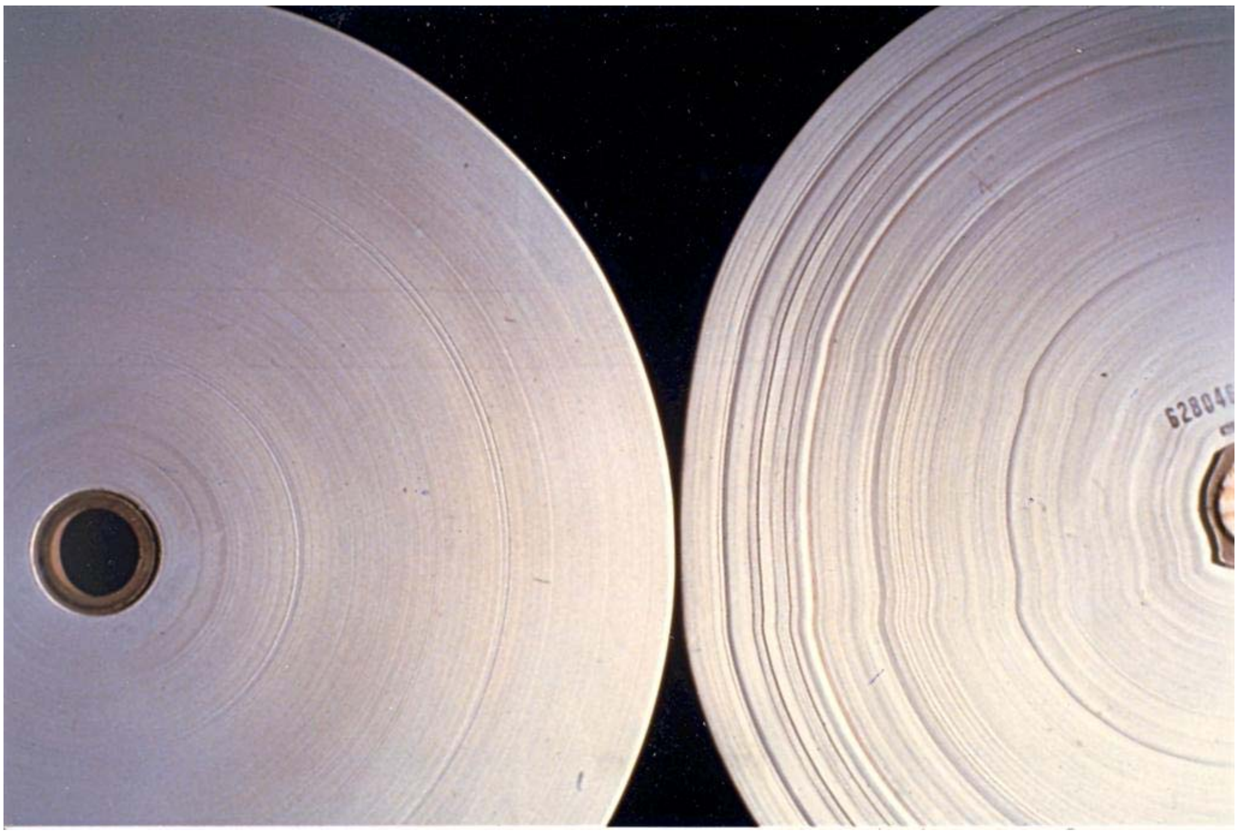
THE ART OF WINDING GOOD ROLLS



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THE ART OF WINDING GOOD ROLLS

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What is a good roll? Any baker will tell you that in making a good roll it must be of the right shape, the right size, the right consistency - not too hard and not too soft, it must look good - no blemishes or visual defects, and it must have a good aroma.

