An Introduction to Wide-Web Laminations and Coatings

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Introduction

Hot melt adhesives are replacing many cold glue and mechanical-fastening methods due to improved dispensing technologies and hot melt material performance. Hot melt adhesive lends itself to pressure-sensitive and reactive applications and does not alter properties of substrates sensitive to water. This paper describes the basics of hot melt adhesive application related to wide-web laminating and coating.

I. Fundamentals of Hot Melt Adhesive Systems

Why use hot melt adhesives?
Hot melt adhesives are used where good bond strength, short open time and precise delivery are required. Faster production speeds demand quicker set times than cold glues with slow set or drying can deliver. Hot melt adhesives typically have shorter open times than cold glue to efficiently bond substrates together. Many substrates are affected by moisture commonly present in cold adhesive formulations, making hot melt adhesives a better alternative for moisture-sensitive substrates. Hot melt adhesives also replace many solvent-based adhesive applications because many solvent-based adhesives are harmful to the environment.

Hot melt adhesives include pressure-sensitive, ethylene vinyl acetates (EVAs) and other reactive adhesives. Pressure-sensitive adhesives remain tacky after application to the substrate and bond under pressure. Reactive hot melts and EVAs can be tacky after application. The bond is affected only after heat, chemicals, ultraviolet or infrared is applied.

Contact and Non-contact Applications
In contact applications, adhesive coating heads make direct contact with the substrate. These slot-type heads are used mainly where full coverage is needed.

Non-contact coating heads apply adhesive at a specified distance from the substrate. Adhesive delivery can be swirl spray, random filament (meltblown), bead or any other method that does not touch the substrate. Generally, non-contact applications are less harmful to the substrate and can reduce tension problems associated with contact applications.
Because product design and functional requirements determine adhesive pattern and system type, production specifications and product requirements must be understood to accurately select the proper adhesive and delivery method.
II. Adhesive Patterns and Delivery Methods
There are a myriad of patterns available for hot melt applications.

- Beads are single continuous straight-line filaments of adhesive, typically 100 to 2000 microns in diameter prior to compression.
  
  ![Bead Pattern]

- Spirals are single continuous filaments seen on the substrate in a spiral pattern (crossing pattern). Fibers are typically 50 to 200 microns in diameter.
  
  ![Swirl Pattern]

- Meltblown filaments are multiple thin filaments applied in a tangled pattern. These filaments appear as evenly distributed, closely tangled, random or threadlike. Fibers range from 50 to 200 microns in diameter and provide good hand characteristics to the finished product. Flexibility of coating weights ranges from 0.8 grams/m² to over 30 grams/m².
  
  ![Meltblown Pattern]

- Sinusoidal filaments are continuous filaments creating a Sinusoidal, “non-crossing”, wave-like pattern on the substrate. These patterns are used where good bond and no burn-through are required.
  
  ![Sinusoidal Pattern]

- Slot coating is continuous 100 percent area coating applied in contact with the substrate.

- Breathable slot coating uses a slot coating head to produce random holes in the adhesive pattern for substrate breathability. This method also provides soft hand qualities to the substrate.

- Other types of hot melt adhesive delivery systems include screen, gravure, roll-on, flexo printers, dot applicators and hand-held applicators.

Pattern external dimensions are based on product size and required bond strength.

- Consider width of the pattern.
  Width is frequently an average measurement due to edge definition of the applicator.

- Consider length of intermittent patterns and spaces between edge and definition patterns.

Pattern internal dimensions depend on the type of application process.

- Percent of coverage is important for fluid acquisition, core integrity and other applications. Coverage is typically less than 5 percent (2 x 0.002-inch filaments in 0.1 x 0.1 inch square gives 4 percent).
III. Adhesives

A. Important Applications of Polymeric Materials

- Natural Resins
- Starches and Dextrine
- Proteins
- Rubber Base (Natural)
- Synthetic Resins
- Thermoplastic Resin
- Thermosetting Resin
- Silicates
- Classification of Adhesives

B. Important Adhesives for Hot Melt
- EVA
- Polyesters / co-polyesters
- Polyamides/Co-polyamides
- Atactic polypropylene
- KRATON®¹
- SIS
- SBR

C. Well Known Suppliers
- EMS
- Bostik Findley Adhesives
- H.B. Fuller
- Henkel
- National Starch and Chemical
- 3M

¹ KRATON is a registered trademark of KRATON Polymers U.S.
IV. System Components

A. Hot Melt Tanks and Pumps
Hot melt tanks progressively melt adhesive and serve as a reservoir to store the pre-melted material prior to delivery by the attached pumps.

