Web Spreading Devices

Slitting and Rewinding Fundamentals for Converters
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Spreader rolls

Web transport rolls – either driven or idle – that cause cross machine direction web movement as the web is traveling in the machine direction.

**Benefits**

1. Remove wrinkles
2. Can separate slit widths to prevent interleaving
3. Web width can be stretched to a predetermined amount
Wrinkling – web handling principle

A web will seek to align itself perpendicular to a roll, in its entry span to that roll.

**SKEWED (NOT PARALLEL) IDLER ROLLS AS VIEWED FROM THE TOP:**

- Skewed (not parallel) rolls will cause wrinkles
- The web will seek to be perpendicular to a roll in its entry span to that roll
- Tensions vary in the cross machine direction causing wrinkles

*figure 11*
Web characteristics that cause wrinkles

Gauge band variations or thickness variations across the web width.

_CROSS SECTION OF WEB GAUGE BAND VARIOATIONS_

- **WEB WITH THICKNESS VARIATIONS**
- **THINNER, LOW TENSION AREA (LESS OR NO SUPPORT BY IDLER ROLL FACE)**
- **THICKER, HIGH TENSION AREA (SUPPORTED BY IDLER ROLL FACE)**

*figure 1*
Web characteristics that cause wrinkles

Tight side/loose side.
Web characteristics that cause wrinkles

Baggy center, tight edges.
Web characteristics that cause wrinkles

Baggy edges, tight center.
Web characteristics that cause wrinkles

Poorly wound roll stock, also known as the parent roll.

Roll end view
"Starring Effect"
Caused by tension too high

Roll end view
Layer slipping
Caused by tension too low

Figure 5

Figure 6
Machine characteristics that cause wrinkles

Idler roll buckling or deflection.

WRINKLES CAUSED BY ROLL DEFLECTION OR BUCKLING AS VIEWED FROM THE FRONT AND SIDE

WRINKLES OCCUR ACROSS ROLL FACE AS THE WEB COMPRESSES WHEN IDLER ROLL DEFLECTS

WEB LOCATION ON IDLER ROLL AT EDGES, NEAR ROLL SUPPORTS LITTLE OR NO DEFLECTION

MAXIMUM LOAD POINT, DELIVERED BY TENSION ON THE WEB

WEB LOCATION AT CENTER OF ROLL (MAXIMUM DEFLECTION POINT IN THIS EXAMPLE). THIS OUT OF PLANE WEB POSITION CAUSES WRINKLES TO FORM

Figure 7
Machine characteristics that cause wrinkles

Air entrainment in webs.

**AIR ENTRAINMENT SIDE VIEW**

- Air entrainment between the surface and roll face will cause wrinkles.
- There is no traction between the roll and the web when this problem exists.
- The web can wander with this condition.

*figure 8*
Machine characteristics that cause wrinkles

Material roll buckling or deflection.

*PARENT (UNWIND) ROLL DEFLECTION AS VIEWED FROM THE FRONT (OR BACK)*

THIS DEFLECTION CAN CAUSE WRINKLES BEFORE THE WEB STARTS OUT INTO A PROCESS

*figure 9*
Machine characteristics that cause wrinkles

**TOP VIEW OF VARYING TENSION ZONES THROUGH MANY CONVERTING OPERATIONS**

**INDEPENDENT, DRIVEN NIP POINTS**

- From Unwind
  - Coating Section
    - Tension May Increase
    - Compressive Forces
    - Causes Wrinkles
  - Printing Section
    - Tension May Decrease
    - Web Decompression
    - Causes Wrinkles
- Drying Section
  - Tension May Decrease
  - Web Decompression
  - Causes Wrinkles
- Slitting Section
  - Tension May Increase
  - Compressive Forces
  - Causes Wrinkles
- Rewind Section
  - Tension May Decrease
  - Web Decompression
  - Causes Wrinkles

**NOTE:** Similar to stretching and contracting a rubber band, tension variances will cause expansions and contractions in the cross machine direction.
Machine characteristics that cause wrinkles

- Skewed (not parallel) idler rolls as viewed from the top.
- Skewed (not parallel) rolls will cause wrinkles.
- The web will seek to be perpendicular to a roll in its entry span to that roll.
- Tensions vary in the cross machine direction causing wrinkles.
Benefit of spreader rolls regarding wrinkle removal

By removing wrinkles, spreader rolls reduce or eliminate defective product – thereby increasing profits.
Example of edge interleaving and roll overlap

