Slot Die Patch Coating

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Introduction

• What we will cover:
  – Introduction
    • Definition
    • Focus
    • Usefulness
  – Application Examples
  – System Description
    • Types
    • Specifications
    • Special Considerations
    • Critical Integration Issues
  – An Example
Introduction: Definition

- What is slot die patch coating?
  - “Using a slot die to coat one or more rectangular areas on a substrate”
  - Examples:
Introduction: Focus

• Coating
  – Excluding remainder of process: e.g., unwinding, treating, drying/curing, rewinding

• Slot die
  – Excluding other coating methods: e.g., roll coating
Introduction: Focus

Why slot die lends itself to patch coating
  - Relatively precise coating start and stop
  - Easy to vary coating width via change of shim
    • In some cases, may need cavity plugs
Introduction: Focus

• Why slot die lends itself to patch coating
  – Multiple coating lanes can be established
Introduction: Focus

• Why slot die lends itself to patch coating
  – Excellent coating thickness uniformity
    • Cross-web and machine directions
  – Up to three coating layers can be applied simultaneously
Introduction: Usefulness

• When is patch coating of interest?
  – Working with sheets of substrate
    • Original form of substrate is rectangular
    • Other process steps require sheet form
    • To facilitate product development work
  – End product construction requires patches
    • E.g., medical patches
Application Examples

• Medical
  – Transdermal patches
    • Caution required!

![Diagram of a patch with layers: Backing, Drug, Rate-controlling membrane, Liner, Adhesive]
Application Examples

• Electronic Displays
  – Wide variety, much development work
  – Rigid or flexible substrate
  – Coating fluids may be expensive
  – End product often rectangular

• Ceramics
  – Sometimes convenient to coat in patches

• Smart Glass
  – Rectangular format
  – Typically expensive coatings
Application Examples

- **Batteries & Fuel Cells**
  - Multi-layer construction, usually on metal foil
  - Stacking of discrete rectangular laminates
  - Uniform coating for proper functionality
System Description

• Types
  – Form of the substrate: web vs. sheet
  – Which is in motion: die or substrate
  – Number of lanes to be coated

• General specifications
  – Mostly similar to other coating systems
    • E.g., web or sheet size, substrate characteristics, special environments (clean room, explosion proof), coating fluid rheology
  – Dimensions and locations of coated patches
  – Coating speed, need for vacuum box
System Description

• Special Considerations
  – Motion
    • Web handling vs. linear motion control for sheet or die
    • 2-axis positioning or robotic arm for more complex patch placements

Patch coater with moving die, stationary sheet, and integrated fluid delivery system (in cabinet)
System Description

• Special Considerations
  – Slot die
    • Cavity to suit fluid rheology
    • What will happen at patch edges?
    • How many layers? Are lower layers to be sealed in by upper layers?

Dual slot die

Lower layer coating sealed in by upper layer
System Description

• Special Considerations
  – Cleaning
    • Usually: avoid need with quick start and stop if possible
    • Otherwise:
      – Rest die lips in damp media between patches
      – Wipe die between patches (manually, or mechanically)
  – Air purge
    • If needed, helpful to be able to swing die so lips are at 12 o’clock
  – Controls
    • Timing & coordination, esp. motion control and fluid delivery
    • Detailed specification helpful
System Description

- Special Considerations
  - Fluid delivery system
    - Pump selection depends on fluid rheology
      - Small systems: syringe pump with suck back feature may be practical
      - Larger systems: gear or progressing cavity pump
System Description

• Special Considerations
  – Fluid delivery system
    • Quick fluid flow starts and stops required
      – Fast-acting valve(s) at die entrance
      – Change flow quickly from die to recirculation
System Description

• Critical Integration Issues
  – Coating gap
    • Gap from die lips to substrate
    • Precision required in:
      – Die construction
      – Die positioning (.0001” increments)
      – Substrate backing roll or surface
      – Alignment of all elements
System Description

• Critical Integration Issues
  – Coating Start / Stop
    • Within what distance must coating go from 0 to specified coating thickness? Back to 0?
      – Valve(s) at die entrance may need to work very quickly
    • Must integrate with die or substrate motion
    • **Timing** is the key, and controls are usually the place
An Example

- **System type**
  - Coats a single patch on each moving sheet that passes under a slot die
An Example

- Selected general specifications
  - Maximum sheet size 1300mm x 1200mm
    - Variable length, constant width for any given run
  - 100% solids
  - Coating uniformity within +/- 2.5% of target thickness
  - Line speed range 2 to 20 mpm (no vacuum box required)
  - Convertible to web coating
An Example

• Motion
  – Sheet is placed on infeed belt, pushed across slide plate, and pulled out by outfeed belt
An Example

- **Slot Die**
  - Standard single slot die
  - Shims establish slot gap and width
An Example

- **Cleaning**
  - Not required between patches
  - Required between runs
    - 90 degree swivel to horizontal facilitates cleaning

![Image showing die positions](image-url)
An Example

- **Fluid Delivery System**
  - Gear pump, cartridge-style filters
  - Minimizing opportunities for air to enter system
  - Equivalent of three-way valve at die feedport
An Example

- Controls
  - Drive system for vacuum belts, pump, blower
  - Color touch screen for operator interface
  - Phone modem for remote service access
  - Photosensor picks up leading and trailing edges of sheet
An Example

• Critical integration issues
  – Coating gap
    • Precision positioner
    • Precision vacuum slide bar
    • Aligned to .001”
    • Adjuster increments of .0001”
An Example

• Critical integration issues
  – Coating start
    • Leading edge of sheet sensed as it arrives near coating head
    • System calculates when to start coating based on belt speed
    • Turns valve to stop recirculation and start coating flow to die
  – Coating stop
    • Trailing edge of sheet sensed as it arrives near coating head
    • System calculates when to stop coating
    • Turns valve to stop coating flow to die and start recirculation
  – At 20 mpm sheet motion, coating thickness reaches 50 microns (start) or 0 (stop) within 6 mm travel
Conclusion

- Slot die works well in patch coating
- Patch coater configurations vary widely
  - Technology evolving
- Critical issues:
  - Establishing precise coating gap
  - Integrating motion w/ fluid delivery for coating start/stop
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