Pumps provide the force, which moves the adhesive.

Gear pumps are used for most disposable product applications. They are used when adhesive flow is nearly continuous and flow rate is controlled, as in chassis construction.

Gear pumps consist of pairs of close-fitting gears running in mesh and mounted in a close-fitting housing.

- Only one of the gears is driven. Adhesive is carried in the cavities formed by the teeth and housing, squeezed out of the teeth and into the output port when the gears mesh.
- Volume per revolution of the pump is determined by the sum of the cavity volumes on both gears.
- There is one adhesive stream per gear mesh, however, multiple-stream pumps are available.
- Gear pump flow rate is determined by gear rotational speed, displacement and slip factor.

- Gear pumps can deliver very accurate flow rates and possibly develop high pressures.
- Gear pumps typically require overload protection.
- Gear pumps are generally manifold mounted.
- The mechanical interaction of the gear pump components results in positive displacement of the adhesive.
- Gear pumps are commonly referred to as positive-displacement gear pumps.

B. Filters

1. Function

   - Filters protect components from damage, abrasion, and plugging caused by contamination.
   - Sources of contamination include dust, paper fiber, grit from hands or tools, contamination in the adhesive and degraded articles of adhesive.

2. Location

   - Filters can be located before or after pumps (or both).
   - Filters should be located near the point of application.
   - Air filters should be used in dusty environments.

3. Mesh Size

   - Mesh size determines the largest particle that will pass through the filter.
   - Follow the manufacturer’s recommendations for mesh size relative to tip size and pump needs. A chart has been provided with this paper, which shows the relative size of micronic particles as they relate to mesh size.
V. General System Types

A. Positive-Displacement Systems
- Pump speed determines the adhesive flow rate.
- Systems are fed by a positive-displacement pump with a controlled pump speed.
- There is one die tip per pump. The amount of adhesive through the tip is determined by pump speed.
- In normal operation, the adhesive can only exit the die tip.
- Flow rate is unaffected by temperature, viscosity, tip size and contamination.

B. Pressure Distribution Systems
- Use one pump with multiple outlets.
- Use a single pumping source of adhesive to supply multiple outlets, usually a gear pump.
- Systems rely on a pressure balance between supply hoses and internal passages to distribute the adhesive evenly to multiple die tips.
- Flow rate distribution is sensitive to back-pressure differences between the alternate adhesive routes.
- Total flow rate is constant, but more adhesive will flow to the paths of least resistance.
- If one outlet is blocked, adhesive flow will increase in the others.
- Typical tip-to-tip flow variation can be as much as ±20 percent of the average flow.
VI. Safety

A. Pressure Relief Valves
   Internal or external relief valves vent adhesive if the system is over pressured. These are also called rupture discs and will prevent damage to critical system components.

B. Safe Design
   • The system must identify and shut down for an unsafe over-pressure condition.
   • The controls must inform the operator the cause of any unexpected condition.
   • **Important!** The operator must be able to vent pressure prior to performing service.
   • The operator must confirm that the system is at low pressure prior to service.
   • It must be failsafe against low air pressure.
   • It must be failsafe against a motor or control failure.

C. Safe Operating Practices
   • Safe operating practices for working on the system, including safety steps and checks are necessary to ensure safe operation.
   • Training for all who work on the system is required.
   • Systems must be well maintained.
   • First-aid training for minor burns and cuts is recommended.

D. Personnel Safety
   • Safety glasses and face shields should be used by anyone working around adhesive equipment and during testing, observation, training and system service.
   • Long sleeves are recommended when working on equipment.
   • **Important!** Work at zero pressure. Adhesive under pressure can travel several feet.
VII. Designing Adhesive Systems

A. Product Design
   Objective: How do you determine the product design?
   • Product design tests should focus on the product. Independent variables include but are
     not limited to: Bond strength, pattern type, dimensions, application density, percent of
     coverage and adhesive contact temperatures.
   • Response variables may relate to product performance, including creep, core integrity,
     percent of bond success in use, peel strength, hand and air permeability.
   • Product tests should be made independent of equipment, if possible.

