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Non-Woven Adhesives

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ASC Hot Melt Short Course

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National Starch & Chemical

A member of the ICI Group

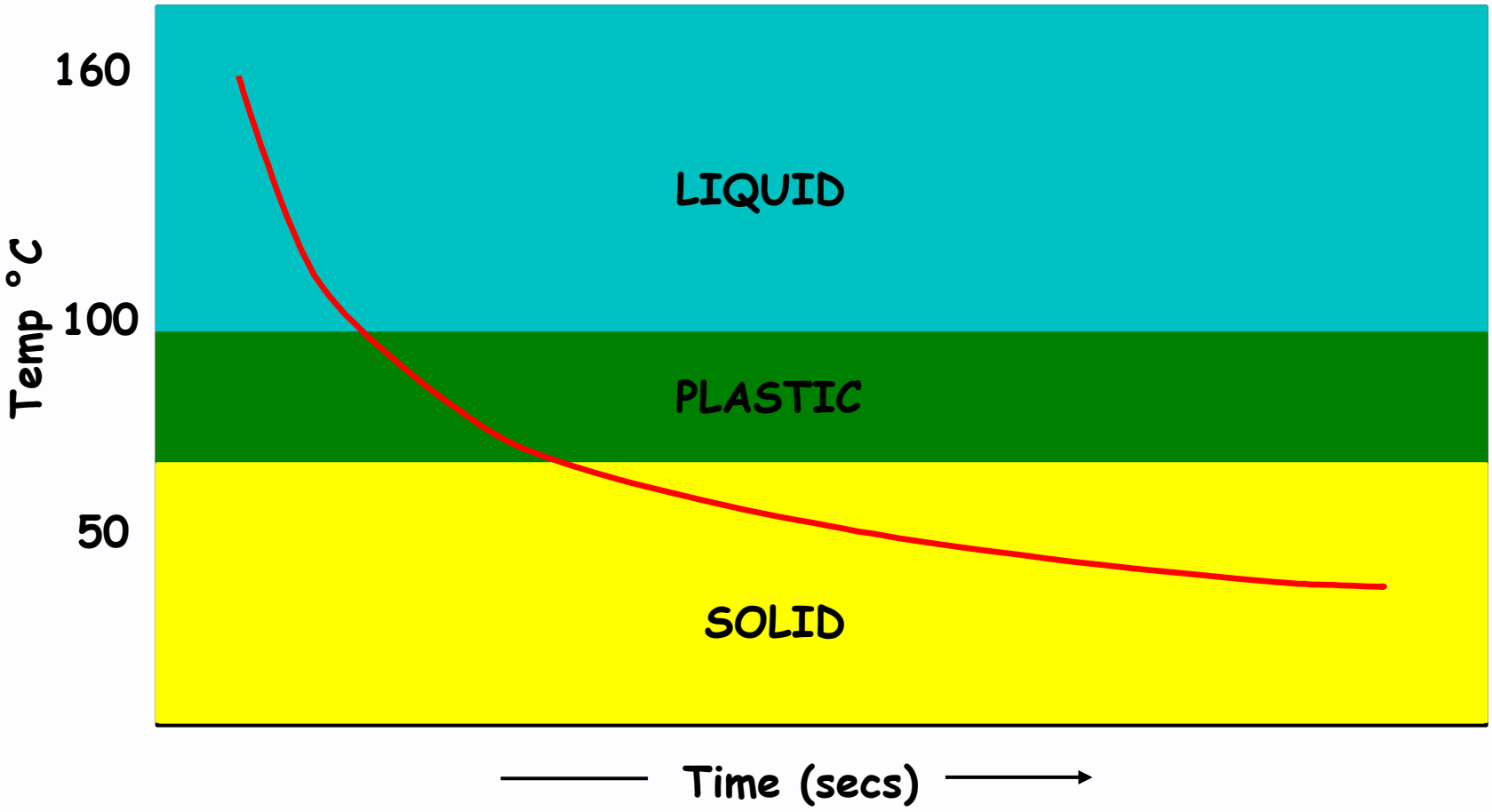
Hot Melt Adhesives

- **General Hot Melts**
  - Applications & Variables
  - HMA Types & Requirements
- **Raw Materials**
  - Polymers
  - Resins
  - Diluents
- **Physical testing of Formulas**

Hot Melt Adhesive Definition

- A thermoplastic compound that can bond materials together
- Solid at room temperature & liquid at elevated temperatures
- Applied molten & forms a bond upon cooling to the solid state

What Happens as a Hot Melt Cools?



