Advantages of Slot Coating Technology

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Agenda

- Slot Coating Technology Review
  - Die System Options
  - Technology Benefits

- Capturing Savings with a Slot Die
  - Using Slot Dies to Your Advantage

- Converting to Slot Coating
  - Case Studies
  - Process of Converting
Why Slot Coating?

Technology Benefits

✓ Benefits

- **Improve coating yields** with a system that applies all of the coating fluid to the substrate via a positive displacement pump and slot die
- **Achieve coating property consistency** with a closed coating system designed to reduce contamination and emission of volatiles while maintaining consistent fluid properties throughout the production run
- **Increase production rates** with a system that allows for better control of the cross-web uniformity and capability to increase the percentage of solids, thus reducing drying time
- **Reduce downtime for product changeovers** with a die designed for a large window of coating widths and thicknesses
- **Expand production capabilities** with a multi-layer die designed to apply up to 3 fluids in one pass
## Slot Coating Systems

### Technology Options

#### Fixed Lip Slot Dies
- Die designs include slot (1-3 layers), slot curtain (1-3 layers), and slide curtain (1-10+ layers)
- Lip gap is adjusted by installed body shims
- Coating speeds range from 0.15 – 900 mpm
- Designed for non-contact draw or tension web (free span) coating applications
- Designed based on fluid rheology and process conditions

#### Flexible Lip Slot Dies
- Single or multi-layer (2-3 layer) dies
- Coating width is determined by installed die body shim and the slot gap is set by adjusting the flexible lip
- Coating speeds range from 0.15 – 900 mpm
- Designed for contact – wipe applications
- Designed based on fluid rheology and process conditions

#### Die Positioners/Stations
- Ensure precise, uniform, and repeatable substrate coatings
- Variety of mounting options, may be designed for new or existing production or lab lines

#### Fluid Delivery Systems
- Designed to provide a clean, closed system to reduce contamination and emission of volatiles during the coating process
Capturing Savings
With Slot Coating Technology

- Coat Weight Tolerance
- Ease of Use
- Edge to Edge Coating
- Flexibility
- Start-up & Surface Defect Control
Coat Weight Tolerances

✓ Coat weight variations are controlled by a slot die’s manifold and flatness of its lip land
  - Manifold - distributes fluid uniformly and parallel to control its flow based on rheology
  - Land Flatness – critical component to reduce variation

✓ Uniform coatings:
  - Use less fluid to achieve the desired performance parameters
  - Create less scrap or “out of spec” product
Ease of Use

✓ Slot die systems are easy to implement into new or existing production lines and require little operator handling
  ▪ Slot die may be installed on a die positioner/station or to a parent machine, depending on the coating process
  ▪ Micro-adjustments to the lip offset may be made manually by replacing an offset shim

✓ Designed to incur less downtime for routine maintenance and cleaning

✓ Production-friendly slot dies:
  ▪ Promote operational efficiency with a simplistic, yet customized, approach to coating

<table>
<thead>
<tr>
<th>Technology Comparison</th>
<th>Dipping Mode</th>
<th>Knife Over Roll System</th>
<th>Gravure Roll System</th>
<th>Slot Die System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Cleaning Time (Minutes)</td>
<td>35</td>
<td>25</td>
<td>45</td>
<td>30</td>
</tr>
</tbody>
</table>
Edge to Edge Slot Coating

✓ Slot Die Technology Enables Product Coat Width and Pattern Versatility
  ▪ Custom Precision Body Shim
  ▪ Shim accuracy and precise fluid placement onto the substrate

✓ Production-versatility:
  ▪ Reduced down time for simple, yet customized, approach to coating by changing shim patterns.
A slot die is an extremely flexible tool, allowing converters a wide processing window with one system

- Lip gaps can be easily adjusted by changing a body shim or an adjustable lip whenever a coating thickness or width modification is required
- A multi-layer die is capable of applying up to 3 fluids in one pass

Versatile tooling:
- Allows production speeds to be increased
- Reduces downtime for product changeovers
- Expands production capabilities (multi-layer slot dies)
Slot die systems offer the ability to control (and potentially eliminate) defects that are inherent in other coating methods.