B. Process
   Objective: How do you make the product?
   • Understand the equipment and system variables and responses.
   • Understand system variation and sensitivities.
   • Optimize the system toward product-oriented targets.
   • Focus on process targets. Independent variables include but are not limited to:
     Temperature set-points, applicator dimensions, flow rates and air pressures. Response
     variables include but are not limited to: Bond strength, pattern dimensions, adhesive
     contact temperatures, peel strength, hand and air permeability.

C. Equipment and Systems
   Objective: What is the best equipment?
   • Explore the capabilities and potentials of existing or new systems relative to product
     design targets.
   • Test the reliability of system components, arrangements and logics.
   • Does the equipment deliver the product design and process?

D. How good is good enough?
   System design and cost is primarily related to the accuracy of the coating weight and the
   percent coverage of the substrate.
   • Determine the basis weight accuracy required for the finished product. If ±10 percent or
     greater is acceptable, the system cost can be considerably lower.
   • Determine if full-width coverage is required. In many cases, stripes, bands or intermittent
     coverage will meet product requirements.
   • Perform application trials in a laboratory to duplicate the material required. A successful
     application trial becomes the qualification standard for the production system.
VIII. Wide-Web Laminating Systems
Wide-web lamination uses one full-width applicator or several smaller applicators spaced across the substrate width. Product requirements determine full-width coverage, zoned or stripe coverage.

A. Typical Markets
- Backsheet lamination for diapers
- Tape and label
- Medical products
- Wide range of other industries

B. Other Market Possibilities
- Textile and apparel
- Automotive textile lamination
- Mattress ticking
- Filtration media for air, oil, water, chemicals and pollen
IX. Selecting a System

A. Step 1
- Determine coverage desired (full or partial).
- Determine the basis weight accuracy required.
- Perform application trials with your substrates in a laboratory setting.

B. Step 2
- Determine the desired adhesive pattern.

**Application Patterns**

**Application Methods**

<table>
<thead>
<tr>
<th>Method</th>
<th>Maximum Line Speed</th>
<th>On-line Width Variation</th>
<th>On-line Variable Add-On</th>
<th>Add-on Range [gsm]</th>
<th>Curing Required</th>
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<tr>
<td>Breathable Coat</td>
<td>500</td>
<td>YES</td>
<td>YES</td>
<td>0.8-30</td>
<td>NO</td>
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<tr>
<td>Powder/Scatter</td>
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<td>NO</td>
<td>NO</td>
<td>1-&gt;20</td>
<td>YES</td>
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<td>Print/Gravure</td>
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<td>YES</td>
<td>NO</td>
<td>3-30</td>
<td>YES</td>
</tr>
<tr>
<td>Spray</td>
<td>130</td>
<td>YES</td>
<td>YES</td>
<td>3-30</td>
<td>NO</td>
</tr>
<tr>
<td>Web and Film Lamination</td>
<td>40</td>
<td>YES</td>
<td>YES</td>
<td>12-50</td>
<td>YES</td>
</tr>
</tbody>
</table>

**General Pattern Selection Rules:**
Larger fibers produce stronger bonds.
Crossing fibers produce local high-strength bonds and higher average bond strength.
Lower variability minimizes waste.

**Lamination Pattern Choices**
Controlled Fiberization
Summit or Mini Swirl
Meltblown
Speed Coat
Contour Coat
Controlled Fiberization (CF)
CF or swirl is used where robust application is required. Pattern widths of 20mm are used with single or multiple modules to create full adhesive coverage. Summit or mini swirl utilizes multiple swirl orifices on a single nozzle and is used where precise edge definition is required.

Meltblown
Small random fibers are applied to a substrate via single or multiple module configurations for full width adhesive coverage. Primarily used for heat sensitive substrates like polyethylene film.

Speed Coat
Contact adhesive application for high-speed pattern applications. This application utilizes common slot-coating with special adhesive modules to create patterns with good adhesive cut-off at high speeds.

Contour Coat (New)
Contact adhesive application to create a contoured pattern for special adhesive applications like feminine hygiene pads.

Other Hot Melt Adhesive Applications of Interest:
Something New - SureWrap™ elastic application (not used for lamination, however, very interesting). Adhesive is applied directly to guided elastic strands. Precision application, simpler process and glue savings are all benefits of this process.
C. Step 3

- Select application system working closely with your equipment supplier.

