PLASTICS PACKAGING TECHNOLOGY CONFERENCE 2014

RINGIER CONFERENCE
27-28 March 2014

March 27/28 2014
SHANGHAI, PRC
SOLVENT LESS ADHESIVE LAMINATION
Advanced principles in Technology solvent less
Historical Background
Historical background

• R&D: 60s.
• Final developments 70s.
• Market ready: 70s, second half.
• First 5 rollers coating unit design 1982.
• First deliveries to North America: mid 80s.
• Market explosion in Europe: 80s, second half.
100% solid lamination and technical requirements.
Two components technology

Urethane Chemistry

Resin

Hardener

Isocyanate

Hydroxyl (-OH)
Dynamic Viscosity

<table>
<thead>
<tr>
<th>Material</th>
<th>Viscosity (cp)</th>
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<tbody>
<tr>
<td>100% Solid Adhesive</td>
<td>4000</td>
</tr>
<tr>
<td>Honey</td>
<td>3000</td>
</tr>
<tr>
<td>SAE 50 oil</td>
<td>2000</td>
</tr>
<tr>
<td>Pancake syrup @ 20°C</td>
<td>1000</td>
</tr>
</tbody>
</table>
Two layers laminator

100% Solid
Advantages and disadvantages
Advantages

- **Lower production costs:**
  - Lower capital investment.
  - Lower energy consumption.
  - Lower coating weight required.
  - Higher production speed.
  - Lower insurance cost.
  - No need of incineration.
  - No solvent costs.
  - Lower floor space requirement.
- No retained solvent
- Easier quality control
- No VOC
- No fire hazard.
TOTAL ENERGY CONSUMPTION

- Solvent Free
- Dry bond
- Extrusion Lamination

TOTAL ENERGY CONSUMPTION %

- 0%
- 20%
- 40%
- 60%
- 80%
- 100%
- 120%
- 140%
- 160%
- 180%
- 200%
Disadvantages

- **Limitations on:**
  - Packaging for sterilization.
  - Packaging for pasteurization.

- **Curing Time.**

- **Slitting in line.**

- **Multi-Layer Lamination in one pass**

- **Water Based Inks**
Curing Time
**Curing time**

<table>
<thead>
<tr>
<th>Chemical definition:</th>
<th>Time required to have Free Isocyanate disappearing form the adhesive compound.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical definition:</td>
<td>Time required to have the laminated product ready for the following production step:</td>
</tr>
<tr>
<td>- Bag making</td>
<td></td>
</tr>
<tr>
<td>- Slitting</td>
<td></td>
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<tr>
<td>- ...</td>
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</table>
POT LIFE
Problems.

Difficulty in coating high viscosity and controlling accuracy, mainly during speed ramps.

Low tack at green, very low bond immediately after coating and until a sufficient amount of time is elapsed.

Problems of handling chemical compounds at high viscosity mainly related to fluctuation in viscosity due to temperature variations.

Maintenance issue due to time related curing of the adhesive.
How technology helps.

Reliable design of the Coating Head, easy to handle, stable in coating weight, operator friendly.

Perfect tension control, so to avoid problems generated by the low green bond.

Perfect temperature control so to help controlling the viscosity of the adhesive and therefore the viscosity related variables.

Proper technology in meter mixer design.
Coating
Weight Accuracy
Importance of Coating Weight accuracy

Coating Weight Accuracy through a production run will influence:

- Costs
- Quality
  - Bond
  - Optics
Coating Unit
(Courtesy Nordmeccanica)

D) Steel, Temperature Controlled (Zone 1).
C) Steel, Temperature Controlled (Zone 1), Motorized.
B) Solid Rubber, Motorized.
A) Steel, Temperature Controlled (Zone 2), Motorized.
Plastic film bonding machine with adhesive spreading devices.

The invention relates to a plastic film bonding machine in which solventless adhesive is used.

The adhesive spreading devices comprise a pair of ground steel rollers which effect an initial rolling of the adhesive, a rubber-covered roller in contact with one of the said steel rollers and with a spreader roller, and pneumatic systems designed to keep the rubber roller pressed against the said rollers at a constant pressure whatever the roller rotation speed.