SLITTING AND SINGLE STATION REWIND
(NO SPREADER ROLL)
TOP VIEW

WEB SPREADING

Figure 12
Separate slit widths to prevent interleaving

**SLITTING AND SINGLE STATION REWIND (WITH SPREADER ROLL)**
**TOP VIEW**

*figure 13*
Stretch the web across the width

**Tenter Frame Example Where Spreader Rolls Are Used to Stretch (or Keep Stretched) a Web**

- **Tenter Frame**
- 'Pins' that grab the edge of the web, are driven along a 'track' similar to tractor feed.
- **Web Edge**
- A tenter frame stretches a web by 'grabbing' each edge in given tracks, angled away from each other.
- **Spreader Roll**
- Helps to maintain stretched width.

*Figure 14*
5 basic types of spreader rolls

1. Crowned and concave spreader rolls
2. Grooved rolls including rigid and flexible
3. Nip type
4. Curved axis (bowed) rolls and bars
5. Expanding surface rolls
Crowned spreader rolls

- Manufactured from steel, aluminum, stainless steel, plated aluminum or plated steel
- Most are rubber covered
- Arced surface, from ends in toward center
- Roll face diameter variance is strictly application dependent
- Wrap angles range from 30° to 180°
The theory of operation for a crowned roll

SIMPLE EXAMPLE OF THE
THEORY OF OPERATION FOR A CROWNED ROLL

THEORY OF OPERATION:
The roll center is larger than the ends
The higher tension, due to the larger
roll center, pushes wrinkles out of the web

figure 15
Crowned spreader rolls – advantages

- Will not mark the surface of the web
- Inexpensive, readily available
- Easy to maintain
- Used with all types of materials
Crowned spreader rolls – disadvantages

• Theory of operation not accurate
• Surface speed variance across its face
• Can stretch, distort and/or tear center of web
• Amount of crown only determined through trial and error or past experience
Concave spreader rolls

- Manufactured from steel, aluminum, stainless steel, plated aluminum or plated steel
- Can be rubber covered
- Arced surface, sweeps in from both ends toward center
- Roll face diameter variance is strictly application dependent
- Wrap angles range from 30° to 180°
The theory of operation for a concave roll

**SIMPLE EXAMPLE OF THE THEORY OF OPERATION FOR A CONCAVE ROLL**

**THEORY OF OPERATION:**
The roll center is smaller in diameter than the ends. The larger roll end diameter causes the web edges to be driven faster than the center, causing wrinkles to be 'walked out.'

*Figure 16*
Concave spreader rolls – advantages

• Will not mark the surface of the web
• One of least expensive rolls
• Simplicity of design
• Flexibility, used with a wide variety of materials
Concave spreader rolls – disadvantages

- May not work/may compound certain wrinkling conditions
- Can stretch, distort and/or tear edges of web
- Amount of concave profile only determined through trial and error or past experience
Grooved spreader rolls

- Rigid metallic or hard rubber; soft flexible rubber
- Manufactured from steel, aluminum, stainless steel, plated aluminum or plated steel
- Groove design is application dependent
- Wrap angles range from 90° to 180°
Grooved spreader roll

EXAMPLE OF ONE TYPE OF GROOVED SPREADER ROLL

'START'- THIS PARTICULAR EXAMPLE HAS 8 'STARTS'
(4 VISIBLE AND 4 LOCATED 180° FROM THIS VIEW)

"LEAD"- THIS IS THE DISTANCE A PARTICULAR THREAD TRAVELS ALONG THE FACE OF THE GROOVED ROLL

15°  1/32" LAND

THERE ARE MANY TYPES OF GROOVED ROLLS MATERIALS AS WELL AS GROOVE DESIGN WILL VARY

figure 17
Grooved spreader rolls – (rigid or hard) advantages

When used as an idler roll …

- Useful for air entrainment
- Readily available, inexpensive to make
- Easy to maintain
- Will not stretch, distort or tear any portion of web
- Ideal for use with textiles and nonwovens
Grooved spreader rolls – (rigid or hard) disadvantages

*When used as an idler roll …*

- Theory of operation not accurate
- Potential to mark web surface
- Groove could form in web’s profile, causing wrinkles
- Limited application with papers, foils and films
Example of grooved roll spreader roll used as an idler roll

Example of a grooved roll being used as an idler roll

- A grooved roll used as an idler roll will not push wrinkles out of the web. This belief is mostly because of the optical illusion created by the rotating grooves.