A slitter winder operator will tell you that a good roll of paper is one that:

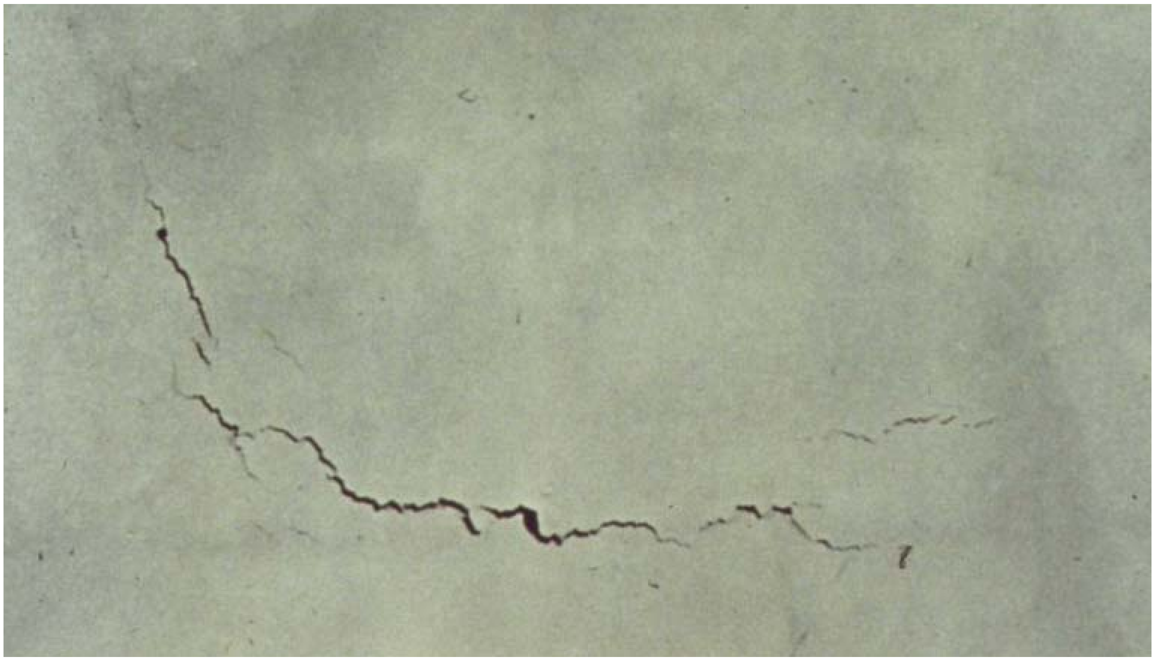
Is the right shape	**- Round and proper width**
Is the right size	**- Not too big or small**
Is of the right consistency	**- Not too hard or soft**
It must look good	**- No blemished or visual defects**
Aroma?	**- Well, start shipping your Customers bad rolls and they are going to Raise a Stink**

Your customers demand a roll that will run without problems. Most will tell you that, if a roll of material looks and feels good, then it will run without problems. It is a well known fact that you can't make paper or other products on the slitter winder. Still, it is every winder operator's job to insure that the web defects are not amplified or made worse during the slitting and rewinding operation. The purpose of this paper will be to discuss the factors that go into the consistent production of top quality rolls off a slitting and rewinding operation. This article will be centered around roll hardness and visual defects and how they can be controlled for consistently rewinding good rolls.

Roll Hardness

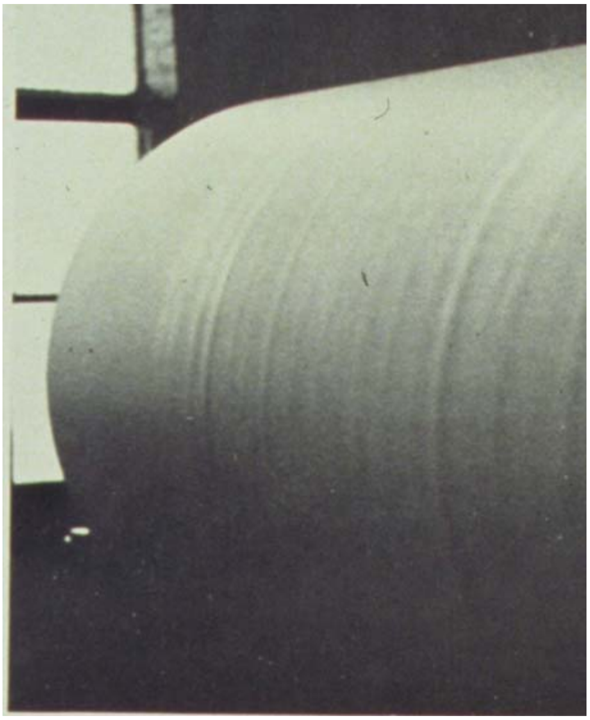
Roll density or hardness is probably the most important factor in determining the difference between a good and bad roll. Rolls that are wound too soft will go out of round while winding or will go out of round when they are handled or stored. The roundness of rolls is very important in your customer's operation. When unwinding out of round rolls, each revolution will produce a tight and slack tension wave. These tension variations can distort the web and cause register variations in the process. The only way to minimize the affect of these tension variations is to run the operation at a much lower speed, which greatly affects the production of the process. Rolls that are wound too tight will also cause problems. Tightly wound rolls contain high inwound tension.

