State of the Art Coating Technologies

5- Roll Coating Method

by POLYTYPE CONVERTING

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Contents

1. The Polytype Group- overview
2. Multi-Roll Coating Technology in High Speed Coating
3. 5-Roll Coating Method and its Leading Position
   • Major Technical Criteria
   • Comparison (5- Roll vs. 6-Roll)
   • Summary/ Conclusions
Polytype Group
Member of WIFAG Group
Today’s focus - High Speed Applications

What is High Speed?

- production speed above 1000 m/min
- large quantities
- new silicones and adhesive formulations
- high market volumes
- reduction of production costs
Evolution in Production Speeds

Looking at the trend of production speeds, determines the requirements for high speed coating lines (e.g. for PSA)

production speed
Requirements for High Speed Coating Lines

- advanced coating methods
- accurate web guides in the complete machine
- drying temperature control
- remoistening after siliconizing and adhesive application
- winding techniques at high speed, roll change without slowing down
- automatic roll handling
- reliable flying splice
Market Share of different silicone use

- **Processes**
  - 100% Solids, EB/UV curing
  - 100% Solids Thermal curing (solventless)
  - Emulsion
  - Solvent-based
Pilot Machine: Coating Method Allocation

General: 25% of total trial tune is utilized for 5-roll coating (4 wet rolls)
Why is there a need for High Speed operation in siliconizing?

Major demands…

- Continuing reduction of production costs in manufacturing of commodity grades (like one-side siliconized liner for labels)

- Increase of production output (demand of jumbo-rolls for labels)
Let's take a look at the Cost Contribution Structure of Label Laminate (printed product):

- **PSA – LABEL** 50 - 60 %
  (considered the “VALUE-ADDED Product”)

- **RELEASE LINER** 50 - 40%
  Totals to 100%
  (considered the “VALUE-ADDED Waste”)

...resulting challenges

(... always with the overall goals in mind)

A) Lowering the cost of the Release Liner (total cost)

B) Improving of the bottom line (profitability)
Coating Methods - Overview
Lets talk about Polytype’s Solution

5-Roll Coating Technology
for High Speed Silicone Application
Multi-Roll Coating Technology
for high speed application available

by Polytype

5-roll coating head ("Z" shape design)
W00) chrome plated steel metering roll
W0 ) Rubber-covered deflection compensated metering roll
W1 ) chrome plated steel transfer roll
W2 ) Speedwell (sleeve-type) coating roll
W3 ) chrome plated steel backing roll

by Competition

5-roll coating head
1) Ceramic coated metering roll
2) Rubber-covered metering roll
3) Ceramic coated transfer roll
4) Sleeve-type coating roll
5) Steel backing roll

6-roll coating head
1) Rubber-covered metering roll
2) Ceramic coated metering roll
3) Rubber-covered transfer roll
4) Ceramic coated transfer roll
5) Sleeve-type coating roll
6) Steel backing roll
The most critical topics in High Speed Silicone Coating

- Minimized coat weight (@ outstanding coverage)
- Coat weight accuracy (tolerance in CD/ MD)
- Film splitting
- Temperature control
What are the results and ...applicable technical solutions...?

• Coat weight/ coat weight accuracy ... roll quantity, foot print, differencial speed, build-in technology

• Film splitting ... misting

• Temperature control ... sleeve growing – tempering, quality of rubber
Multi-Roll Coating Heads - operational window achievable with respect to speed

by POLYTYPE

5-roll coating head up to 1’500 mpm

by Competition

5-roll coating head up to 800 mpm

6-roll coating head up to 1’610 mpm
Multi-Roll Coating Heads—operational window achievable with respect to coat weight range vs. speed of rolls

**Figure 8:** Coat weight = f (V₀).

**Figure 11:** Coat weight = f (roller speeds).
5-Roll Coating Head in Silicone Coating
Silicone Coating – 5-Roll Coating Head

...performance requirements:
- evenness across the web of coat weight
- reduced misting and air boundary layer
- deflection control for all application rolls
- web tension control
- roll temperature distribution management to prevent thin layer polymerisation
- prevent air entrainment in nip
Silicone Coating Head

...design solutions:
- 5 roll standard coating head
- adjustable speed of each roll
- deflection compensated metering roll W0
- misting removal at source
- accurate temperature control of all rolls
5-Roll Coating Technology

W3: Steel roll - backing roll
W2: Speedwell (sleeve type) - application roll / 55 shore A
W1: Steel roll - transfer roll
W0: Rubber roll - pressuring roll / 80 shore A
W00: Steel roll - metering roll

<table>
<thead>
<tr>
<th>Roll #</th>
<th>Speed [ % ]</th>
<th>Footprint [ mm ]</th>
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<tbody>
<tr>
<td>W3</td>
<td>100</td>
<td>10-25</td>
</tr>
<tr>
<td>W2</td>
<td>~102-105</td>
<td></td>
</tr>
<tr>
<td>W1</td>
<td>~70</td>
<td></td>
</tr>
<tr>
<td>W0</td>
<td>~12</td>
<td>8-20</td>
</tr>
<tr>
<td>W00</td>
<td>~1,2</td>
<td></td>
</tr>
</tbody>
</table>
Film Thickness Model