The machine also includes a stop element designed to limit the movements of the said rubber roller.
Coating Weight Control Technology

REQUESTS HIGH ACCURACY IN ROLLERS AND ALIGNMENTS

Roll A
Roll B
Roll C
Roll D

~ 80 μ (3 mil)

Δ 1
Δ 2
Δ 3
Ω A
Ω B
Ω C

Ω D = 0

Roll A
Roll B
Roll C
Roll D
Temperature Control
Temperature Control

REQUESTS TEMPERATURE HIGH ACCURACY

- Coating Section: 2/3 Temperature Zones.
- Meter Mixer: 3 temperature Zones.
- Temperature Check on Mixer.
- All Conditioning Rollers/Calanders: Dual chamber and spiral core.
- All heated rollers to be in close loop with temperature control (stabilizer).

With the special cylinder NORDMECCANICA the constancy of temperature is warranted within 1 C at the max speed
Tension Control
**SOLVENT LESS = TENSION CONTROL**

- Nip to Nip circuit: **all tension controlled!!!**
- Load Cell and Dancer Roller.
- Use of AC Vector Digital Drives and Servo Motors.
- Perfect Software to drive Tension Control.
- Fast communications.
- Low Friction Bearings.
- Dynamically balanced rolls (idle & motorized).
- Motorized Idle Rollers on longer paths.
- **Motorized Unwinds For Critical Substrates!!!**
SOLVENT LESS = TENSION CONTROL

- DIGITAL VECTOR DRIVES AND SERVO MOTOR MUST
- BE PERFECTLY COORDINATED
- ONLY ONE TECHNOLOGICAL SUPPLIER FOR HARDWARE AND SOFTWARE – SIEMENS THE VECTOR DRIVE – SIEMENS THE SERVO MOTORS
- THE SEVERAL DRIVES ARE LINKED IN PROFIBUS TECHNOLOGY IN ORDER TO REDUCE THE COMMUNICATION TIME
- THE DIGITAL TECHNOLOGY ALLOWS TO AVOID THE USE OF SENSOR FOR DIAMETER CONTROL
Cleaning

- Adhesive is cured by time.
- No way to lower viscosity with solvent.
- Cleaning Effects:
  - Quality of lamination.
  - Productivity.
  - Set up time for next job.
  - Life of the machine.
- The race against the clock
- Implement Cleaning Procedures
- Operator training
- Operator experience
- Safety Issues.
Barrier Film Lamination
Barrier structure does not allow moisture to reach the adhesive and CO\textsubscript{2} to be released
Non-Barrier film is permeable to moisture and CO$_2$
TIME FACTOR

Location of the two nips is primarily influencing the time between the two steps, a wider gap allows a longer time.

At 300 m/min time between coating and lamination:

- Close nips (1 m): .2 sec
- Open nips (5 m): 1 sec

For barrier substrate .2 sec is not sufficient to let chemical-physical interaction be performed. Evidence is given by the need to slow down lamination speeds on such substrates. With the proper laminator configuration the performance is improved.
Adhesive Mixer
Meter Mixer

- Technology of Meter Mixers developed in function of developments of 100% Solid adhesives.
- New design based on gear pump technology presented in 1999.
- Currently the majority of total sales of meter mixers is gear pump.
- Influence of new generation mixer on easier handling of solvent free lamination.
- Gear pumps, encoder controlled, computer managed mixing ratio.
- Integration between Mixer and Laminator.
- 3 zones temperature control.
- Temperature check.
- Heating technology.
- Removable reservoir.

Meter Mixer

- Resin
- Hardener
- PV1, PV2
- MR1, MR2
- T1, T2, T3
Two components technology

REQUESTS ACCURACY AND CONSTANCY OF MIXING RATIO

THE MIXING RATIO IS HIGHLY AFFECTED BY THE VISCOSITY OF THE ADHESIVE
Europe

USA
China Market data
NUMBER OF MACHINES NORDMECCANICA IN CHINA

No. of SL

<table>
<thead>
<tr>
<th>Year</th>
<th>Count</th>
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<tbody>
<tr>
<td>2007</td>
<td>30</td>
</tr>
<tr>
<td>2008</td>
<td>40</td>
</tr>
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<td>2009</td>
<td>50</td>
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<tr>
<td>2010</td>
<td>55</td>
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<tr>
<td>2011</td>
<td>70</td>
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<td>2012</td>
<td>150</td>
</tr>
<tr>
<td>2013</td>
<td>220</td>
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TREND OF SOLVENT LESS

• BY THE END OF 2014 THEY ARE EXPECTED MORE THAN 300 MACHINES NORDMECCANICA IN CHINA
• THE ACTUAL SHARE OF SOLVENT LESS IS ABOUT 10% INCREASING
• IN 2014 IT WILL BE AT LEAST THE 16/18%
Thank you