These rolls can split open like a watermelon when dropped or squeezed by a roll handling truck. The web will stretch and deform as these stresses are relieved as the roll cures during storage. If this inwound tension becomes too high, bursts can occur inside the wound roll. These cross machine tension bursts are normally well hidden and can not be detected until the roll is unwound. These bursts cause web breaks which cause major production losses on your customer's production lines.



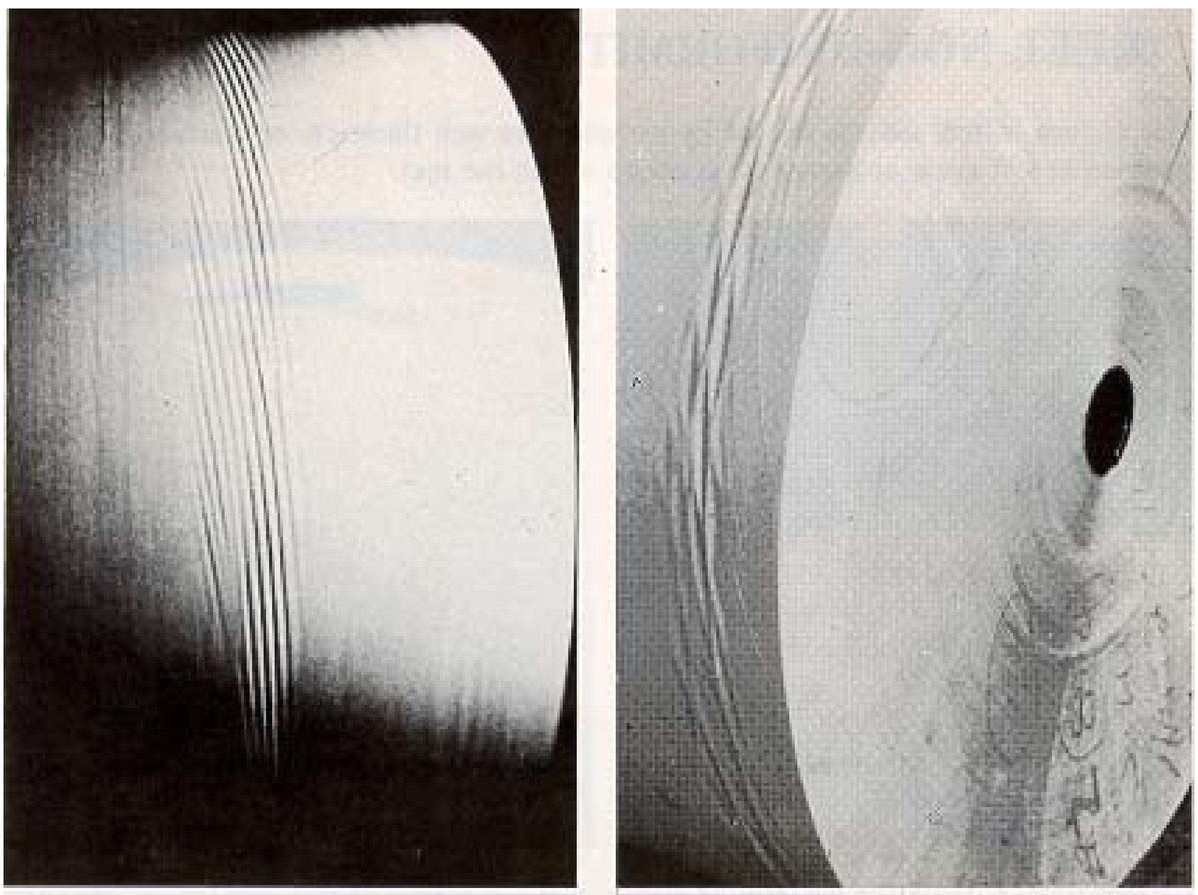
Cross Machine Tension Burst

Since there is no such thing as a perfect web, it is the responsibility of the winder operator to make sure that these slight imperfections do not stand out in appearance and do not cause their customers process problems. Rolls that are wound too tightly will exaggerate web defects. No web is perfectly flat or the same thickness from one side to the other. Typically webs will have a slight high and low areas in the cross machine profile where the web is thicker or thinner. If the rolls are wound too hard then the web will stretch over these thicker areas causing bumps or ridges. As the web is stretched over these ridges, it deforms in these areas. This causes untensioned areas or baggy paper when the roll is unwound. There may also be moisture streaks where the web is higher in moisture in localized areas across the web. These moisture bands will cause web defects know as corrugations or rope marks in rolls which are wound too tight. Ridges and corrugations cause the customer process problems such as poor registration on a printing line.