Why use Hot Melt Adhesives

- Fast setting speed, high production rate
- Short compression time
- More environmental friendly than solvent based adhesives
- Immediate use of product, no drying

Hot Melt Adhesives Functions

- **Wet-out**
  - The adhesive in a liquid phase flows into the substrate – important for adhesion

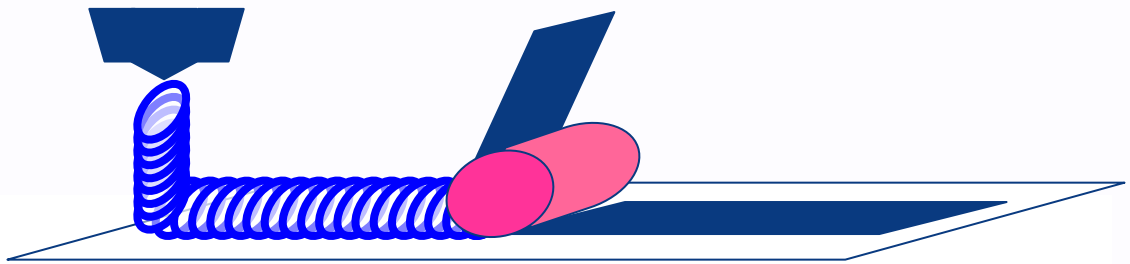
- **Set-up**
  - After wet-out the HMA solidifies rapidly to gain strength – important for cohesion

HMA Application Variables

- **Application Temperature**: the temperature when the adhesive contacts the primary substrate
- **Add-on Level**: the amount of HMA used
- **Compression**: the force to laminate the substrates
- **Open Time**: the time it takes for the HMA to travel from the application head to the compression zone

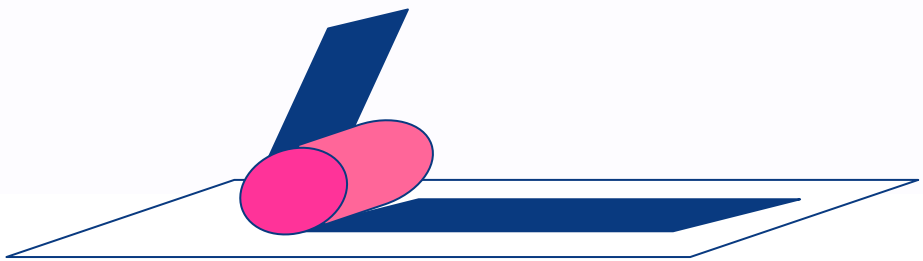
Open Time

- Definition: is the time from the nozzle to the compression zone
- It effects the application temperature and the wet-out on the secondary substrate
- Specified by the customer based on each line



Compression

- Definition: is the force required to form a lamination between two substrates
- It effects the wet-out on both substrates
- Should be as high as possible
  - "bleed through" issues



Type of Hot Melt Adhesives

- **Elastic**: they require high cohesive strength to hold the elastic strands together under constant stress
- **Construction**: require higher tack to hold a variety of substrates together
- **Multipurpose**: a combination of elastic and construction
- **Positioning**: very good balance between adhesion on specific substrates and transfer resistance

Hot Melt Adhesives Requirements

- **Elastic**:
  - Requires high cohesive strength and moderate adhesion
  - Typically formulated with large amounts of polymer and little plasticizer, usually higher viscosity product
- **Construction**:
  - Requires moderate cohesive strength and excellent adhesion
  - Typically formulated with low amount of polymer and moderate plasticizer, usually lower viscosity product with better cost leverage

Hot Melt Adhesives Requirements

- **Multipurpose**:
  - Requires a balance between cohesion and adhesion
  - Typically formulated with moderate amounts of polymer and moderate plasticizer, a range of viscosity can be achieved
- **Positioning**:
  - Requires excellent adhesion on specific substrates
  - Good balance between adhesion and transfer resistance
  - Typically formulated with specialized raw materials

Rubber based formulation

Raw Material	Quantity	Function
Polymer	20-50%	Backbone of adhesive. Provides strength and flexibility
Resin	25-60%	Provides tack, lowers viscosity, raises Tg and softens
Oil	10-35%	Reduces viscosity only, processing aid
Antioxidant	<1%	Heat resistance

Polymer Types

- Ethylene-vinyl acetate (EVA)
  - ☺ stability, adhesion, set speed, versatility
  - ☹ Plasticizer resistance, heat resistance
- Block copolymers (SIS, SBS, rubbers)
  - ☺ adhesion, flexibility, open time
  - ☹ setting speed (fast - can be a plus), heat stability
- Olefins
  - ☺ long open time, good adhesion
  - ☹ stiffness (poor bonding to rigid substrates), compatibility

Properties of EVA based Adhesives

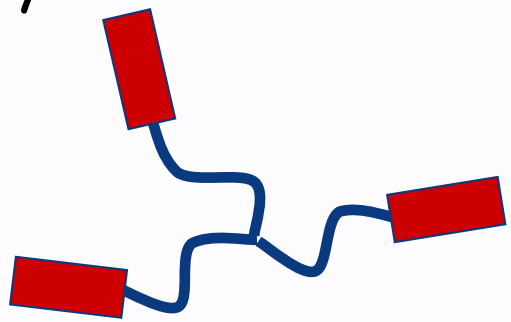
- Good thermal stability and cold resistance
- Wide formulating latitude
- Tend to be stiff and not very elastic
- Good clean application without stringing