Breathable Film System
(with drum unloader and melter)

1. Breathable Film Application Systems
- Breathable film application offers many advantages over standard slot coating systems.
- Used primarily in wide-web applications that require uniform and accurate bonding.
- Used where good hand and a flexible bonded sheet are required.
- Used for temperature-sensitive substrates, such as low-mill polyethylene film.
- Used where optional adjustable-width capability is required.
- Provides a consistent, breathable adhesive pattern.
- Offers flexibility of coating weights from 0.8 gsm to over 30 gsm.
- Provides good hand and drape characteristics. Adhesive application does not result in stiff laminates.
- Operates with adhesive viscosities ranging from 500 to 50,000 centipoise.
- Provides easily adjusted coating weights via pump speed.
- Maintains consistent coating weight at varying line speeds.
- Maintains consistent coating weight for varying product widths.
2. Coating Width Adjustment
Specialized system technology makes it possible to adjust the coating width.

Coating Width Adjustment

Full-Width Application with Drum Unloader
Multiple Applicator Configuration (full-width coverage)

Multiple Applicator Configuration (stripe coverage)
3. Ply Bonding

Ply bonding systems are typically 102 inches or greater in width and apply non-contact meltblown adhesives to very sensitive substrates. The add-on rates for these systems can be as low as 0.05 gram per square meter or as high as 10+ grams per square meter, depending on product needs. Metered delivery produces extremely accurate cross-web uniformity.

- Produces high loft and softer feel (primarily used for tissue).
- Eliminates perforation mismatch.
- Provides proper surface orientation.
- Maintains loft with hot melt bonding.
- Allows precise control of adhesive add-on.
- Maintains product loft due to non-contact adhesive application.
- Produces metered delivery with low add-on rates of 0.05 gsm and cross-web uniformity within ±5 percent.
- Accepts re-pulpable hot melt adhesive spray. Provides full-width coverage or adhesive stripes.
- Alter adhesive pattern by changing die tip.
- Produce adhesive pattern using standard modules.
- Gain product flexibility through numerous adhesive pattern options.

D. Selecting a System

D. Step 4
- System quotation
- Purchase
- Installation, testing and training
Conclusion
Wide-web laminating and coating can be accomplished by a multitude of hot melt application methods. Application uniformity, bond strength and speed can have the highest effect on system cost and there is a tendency to “over-engineer” a system when exact product performance characteristics are unknown. Careful system selection and pre-testing are recommended to insure the right equipment selection for the right job. We have invested significant resources to perform application trials in our laboratories and can design trials to duplicate production substrates. Trials are highly recommended prior to system hardware specification to insure value and performance.

X. Contact Information for Sales and Application Engineering

[Website Link]

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Nordson Nonwovens and Web Coating Systems
Dawsonville, GA 30534-6672

EUROPE
Nordson Nonwovens Systems
Nordson Web Coating Systems
D-21337 Luneburg, Germany

JAPAN Nordson Nonwovens Systems
Nordson Web Coating Systems
Nordson K.K.
Tokyo 140-0012, Japan
**Fundamentals of Wide-Web Hot Melt Adhesive Bonding**

**Welcome...**

Please remember that this session is to be held in strict compliance with the TAPPI Antitrust Policy. Specifically, discussing prices or pricing policy and discussing any restraint on competition of any kind will not be tolerated.

**Why use Hot Melt?**

Hot melt adhesives are used where good bond strength short open time and precise delivery are required. Faster production speeds demand quicker set times than cold glues which normally require set or drying time.

Hot melt lends itself to pressure sensitive and reactive applications and does not alter properties of substrates sensitive to water.
Contact and Non-Contact Applications

Contact:
Adhesive coating heads make direct contact with the substrate and are normally slot applications where full coverage is needed.

Non-Contact:
Apply adhesive at a specified distance from the substrate. Adhesive delivery can be swirl spray, random filament (meltblown), bead or any other method that does not touch the substrate.

Multiple Application Patterns are Possible
Hot melt adhesives, sealants and coatings can be applied to a broad range of consumer and industrial products during manufacturing operations.

Some Common Application Patterns
Bead or Dot:
Spirals or Swirl:
Random Filament or Meltblown:
Sinusoidal or Non-Crossing:
Slot or Continuous:
**Hot Melt Adhesive Polymeric**

- Natural Resins
- Starches and Doctrine
- Proteins
- Rubber Base
- Hot Melt Adhesives
- Synthetic Resins
- Inorganic Materials
- Silicate Adhesive Class
- Thermosetting Resin
- Thermoplastic Resin
- Synthetic Rubbers

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**Important Adhesives for Hot Melt**

- EVA
- Polyesters and co-polyesters
- Polyamides and co-polyamides
- Atactic polypropylene
- KRATON
- SIS
- SB

Some well known hot melt adhesive suppliers are:
EMS, Bostik Findley, H.B. Fuller, Henkel, National Starch, 3M

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**System Components**

- Hot Melt Tanks
- Pumps
  - Gear Pumps
  - Piston Pumps
- Filters
- Hoses
- Applicators and Nozzles
  - Non-metered
  - Metered
General System Types

- Positive Displacement Systems
  - Pump(s) determine the adhesive flow rate.
  - Uses meshed gears with speed control for flow rate.
  - Flow rate is unaffected by temperature, viscosity, tip size or contamination.

