Introduction to Pressure Sensitive Adhesive Technology

Process Engineering Technical Training Series

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Definition of PSA  
(Pressure Sensitive Adhesives)

A special class of adhesive that is:

• *Permanently tacky at Room Temperature*
• *Spontaneously adhere on contact or with little pressure*
• *Require no activation by water, solvent or heat to form a strong bond*
PSA Polymers Life Cycle

Infancy
- Hot Melts of
  - UV radiation cured Acrylic

Growth
- Emulsions of
  - Acrylic copolymers
  - SB copolymers

Maturity
- Hot Melts of
  - SIS/SBS block Copolymers

Age
- Solvent Solutions of
  - Rubber/Resin
    - Acrylic
## Common PSA Classification

<table>
<thead>
<tr>
<th></th>
<th>Solvent</th>
<th>Emulsion</th>
<th>Hot Melt</th>
<th>UV Hot Melt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone</td>
<td>High Temperature</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Acrylic</td>
<td>Specialty</td>
<td>Most Common</td>
<td>Developmental</td>
<td>Emerging</td>
</tr>
<tr>
<td>Rubber</td>
<td>Few</td>
<td>Few</td>
<td>Common</td>
<td>Emerging</td>
</tr>
</tbody>
</table>

### Solvent Types
- Silicone: High Temperature
- Acrylic: Specialty
- Rubber: Few

### Emulsion Types
- Silicone: None
- Acrylic: Most Common
- Rubber: Few

### Hot Melt Types
- Silicone: None
- Acrylic: Developmental
- Rubber: Common

### UV Hot Melt Types
- Silicone: None
- Acrylic: Emerging
- Rubber: Emerging

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**Polymer solutions**
- SC = 30-50%

**Aqueous Dispersions**
- SC = 50-70%

**Hotmelts**
- 100%

**UV-crosslinking**
- Hotmelt technique
- Acrylic chemistry

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Common PSA coating methods

- Gravure Coater
- 3-Roll Coater
- Rod Coater
- Reverse Gravure Coater
- Split Film Coater
- Slot Die Coater

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## Capabilities / Limitations of Common Coating Methods

<table>
<thead>
<tr>
<th>Coating Method</th>
<th>Viscosity, &gt;cps</th>
<th>Coating Weight, gm/m²</th>
<th>Coating Accuracy, +/- %</th>
<th>Coating Speed, m/min</th>
<th>Type of Adhesives Commonly Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire rod</td>
<td>100-1,000</td>
<td>15-100</td>
<td>10</td>
<td>100-150</td>
<td>Solution, emulsion</td>
</tr>
<tr>
<td>Knife over roll</td>
<td>4,000-50,000</td>
<td>25-750</td>
<td>10</td>
<td>100-400</td>
<td>Solution, emulsion, 100% solids</td>
</tr>
<tr>
<td>Reverse roll</td>
<td>300-50,000</td>
<td>25-250</td>
<td>5</td>
<td>100-700</td>
<td>Solution, emulsion</td>
</tr>
<tr>
<td>Gravure</td>
<td>15-1500</td>
<td>2-50</td>
<td>2</td>
<td>100-700</td>
<td>Solution, emulsion</td>
</tr>
<tr>
<td>Extrusion die</td>
<td>400-500,000.</td>
<td>15-750.</td>
<td>5</td>
<td>300-700</td>
<td>Emulsion, hot melt, 100% solids</td>
</tr>
<tr>
<td>Slot die</td>
<td>400-200,000</td>
<td>20-700</td>
<td>2</td>
<td>100-300</td>
<td>Emulsion, hot melt, 100% solids</td>
</tr>
<tr>
<td>Curtain</td>
<td>50,000-125,000</td>
<td>20-500</td>
<td>2</td>
<td>100-500</td>
<td>Emulsion, hot melt</td>
</tr>
</tbody>
</table>

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Variation of Adhesion with Coat Weight

Variation of Adhesion with Coat Weight

Adhesive Coat Weight (gsm)

Adhesion (N/25mm)
Typical Emulsion PSA Materials
Manufacturing Process

1) Storage
2) Mixing
   - Formulating tank
   - Run tank, Optional deaeration
3) Coating
   - Filtration, Recirculation
4) Drying
   - Optional Lamination

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Emulsion PSA Label Manufacturing Process

- 5 Rollers Silicone Coater
- Vario Gravure Adhesive Coater Laminator
- Corona Discharge
- Adhesive Oven UV Radiation
- Product Rewind
- Facestock Unwind
- Face-stock Adhesive Silicone Release Liner
- Liner Unwind
- Corona Discharge
Emulsion Vario Gravure Coater

- Speed Ratio
- Application roll / Line Speed Ratio Range: 1.1 - 1.3

- Backing roll

- Feed box
- Pressure Range: 0.2 - 0.6 bar Above Atmospheric Pressure

- Gravure roll
- Application roll
Reverse Gravue Coat Weight Chart

Wet Coat Weight (gsm)

Speed Ratio

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Relative Effects of Parameters on the Evaporation Time of Polymer - Water Mixtures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range Investigated</th>
<th>Effect on Evaporation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative humidity, %</td>
<td>10-90</td>
<td>60.2</td>
</tr>
<tr>
<td>Temperature, °C</td>
<td>20-40</td>
<td>20.2</td>
</tr>
<tr>
<td>Air speed, l/min</td>
<td>10-30</td>
<td>1.6</td>
</tr>
<tr>
<td>Water content, %</td>
<td>60-100</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Other</td>
<td>10.2</td>
<td></td>
</tr>
</tbody>
</table>

The combination of hot air and infrared radiation are well suited for the accelerated drying of waterborne adhesives and coatings. This is probably the most effective variation in formulation or production to gain a large improvement in speed. The hot air primarily affects the coating surface while the IR radiation, depending on the wavelength can penetrate into the deeper layers of the coating. With the IR method, favored evaporation of water can be achieved through irradiation in the OH band region.
Formulation of Emulsion PSA

- Thickener/Water
- Ammonia
- Wetting Agents
- Defoamers

QC:
- Solid Content
- pH
- Viscosity
- Wetting
- Foam

Storage Tank

Filter

Pump

Mixer

Base Dispersion

Plasticizer

Tackifiers
Quality Control after Coating Process

Quantitative Criteria:
1. Adhesion
2. Initial Tack
3. Cohesion
4. Coat Weight

Qualitative Criteria:
1. Adhesive Voids
2. Air Bubbles
3. Foreign Particles
4. Clarity