td>11.0</td>
</tr>
<tr>
<td>LLDPE</td>
<td>67</td>
<td>0.16</td>
<td>567</td>
<td>171</td>
<td>13.6</td>
</tr>
<tr>
<td>B.HDPE</td>
<td>23</td>
<td>0.06</td>
<td>723</td>
<td>140</td>
<td>15.9</td>
</tr>
</tbody>
</table>

Stiffness
Oxygen Transmission Rate
SURPASS HPs167-AB Barrier HDPE Blends

\[ y = 0.0499e^{0.3955x} \]
\[ R^2 = 0.979 \]
Moisture Barrier Transmission Rate
SURPASS HPs167-AB Barrier HDPE Blends

y = 0.0499e^{0.3955x}
R^2 = 0.979

MVTR g/100in^2/day

100% B.HDPE 90% B.HDPE 70% B.HDPE 50% B.HDPE 30% B.HDPE 15% B.HDPE 100% 1MI, 0.920g/cc C8 LLDPE
# BONFIRE™ Multilayer Property Predictor

## 3 Layer FP016/19C/FP120

<table>
<thead>
<tr>
<th>Layer</th>
<th>Materials</th>
<th>Ratio</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>FP016 - 100%</td>
<td>20%</td>
<td>0.60</td>
</tr>
<tr>
<td>B</td>
<td>19C - 100%</td>
<td>60%</td>
<td>1.80</td>
</tr>
<tr>
<td>C</td>
<td>FP120 - 100%</td>
<td>20%</td>
<td>0.60</td>
</tr>
</tbody>
</table>

## 5 Layer 13.3 FP016/HPs167/FP120/HPs167/FP120

<table>
<thead>
<tr>
<th>Layer</th>
<th>Materials</th>
<th>Ratio</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>FP016 - 100%</td>
<td>13.3%</td>
<td>0.40</td>
</tr>
<tr>
<td>B</td>
<td>HPs167 - 100%</td>
<td>30%</td>
<td>0.90</td>
</tr>
<tr>
<td>C</td>
<td>FP120 - 100%</td>
<td>13.3%</td>
<td>0.40</td>
</tr>
<tr>
<td>D</td>
<td>HPs167 - 100%</td>
<td>30%</td>
<td>0.90</td>
</tr>
<tr>
<td>E</td>
<td>FP120 - 100%</td>
<td>13.4%</td>
<td>0.40</td>
</tr>
</tbody>
</table>
# BONFIRE Sm Multilayer Property Predictor

## Property Comparisons

<table>
<thead>
<tr>
<th></th>
<th>5 Layer Poultry Film with SHDPE</th>
<th>3 Layer Poultry Film</th>
<th>Delta</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTR</td>
<td>23.25</td>
<td>67.81</td>
<td>-66%</td>
<td>cc/100in2-day-atm</td>
</tr>
<tr>
<td>WVTR</td>
<td>0.06</td>
<td>0.16</td>
<td>-63%</td>
<td>g/100in2-day</td>
</tr>
<tr>
<td>1% MD Sec Modulus</td>
<td>723.5</td>
<td>564.2</td>
<td>28%</td>
<td>MPA</td>
</tr>
<tr>
<td>Penetration Energy</td>
<td>0.5</td>
<td>1.2</td>
<td>-59%</td>
<td>Joules</td>
</tr>
<tr>
<td>MD Tear</td>
<td>139.7</td>
<td>241.2</td>
<td>-42%</td>
<td>Crams</td>
</tr>
<tr>
<td>Bending Stiffness</td>
<td>19.3</td>
<td>11</td>
<td>75%</td>
<td>N-μm</td>
</tr>
</tbody>
</table>
The above values are from the BONFIRE\textsuperscript{SM} Multilayer Property Predictor tool, the first in a series of planned calculators and models in support of application development in the food packaging and other flexible film markets.
# Engineered Poultry Film Using BONFIRE<sup>sm</sup> Multilayer Property Predictor Tool

The above values show how you can adjust the desired film properties / thickness and cost using the BONFIRE Multilayer Property Predictor tool.

<table>
<thead>
<tr>
<th>Layer Composition</th>
<th>OTR</th>
<th>WVTR</th>
<th>1% Secant</th>
<th>Cost</th>
<th>Bending Stiffness</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 mil</td>
<td><strong>67 cc/100in2/day</strong></td>
<td><strong>0.16 g/100in2/day</strong></td>
<td><strong>564 Mpa</strong></td>
<td><strong>7.5 cents/msi</strong></td>
<td><strong>11 N-um</strong></td>
</tr>
<tr>
<td>2.75 mil</td>
<td><strong>31 cc/100in2/day</strong></td>
<td><strong>0.08 g/100in2/day</strong></td>
<td><strong>584 Mpa</strong></td>
<td><strong>7.3 cents/msi</strong></td>
<td><strong>10.5 N-um</strong></td>
</tr>
</tbody>
</table>

**Materials:**
- LLDPE
- HDPE
- sLLDPE

**Properties:**
- OTR
- WVTR
- 1% Secant
- Cost
- Bending Stiffness

**Formulations:**
- B. HDPE + 30% LLDPE
- LLDPE
**Designed Film for VFFS Poultry package**

- **Desired Properties**
  - Medium oxygen barrier
  - Seal-through contamination
  - Dart and puncture resistance
  - Burn-through resistance
  - Bending Stiffness
  - Maximum Shelf life
  - Reduced Leakers
  - Package Integrity
  - Packaging speed
  - VFFS speed

**Material Compositions**
- sLLDPE
- B. HDPE + 30% LLDPE
- LLDPE

**Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>OTR</td>
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<td>584 Mpa</td>
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<tr>
<td>Cost cents/ksi</td>
<td>7.3</td>
</tr>
<tr>
<td>Bending Stiffness</td>
<td>10.5 N-um</td>
</tr>
</tbody>
</table>
Conclusions

- Poultry is the fastest growing segment of the protein market
- Distribution is roughly split between food service and retail
- Food service segment is seeing increased use of Vertical Form Fill and Seal to package parts
- Engineered films using a Barrier HDPE are ideal for a stiffer, downgauged film while maintaining shelf life requirements.
- The BONFIRE\textsuperscript{sm} Multilayer Property Predictor allows customers to quickly simulate the properties of potential multilayer films.
Come work with us!

Shrink Tunnel  
Horizontal FFS  
Vertical FFS  
9 Layer Blown Film Line

Testing Labs  
Virtual Design Tools  
Adhesive Laminator  
Thermoformer