Continuous Splicing Techniques

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Trends for higher productivity

Running Thinner and Faster!

- Downgauging Materials for reduced material costs
  - Lighter Tensions
  - Smaller Roll Diameters

- Higher Line Speeds for greater production
- More Uptime for Greater Yields
High productivity =

Unwinding/splicing thinner materials at higher production speeds with 100 percent splicing efficiency.
100% Splicing Efficiency requires

• Accurate web transfer tension
• Reliable pasting and cutoff operations
• Repeatable splicing operation for a variety of speeds and roll diameters
Splicing Efficiency

Web breaks due to missed splices are costly!

- **Costly product loses**
  - Scrap material from web break
  - Scrap material from rethreading
  - Scrap material from start-up

- **Costly downtime (loss of production)**

- **Costly labor to clear scrap and rethread**
Key Features of Modern Full Speed Splicers

- Little or no web length change during splicing operation
- Paster roll driven at line speed
- Fast and accurate paster actuation
- Controlled and uniform paste pressure
- Soft and precise tension control
Video of Modern Splice Sequence (Click to Play)

Splicing Operation at 300mpm (1000fpm)
Causes of Missed Splices

- Improper splice preparation
- Improper Lack of speed match of the new roll
- Improper paster operation
- Poor paster repeatability
- Poor cut-off operation and repeatability (long tail lengths)
To achieve 100 percent splicing reliability, break down your splicing operation into specific components and optimize each component.
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Continuous Splicing Techniques
Article published in
AIMCAL's Converting Quarterly
(Issue 2013, Quarter 4)

Flexible packaging: New film & lamination developments

Abstract
The productivity of web-processing lines relies on the ability of the splicing operation to consistently introduce new rolls of materials into the process at the required speed and without loss of operator fatigue. Industry trends are toward higher line speeds processing thinner materials. The leading edge of the web is made up of a series of minute fibers which create the web's ability to stretch. The leading edge can be made more consistent with the use of a splice suction device (Figure 1). A square leading edge allows for effective splicing with a close, even, and stable bond.

The leading edge of the web in a splicing application is the weakest point of the web. The leading edge can be made more consistent with the use of a splice suction device (Figure 1). A square leading edge allows for effective splicing with a close, even, and stable bond.

Introduction
Tidtly high productivity is achieved when converting operations. In order to maintain high productivity, new rolls of material must be available at a delivery point adjacent to the splicing area. The leading edge of the new roll must be clean and free from contamination. The leading edge of the new roll is the most critical component of the splicing operation. The leading edge is the starting point of the micrometer-thin web. Any defects in the leading edge can cause the web to break at the splice. A square leading edge reduces the number of defects that can occur at the splice. The leading edge is the starting point of the micrometer-thin web. Any defects in the leading edge can cause the web to break at the splice. A square leading edge reduces the number of defects that can occur at the splice.

Splice Preparation
Splice preparation is an important step in the splicing process. A splice suction device (Figure 1) is used to remove any contamination from the leading edge of the web. The splice suction device is effective in removing any defects from the leading edge of the web. The splice suction device is effective in removing any defects from the leading edge of the web.

FIGURE 1: Tidtly high productivity is achieved when converting operations. In order to maintain high productivity, new rolls of material must be available at a delivery point adjacent to the splicing area. The leading edge of the new roll must be clean and free from contamination. The leading edge of the new roll is the most critical component of the splicing operation. The leading edge is the starting point of the micrometer-thin web. Any defects in the leading edge can cause the web to break at the splice. A square leading edge reduces the number of defects that can occur at the splice. The leading edge is the starting point of the micrometer-thin web. Any defects in the leading edge can cause the web to break at the splice. A square leading edge reduces the number of defects that can occur at the splice.
Important Components of a Splicing Operation

• Preparation of the Incoming Roll
• Speed up operation
• Splice Tension
• Paster operation
• Cut-off operation
• Tail length control

Improper splice preparation is the #1 cause of missed splices
Important Components of Preparing the Leading Edge of a New Roll of Material -

• Easy application for operators

• Leading edge securely held so air does not break hold down tabs during speed-up

• Proper splice adhesive with good “wet grab” strength and proper heat strength

• Leading edge properly marked
New splice tapes combine leading edge holddown and splice adhesive into a single tape, and laser marking systems greatly improves splice preparation ease and accuracy.
Video of Modern Splice Preparation (Click to Play)

Splice Preparation
Important Components of a Splicing Operation

- Preparation of the incoming roll
- **Speed up operation**
- Splice tension
- Paster operation
- Cut-off operation
- Tail length control

Proper speed match is extremely important for a highly reliable splicing operation.
Speed-up Operation

Just before the splicing takes place, the new incoming roll of material is accelerated so the outer surface is at or slightly below the line speed at the time of the splice.