Block Copolymers

- **Source: Hydrocarbons**

- **Physical form may be:**
  - Linear di- or tri-blocks

    - Mixtures or only one physical form
  - Branched / Stars
    - Allows formulation of lower viscosity adhesives
    - Higher cost



SBS vs. SIS

- **At the same molecular weight:**
  - SBS gives higher viscosity
    - At equivalent molecular weight SBS melt viscosity approximately two times SIS melt viscosity
  - SBS provides more stiffness
  - SIS gives more tack
  - SBS has higher solubility parameter
    - therefore it phase separates more slowly giving a longer open time

Hydrogenation of SBS & SIS

- **Hydrogenation of modified SBS → SEBS & SIS → SEPS**
- **Hydrogenation reduces:**
  - entanglement molecular weight
    - decreases elasticity
  - solubility parameter
    - decreases open time
- **Hydrogenation increases:**
  - Thermal stability
  - Price (approximately x2)

Properties of SEBS & SEPS

	SBS	SIS	SEBS	SEPS
Thermal Stability	Fair	Poor	Excellent	Excellent
Mid block				
Tg	-85	-60	-55	-55
Solubility Parameter	8.35	8.15	7.75	7.65

Metallocene Polymerised Olefins

- Exhibit narrow molecular weight distribution
- Broader formulating window
- Allows better control over spraying
- Typically more expensive than conventional olefins

Resins / Tackifiers

- **Natural Sources (trees & paper industry)**
  - Rosin Esters derived from pine tree resins
  - Terpenes formed from orange peel

- **Hydrocarbon base (Oil & gas)**
  - Acyclic and cyclic C5 & C9 hydrocarbons

Rosin Esters

- **Used extensively in packaging & IPS applications**
  - Skin sensitivity is unclear, so use has been limited in non woven applications
- **Contain high quantities of aromatic compounds providing excellent tack**
  - Processing techniques have improved odour and reduced colour. Also raises price and reduces tack
- **Good compatibility with all types of HMA**
  - Range of softening points available allow formulating latitude

Terpenes

- **Extremely good tack and adhesion**
  - Typically used for bonding onto difficult plastics which require good heat / cold stability
- **Extremely expensive**
  - Formed from limonenes which are expensive to extract
  - Not typically price stable
- **Strong odour**
- **Provide formulating latitude**

Hydrocarbon Resins

- **Used extensively in non woven market**
  - Good adhesion to both stiff and more flexible substrates
- **Low odour and colour**
  - Key factors in some regions for products used in the hygiene market
- **Wide formulating latitude**

Diluents

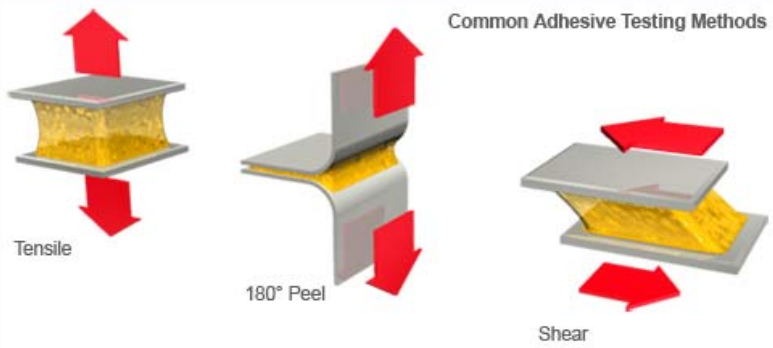
- **Plasticizers**
  - Oils
    - Paraffinic & Napthenic
  - Used in rubber and APAO products
    - Low molecular weight liquids
    - Lubricate polymer chains
    - Improve wetting
    - Adjust Tg
- **Waxes**
  - Paraffin, Microcrystalline & Synthetic
  - Used in EVA and APAO products to add crystallinity and offer control of:
    - Rigidity
    - Open time
    - Setting speed
    - Prevent blocking

Adhesive Evaluation & Testing

- Physical Properties
  - Viscosity, tensile strength & softening point
- Thermal Stability
  - Color, viscosity retention
- Rheology
  - Viscoelastic behavior
- End-use Performance Testing
  - Peel Test, Creep Test

Physical testing of HMA

- **Instron for**
  - Cohesive strength of adhesive
  - Adhesive bond strength
    - Lamination specific
  - Shear testing



Physical testing of HMA

- **Rheology**
  - Provides a fingerprint of the adhesive and the neat raw materials
  - Test variables: temperature, frequency and stress

For more information…

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