<table>
<thead>
<tr>
<th>Coating Defect</th>
<th>Slot Coating Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voids</strong></td>
<td>Are eliminated with accurate die positioning to the substrate, and optional vacuum box system.</td>
</tr>
<tr>
<td><strong>Bubbles</strong></td>
<td>Closed Fluid Delivery System and avoidance of film splitting with a slot die.</td>
</tr>
<tr>
<td><strong>Quality Surface Appearance</strong></td>
<td>Achieved with the proper lip design, accurate die positioning to the substrate, and option of vacuum box system.</td>
</tr>
<tr>
<td><strong>Coat Weight</strong></td>
<td>Easily achieved with a positive displacement pump and line speed control</td>
</tr>
<tr>
<td><strong>Cross Web Coat Weight Uniformity</strong></td>
<td>Custom manifold design and precise die lip flatness</td>
</tr>
</tbody>
</table>
## Case Study: PSA Label Adhesive

### Conversion from Roll Coating to Slot Coating

<table>
<thead>
<tr>
<th>Coating Process</th>
<th>Roll Coater</th>
<th>Slot Die</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Web Material</td>
<td>Paper</td>
<td>Paper</td>
</tr>
<tr>
<td>Base Web Coating</td>
<td>Silicone</td>
<td>Silicone</td>
</tr>
<tr>
<td>Coating Width</td>
<td>1500mm</td>
<td>1500mm</td>
</tr>
<tr>
<td>% Solids</td>
<td>54%</td>
<td>54%</td>
</tr>
<tr>
<td>Coat Weight – Wet</td>
<td>37.0 gsm</td>
<td>37.0 gsm</td>
</tr>
<tr>
<td>Tolerance</td>
<td>±4% gsm</td>
<td>±2% gsm</td>
</tr>
<tr>
<td>Line Speed</td>
<td>130 mpm</td>
<td>260 mpm</td>
</tr>
<tr>
<td>1st Pass Yield %</td>
<td>87.0%</td>
<td>90.0%</td>
</tr>
</tbody>
</table>

### Key Considerations
- Supplying a bubble-free delivery system
- Quicker product changeover
- Operator training

### Success Factors
- Coat expanded range of products – different thicknesses, viscosities, coating widths
- Yield improvements – reduced downtime and defects, increased line speeds

### Potential Annual Cost Savings

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid Material</td>
<td>$177,000.00</td>
</tr>
<tr>
<td>Web Material</td>
<td>$301,000.00</td>
</tr>
<tr>
<td>Final Coating Yield Loss</td>
<td>$265,400.00</td>
</tr>
<tr>
<td>Labor Costs (per meter)</td>
<td>$559,100.00</td>
</tr>
</tbody>
</table>

**TOTAL:**
Over $1.3 million annually!
## Case Study: Electronic Components

### Conversion from Roll Coating to Slot Coating

### Coating Process Comparison

<table>
<thead>
<tr>
<th></th>
<th>Knife Over Roll</th>
<th>Slot Die</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Web Material</strong></td>
<td>Polypropylene</td>
<td>Polypropylene</td>
</tr>
<tr>
<td><strong>Base Web Coating</strong></td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Coating Width</strong></td>
<td>300mm</td>
<td>300mm</td>
</tr>
<tr>
<td><strong>% Solids</strong></td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td><strong>Coat Weight – Wet</strong></td>
<td>22.9 gsm</td>
<td>5.7 gsm</td>
</tr>
<tr>
<td><strong>Tolerance</strong></td>
<td>±4% gsm</td>
<td>±1% gsm</td>
</tr>
<tr>
<td><strong>Line Speed</strong></td>
<td>10.0 mpm</td>
<td>15.0 mpm</td>
</tr>
<tr>
<td><strong>1st Pass Yield %</strong></td>
<td>10.0%</td>
<td>90.0%</td>
</tr>
</tbody>
</table>

### Key Considerations
- Coat weight thickness reduction
- Coat weight tolerance

### Success Factors
- Thickness control
- Yield increases

### Potential Annual Cost Savings

**Fluid Material** - $280,000.00  
**Web Material** - $99,500.00  
**Final Coating Yield Loss** - $298,700.00  
**Labor Costs (per meter)** - $569,200.00  

**TOTAL:** Over $1.2 million annually!
Converting to Slot Coating

What are the next steps?

✓ Know your production benchmarks
  - What factors are most important to your operation? *Efficiency, Coating Quality, Flexibility, Operating Costs, Product Performance Needs*
  - What are your current operating outputs?

✓ Perform ‘Proof of Process’ trials
  - Contact technology manufacturer to discuss testing slot coating equipment for your production parameters in their coating lab or with modular trial equipment in your own facility

✓ Compare cost of different technologies with expected return on investment
  - Slot coating technology has proven results of operational savings, after the initial capital investment