If the incoming roll's speed is:

- Rotating too fast, Tension Loss (slack) will occur in the web after the splice.
- Rotating too slowly, the resulting high tension after the splice can pull the splice apart.
Speed-up Operation

The critical task for proper speed match of incoming roll is accurately measuring the new roll’s diameter.

Methods to measure incoming diameter:

- Manual Pi Tape to measure circumference - Most Accurate but requires operator’s interface
- Auto Lay-on Tach to measure the roll’s circumference - Very Accurate but requires area without splice adhesive
- Auto Sonic or Laser to measure the roll’s radius - Requires high and of rolls
  rotating roll while measuring and averaging the low readings for accurate diameter measurement that are slightly out of round- flat spots.
Important Components of a Splicing Operation

• Preparation of the incoming roll
• Speed up operation
• **Splice tension**
• Paster operation
• Cut-off operation
• Tail length control

**Splice tension** refers to the web tension immediately after a splice occurs.
Splice Tension

After the splice occurs, the new incoming roll must switch from speed control to tension control without an upset in the process tension.

To minimize splice tension upsets:

- Proper speed match of +0 / -1% of line speed
- Speed to tension transition needs to be done right after the paste is made.
- Friction braking systems need proper precharging pressure for incoming roll’s pneumatic brakes

For thin webs processed at high speeds, the tension needs to be controlled by a regenerative drive system. The timing and the required braking torque from drive’s logic based on the diameter and tension setting is critical for proper splice tension.
Important Components of a Splicing Operation

- Preparation of the incoming roll
- Speed up operation
- Splice tension
- **Paster operation**
- Cut-off operation
- Tail length control

Pasting operation is very critical when splicing small diameter rolls at high speeds
Paster Operation

The important components of a paster Operation:

- The paster needs to be positioned close to the incoming roll before firing it onto the incoming roll of material.
- The paster roll needs to be driven to match the web speed.
- The paster needs to contact the incoming roll parallel to the spindle centerline and then confirm to the incoming roll’s outer surface.
- The paste pressure needs to be controlled separately from the firing pressure.
Successful pasting operation requires **absolute control** of the paster actuation.
Pasting Zone

Pasting window allowed zone
180 degrees +/- 90 degrees from paster nip

Prepared splice

Paster nip roll
Zones of frequent splice failure

Paste Just After Tape
Tabs Can Tear

Paste Just Before Tape
Roll Bounce
Video - Paster Operation 300 mpm (1000 fpm)

Splicing Operation at 300 mpm (1000 fpm)
Slow Motion Video –

Splicing Operation at 300 mpm (1000 fpm)
Predictive Actuating

of the paste roll firing is required for a successful splicing operation.

The *repeatability* of this actuation is more critical as splicing speeds increase and/or new roll diameters decrease.
Staying within the pasting window at high speeds and small roll diameters requires a very small variation in the reaction time of the paster.
The repeatability of a properly designed pneumatic paster was measured and found to have a variation of 0.130 seconds.
Min. roll diameters for splicing with pneumatic systems

- 1000 FPM
- 2000 FPM
- 3000 FPM

Measured paster reliability & roll diameter
For Pneumatic Pasting Systems
Today’s Market Requirements

• Thinner webs = Smaller diameter
• Higher line speeds

Pneumatic systems’ repeatability of reaction times are not adequate for many roll diameters being processed.

An alternative is needed!
Answer: Servo-Actuated Splicer

- Paster roll assembly
- Single direction air cylinder
- Always air loaded extended
- Paster carriage
- Gear rack & pinion
- Carriage drive servomotor
- Knife
- Knife servomotor
• Repeatable reaction time of a servo-fired paster is better than one half that of a pneumatic system.

• Paster acceleration and velocity is precisely controlled.