- The tangent point of a groove on the web remains in a constant position through rotation, so the groove has no effect.

- This roll will remove wrinkles caused by air entrainment.

**Figure 18**

*WEB SPREADING*
Grooved spreader rolls – (rigid or hard) advantages

When used as a dead bar ...

- All benefits like when used as an idler roll
- Grooves will push web outward toward each edge of roll face
Example of grooved roll spreader roll used as a dead bar

Example of a grooved spreader roll being used as a dead bar

- When grooved roll is used as a dead bar or a non-synchronous driven roll, the groove will push wrinkles out of the web.
Grooved spreader rolls – (rigid or hard) disadvantages

When used as a dead bar ...

- More marking and scratching
- Can cause edge guiding and wrinkle problems down-line
Grooved spreader rolls (soft)

- Rubber is soft enough to flex under pressure of web tension
- Flexible lands allow for web spreading
- Wrap angle ranges from 30° to 180°
Grooved spreader rolls (soft)

Flexible - Soft Rubber Grooved Roll

- As the roll rotates, the web, under tension, deflects the lands to remove wrinkles
Grooved spreader rolls (soft) – advantages

• Useful for air entrainment
• Will not stretch, distort or tear
• Will not mark or scratch web
• Can be used with all types of webs
Grooved spreader rolls (soft) – disadvantages

- Some wrinkles may return
- May deform inside groove, taking on the profile of groove
Nip type spreader rolls

- Short-face rolls, small diameter
- Left- and right-hand set
- Preloaded parallel to each other so that each roll face is pressed together
- No wrap angle
Nip type spreader rolls

NIP TYPE SPREADER LEFT SIDE ONLY SHOWN

figure 21
Nip type spreader roll – application

**NIP TYPE SPREADER ROLL - APPLICATION**

- This type of spreading device makes use of the web handling principal that a web will seek to align itself perpendicular to a roll in its entry span to that roll.

- Each edge of the web seeks a 90° angle to each nip set, thereby pulling wrinkles from each edge of the web.

![Diagram of Nip Type Spreader Roll](figure 22)
Nip type spreader rolls – advantages

- Aggressiveness in ability to stretch
- Easy to maintain
- Easy to adjust amount of spreading
- Works well with both woven and nonwoven webs
Nip type spreader rolls – disadvantages

• Can mark, distort, and possibly tear most foils and films
• Designed specifically for wovens and nonwovens, may have difficulty with web distortion when used with webs other than wovens and nonwovens
Curved axis (bowed) spreader rolls

- Non-linear center axle
- Amount of curve is application dependent
- Available in adjustable and non-adjustable version
- Wrap angle usually less than 30°
- Lead-in should be roughly double lead-out distance
Curved axis (bowed) spreader roll

Example of a curved axis (bowed) roll construction

Curved axis (bowed) rolls are available with both fixed and adjustable amount of bow.

Spool segment (supports rubber sleeve)
Rubber sleeve (type to suit application)
Ball bearing (supports spool segment)

Cross section view

Axle (supports bearings) to be mounted in clamp type mounting blocks

Figure 23
Curved axis (bowed) spreader roll application

**CURVED AXIS (BOWED) ROLL SPREADER ROLL APPLICATION**

**TOP VIEW**

- **Entry span** = 2X exit span
- **Lead-in idler roll**
- **Curved axis (bowed) roll**
- **Lead-out idler roll**

**Any given point, measured across web width**

- This type of spreading device makes use of the web handling principal that a web will seek to align itself perpendicular to a roll in its entry span to the roll.

- At any given point, across the web width, the web is attempting to maintain a 90° angle to the centerline of the curved axis roll.
Curved axis (bowed) spreader rolls – advantages

• Aggressiveness in ability to stretch
• Versatile
• Its wide acceptance for all facets of converting
• Used for all types of webs in all types of converting processes
• Available with multitude of different sleeve compounds
• Will spread multiple slit widths evenly
• Will not mark or scratch the web’s surface
Curved axis (bowed) spreader rolls – disadvantages

- Can permanently distort or tear center of web
- Maintenance is needed
- Rubber sleeve needs to be replaced periodically
Stationary curved axis (bowed) spreader bars

- Made of steel or aluminum
- Works on a tension differential
- Wrap angle ranges from 15° to 90°
The theory of operation for a curved axis bar