- Pressure Distribution Systems
  - Uses one pump (located at the melter) with multiple outlets.
  - Systems rely on pressure balance between adhesive supply and internal passages.
  - Flow rate is sensitive to back pressure.
  - More adhesive will flow to the path of least resistance.
  - Typical flow rate variation is not as accurate as positive displacement systems.

System Safety

IMPORTANT:
- Insure presence of pressure relief prior to maintenance.
- Observe safe design principals and manual safety checks.
- Train personnel in regard to safe operation.
- Use safety glasses, shields and gloves during maintenance.
- Long sleeves are recommended.
- Always work at zero pressure. Adhesive under pressure is very hot and will travel several feet.

Designing Adhesive Systems, (the Basics)

- Perform product design testing
- Product tests should be performed independent of equipment if possible.
- Understand how to make the final product.
- Understand system variation and sensitivities.
- Focus on process targets.
- Optimize the system toward product-oriented targets.
- Explore more than one system capability.
- Consider reliability and maintenance for your final system design.
How Good is Good Enough?

System design and cost is primarily related to the accuracy of the coating weight and percent coverage.

- Determine the Basis Weight accuracy required for the product. (It is common to build in more accuracy than required for the product...this is expensive).
- Determine required coverage. (Will less coverage do the job?) Consider raw material costs.
- Perform application trials to duplicate manufacturing and the final product.
- Do not over-design for meaningless performance gains.

Production, Laminating, Bonding and Coating Technologies

- Wide-Web Coating Systems
- Nonwovens Assembly Systems
- Web Coating Systems

Web Coating Systems

Improve product quality with precision coating and laminating systems to apply adhesives, sealants, lotions, surfactants and other materials on continuous-roll goods.
Wide – Web Coating and Laminating Markets

Typical Markets
- Back sheet lamination for diapers
- Tape and label
- Medical products (drapes, gowns and face mask media)
- Shoe insoles
- Tissue and towel lamination

Other Market Possibilities
- Textile and apparel
- Automotive textiles
- Mattress ticking
- Filtration media for air, oil, water or chemicals

Configuring Wide – Web Coating and Laminating Systems

Step # 1
- Determine coverage desired.
  - Full width
  - Zoned coverage
  - Stripe coverage
- Determine basis weight add-on accuracy (for full width).
- Perform application trials in a lab setting.

Step # 2
- Determine adhesive pattern.
  - Spray, synt, slot coat etc.

Step # 3
- Select equipment with help from your equipment supplier.

Step # 4
- Request system quotation
- Purchase
- Install system
- Functional test
- Train operations personnel

Wide – Web Coating and Laminating Systems

Determine the adhesive pattern.
## Wide – Web Application Methods

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<td>90</td>
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</tbody>
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### Breathable Film Application

- System Includes:
  - Bulk Melter
  - Melt Tank
  - Coating Stand
  - Applicator

### Multiple Applicator(s) for Full-Width Coverage

Multiple Applicator Configuration for full-width coverage
Applicators are staggered for full width.
Multiple Applicator(s) for Full-Width Coverage

- Multiple applicator configuration for stripe coverage.
- Applicators are spaced across sheet width.

Ply-Bonding Systems

- Typically 102 inches or greater in width.
- Non-contact application in spray (meltblown) or swirl (Summit).
- Add-on rates as low as 0.05 grams/m².
- Accepts repulpable adhesive.
- Capable of full-width or stripe coverage.
- Cross-web uniformity within ±5%

Conclusion

Wide-web laminating and coating can be accomplished by a multitude of hot melt application methods. Application uniformity, bond strength and speed can have the highest effect on system cost and there is a tendency to "over engineer" a system when exact product performance characteristics are unknown. Careful system selection and pre-testing are recommended to insure the right equipment selection for the right job. Lab trials are highly recommended prior to system hardware specification to insure value and performance.