Mass balance in nip:

\[ V_{i+1} (h_{i+1} - h'_{i+1}) = V_i (h_i - h'_i) \]

Film split ratio:

\[ \frac{h'_{i+1}}{h_i} = \alpha_i \left( \frac{V_{i+1}}{V_i} \right)^{\beta_i} \]

Flow rate at metering gap \( W_0/W_00 \):

\[ \lambda = \frac{Q}{gV} \]
Basic Flow Field – Deformable Gap: Steel/ Rubber Roll

Deformable gap:

Steel roll

Rubber covered roll

The nip geometry (gap) is unknown: elasto-hydro-dynamic system

- Moving roll surfaces drag liquid into the gap
- Converging geometry causes pressure peak in fluid
- Pressure gradient causes additional flow
- Pressure causes deflection of deformable rubber roll surface
- Gap depends on roll radius, material properties and operating conditions
Technical Solution – Polytype’s deflection compensated roll patent

Standard Pressure system
Normal flexion causes problems for coating quality.

1) Metering Roll (W0)
2) Metering / Transfer Roll (W00)

Deflection compensated roll “W 0”
The pressure on to the rolls can be guaranteed over the complete length.
Deflection compensated roll

Patented by Wifag
Difficult to manufacture
Technical Solution - Mechanical Stops

Precision mechanical stops. The mechanical stops are sized such that the footprint (i.e. gap between 2 rolls) can be set under hydraulic pressure.
1 rotation of the hand-wheel reduce the gap about 0.1-0.2mm

Easy change of the rolls.
Each roll can be changed individually.
Technical Solution - Feeding System

Oscillating feeding of the silicone into the gap between roll W0 and W00
Technical Solution – Side Dam Assembly
Technical Solution – Level Control System
Technical Solution – Roll “W2” Cleaning Assembly

Oscillating cleaning head mounted on a linear pneumatic cylinder.
Technical Solution – Silicone Mist Exhaust Assembly

1. Substrate
2. Backing Roll (W3)
3. Applicator Roll (W2)
4. Air Boundary Layer Air Knife
5. Main Silicone Mist Exhaust
6. Upper Silicone Mist Exhaust
7. Lower Silicone Mist Exhaust
- view from TS (silicone exhaust assembly in service position)

- view from TS (silicone exhaust assembly in engaged position)
5-Roll Coating Head –
General Component Requirements

W3: Steel roll
W2: Speedwell
W1: Steel roll
W0: Rubber roll
W00: Steel roll

1. Cleaning device
2. Scraper
3. Level control
4. Side dams
5. Silicon holding tank
6. Pump
7. Motor
8. Spherical facet
9. Quick disconnect coupling
10. Catch pan
5-Roll Coating Technology – Drive Arrangement

All drives (W3, W2, W1, W0, W00) with AC motors and frequency control.
Silicone coating head in trolley design
Silicone Coating head in fixed design
# Comparison of high speed Coating Methods

<table>
<thead>
<tr>
<th>Criteria</th>
<th>5-Roll Coating Head (by Polytype)</th>
<th>5-Roll Coating Head (by Competition) *</th>
<th>6-Roll Coating Head (by Competition) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>High speed operation (machine speed) (≤ 1500 mpm)</td>
<td>Yes</td>
<td>No ≤ 800 mpm</td>
<td>Yes</td>
</tr>
<tr>
<td>Coat weight achievable</td>
<td>0,3 – 3,0 gsm</td>
<td>0,5 – 3,0 gsm</td>
<td>0,3 – 2,0 gsm</td>
</tr>
<tr>
<td>Coat weight tolerance achievable</td>
<td>± 0,02 gsm</td>
<td>± 0,05 gsm</td>
<td>± 0,03 gsm</td>
</tr>
<tr>
<td>Tempering of rolls (heating/cooling)</td>
<td>5 rolls tempered</td>
<td>3 rolls tempered</td>
<td>6 rolls tempered; thus no temperature changes</td>
</tr>
<tr>
<td>Turbulences of the mass in the coating sump</td>
<td>Very low (due to dip blade)</td>
<td>Greater (greater speed roller 2)</td>
<td>Lower</td>
</tr>
<tr>
<td>Speed of metering rolls</td>
<td>W0 5-15,0 % W00 2 mpm</td>
<td>2 14,0 % 1 0,6 %</td>
<td>2 10,0 % 1 0,6 %</td>
</tr>
<tr>
<td>Deflection Compensated Roll</td>
<td>Yes (W0)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Silicone misting</td>
<td>Very low due to 2 nips only (less film split)</td>
<td>Greater due to higher circumferential velocity and scraper setting</td>
<td>Lower due to reduced circumferential velocity and sleeve technique already at roller 3</td>
</tr>
</tbody>
</table>

* Based on published data in Flexo & Gravure Asia 3-2007
Thank you very much for your interest and confidence in polytype Converting products and services