**SIMPLE EXAMPLE OF THE THEORY OF OPERATION FOR A CURVED AXIS (BOW) BAR**

- **SINCE THE WEB IS NOT IN TRACTION WITH THIS BAR, THE WEB HANDLING PRINCIPAL IS NOT IN EFFECT**

- **THE RAISED BAR CENTER CAUSES UNEVEN TENSION WHICH PUSHES WRINKLES OUT TO EACH SIDE**
Stationary curved axis spreader bars – advantages

• Easy to manufacture
• Smooth surface
• Low maintenance
• Will separate slit widths
• Used with woven, nonwoven and paper webs
Stationary curved axis spreader bars – disadvantages

- Can permanently distort or tear web center
- Amount of bow is application dependent
- Amount of bow determined through trial and error or past experience
- Web can become scratched and marked
- Creates drag on web
Expanding surface spreader rolls – slat type

- Slats made from aluminum, steel or wood
- Slats mechanically pushed from center to each roll end for 180° of rotation
- Next 180° of rotation, slats move back toward center of roll
- Wrap angle ranges from 90° to 180°
- Amount of spreading directly proportional to amount of wrap angle
The theory of operation for an expanding surface spreader roll – slat type

**SLAT EXPANDER THEORY OF OPERATION**

- **Journals must be fixed.**
  - This roll must be a dead shaft idler.

- **Slats move inward toward center**
  - (Web off)

- **Slats move outward toward edges**
  - (Web on)

- **Web must enter where slats are closest to the center**
- **Web must exit where slats are farthest from the center**

*figure 26*
Expanding surface spreader rolls – slat type – advantages

- Aggressive in removing wrinkles
- Tension evenly distributed across face
- Will not permanently distort or tear center or edges of web
- Mainly for woven and nonwoven webs
Expanding surface spreader rolls – slat type – disadvantages

- Can mark, scratch or deform many webs
- Can be high maintenance because of many moving parts
- Amount of spreading is not adjustable
Expanding surface spreader rolls – polymer band type

- Manufactured with aluminum roll face
- Polymer bands laid in grooves, raised above surface
- Must be mounted as dead shaft idler or driven roll
- Wrap angle ranges from 90° to 180°
Expanding surface spreader rolls – polymer band type

**POLYMER BAND TYPE EXPANDING SURFACE SPREADER ROLL**

- **Expand side of polymer bands**
- **Roll face with longitudinal grooves to house polymer bands**
- **Contracted side of polymer bands**
- **Adjustable angle end cap (clamps end of polymer bands)**
  - Journals must be fixed, this roll must be a dead shaft idler.
- **Polymer bands stretch toward the roll ends (web on)**
- **End view end cap not shown for clarity**
- **Web must exit the roll prior to band relaxation**
- **Polymer bands relax toward the roll center (web off)**
- **Typical web wrap**
- **Web must exit where slats are farthest from the center**
Expanding surface spreader rolls – polymer band type – advantages

- Aggressive in removing wrinkles
- Linear face keeps tension constant
- Will not distort or tear center or edges of web
- Amount of spreading is adjustable
- Used with all types of webs
Expanding surface spreader rolls – polymer band type – disadvantages

• Can cause webs to be marked, scratched or deformed
• Possible wrinkles from raised surface
• Polymer bands wear out over time
Expanding surface spreader rolls – continuous rubber sleeve type

- Must be incorporated as a dead shaft idler roll
- Stretching action of rubber sleeve spreads web
- Wrap angle ranges from 90° to 180°
- More wrap means more spreading
Expanding surface spreader rolls – continuous rubber sleeve type

**EXPANDING SURFACE TYPE SPREADER ROLL UTILIZING A CONTINUOUS RUBBER SLEEVE**

- **Expanded side of continuous rubber sleeve**
- **Contracted side of continuous rubber sleeve**
- **Clamping end collar**
- **Mounting block**
- **Center shaft**
- **Adjusting screw and flange for spread adjustment**

*Figure 28*
Expanding surface spreader rolls – rubber sleeve type – advantages

• Aggressive in removing wrinkles
• Spreading amount adjustable from 0% to 100%
• Spread adjustment can be made from either end of roll, while machine is running, with standard tools
• Tension evenly distributed across roll face
• Will not distort or tear center or edges of web
• Available with multitude of different sleeve compounds
• Will not mark, scratch or deform web
• Used with all types of webs
Expanding surface spreader rolls – rubber sleeve type – disadvantages

- Web speeds are a consideration
- Rubber sleeve will degrade over time
- Spreading is not even in measured increments across face of roll
The future of spreader roll technology

Industry will need to continuously strive to make new advances to supply converters with products and service that meet their needs
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