• Servo feedback allows paster position to be controlled to minimize bounce.
High Speed Video - Paster Operation 915 mpm

915 mpm (3000 fpm) Splice
Slow-Slow Motion High Speed Video of Paster Operation 915 mpm (3000 fpm)

3000 fpm 1/20 Speed
Minimum roll diameters with servos

Min. roll diameters for splicing with servomotors

<table>
<thead>
<tr>
<th>Min. incoming roll diameter (inches)</th>
<th>Repeatability of paste reaction time (Seconds)</th>
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<tr>
<td>8</td>
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<tr>
<td>10</td>
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<tr>
<td>32</td>
<td>0.325</td>
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</tbody>
</table>

- 1000 FPM
- 2000 FPM
- 3000 FPM
Chart #4  Servomotor versus pneumatic system

Minimum roll diameters with servos versus the pneumatic systems

Line speed (FPM)

0 10 20 30 40 50

Minimum new roll diameter (inches)

1000

2000

3000

Servo system
Pneumatic system
Cutoff Operation of the Expiring Web

- Improper splice preparation
- Improper Lack of speed match of the new roll
- Improper paster operation
- Poor paster repeatability
- **Poor cut-off operation and repeatability (long tail lengths)**

Successful Splicing operations require cleanly cutting the expiring web and short and controlled tail lengths with minimum wraps of scrap material on the expired roll.
Accutail™ Predictive Cutoff Operation

The Accutail™ Predictive Cutoff Operation features:

- Automatic initiation of indexing, speed-up, predictive pasting and predictive cutoff operation based on line speed and programmed splice diameter.
- Short and controlled programmed tail length within +/- 10” at 3000 fpm splicing speed.
- Splice Tracking to open and close nips and to initiate a roll change sequence to put splice at the outer wraps of the wound roll.
Predictive Cut-off Operation for Lap Tail Splice With Minimum Tail Length

Leading Edge and Cut Tail of Expiring Roll Join at the Paste Point
A servo-actuated cut-off knife improves the repeatability of knife reaction time and enables shorter and consistent tail lengths.

Consistent tail lengths reduce missed splices due to web breaks from long splice tails.
Conclusions

• Higher productivity = unwinding/splicing thinner materials at higher speeds at 100 percent efficiency.

• Splicing thinner materials wound to smaller diameters at higher speeds greatly challenges the unwind/splicing operation.

• Modern splicers with servo-driven paster and cutoff operations and predictive controls are required to achieve high productivity on today’s high speed coating and laminating lines.
Questions?

Slide Courtesy of
Dr. David Roisum
Continuous Splicing Techniques

Article published in AIMCAL's Converting Quarterly (Issue 2013, Quarter 4)

Flexible packaging: New film & lamination developments

Abstract

The productivity of web processing lines relies on the ability of the entire operation to consistently introduce new rolls of materials into the process at the production speed and without loss of machine efficiency. Press speeds are toward higher line speeds processing thinner materials. The loading of both inline and cross ply lamination materials at similar tension and higher speeds can often demand more attention on the splicing operation. To meet these splicing operation demands, it is a good practice to understand the components of a splicer. Optimizing each of these is critical to improve splicing quality and output productivity of the line. This article will address the mechanics, components of the web splicing operation, and the welding configuration commonly used among multiple types of pressure-sensitive adhesives (PSA) splicing mechanisms. Different types of splicing control systems and their applications and functions for each type is described. These range from a simple mechanical system to the most modern, automatic web splicing control system for precise web processing equipment, allowing even higher lamination splicing speeds up to 3,000 ft/min (915 m/m)

Introduction

The high-speed lamination is a continuous web processing system that transports material from new rolls of web material to a continuous web splicing mechanism at speeds approaching 1,500 feet per minute (FPM). The continuous web splicing operation, and component of the web splicing operation, results in a product that is consistent with the precise overlap of the splicing mechanism. That process is dependent on proper components in the package, as well as the nature of the material. These components are necessary to assure proper pressure transfer on the material, the nature of the material, the coating, the web tension, the temperature, the web speed, the position of the splicer in the continuous web splicing operation, and the web tension control.

Splice preparation

Splice preparation is a critical operation that requires proper attention and application. Proper splice preparation is critical to ensure that the splice is properly aligned and that the proper amount of adhesive is applied to the splice. This ensures that the splice is properly aligned and that the proper amount of adhesive is applied to the splice. This ensures that the splice is properly aligned and that the proper amount of adhesive is applied to the splice.

FIGURE 1: "Y" slot splice preparation (left) and "T" splice preparation (right)