Ridges in a Roll

Baggy Paper



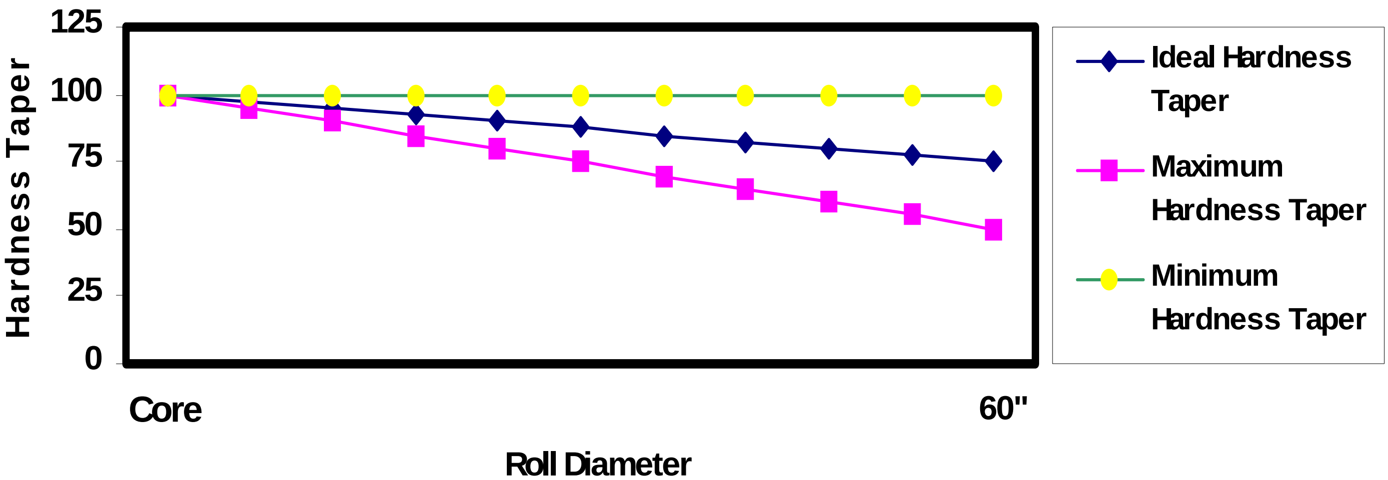
Corrugations or Rope Marks

These slight defects will not be noticeable in a wound roll if sufficient air is wound into the roll in the low or wet areas and the web is not stretched over the high areas. Still the rolls must be wound hard enough that they will be round and will stay that way during handling and storage.

Some webs, either by their formation process or by their coating or web conditioning process, have cross machine variations of thickness or moisture too severe to be wound without exaggerating these defects. To overcome this, these webs are moved back and forth before they are slit. This is called oscillation, which randomizes these localized defects across the wound rolls. On a slitter winder, the unwind is normally oscillated. Oscillation may be either a constant speed, stop and constant speed back or a sin type wave speed curve. What is important is that the oscillation speed is fast enough to randomize defects and slow enough that it does not strain or wrinkle the web and that the rolls after they have been slit are wound with straight edges. The rule of thumb for the maximum oscillation speed is 1” per minute per 500 feet per minute winding speed. For best results, the oscillation speed should vary proportional to the winding speed.

How to Achieve and Measure Roll Hardness

Now we know why roll hardness is important. Next let’s discuss how to achieve and measure roll hardness. As a roll of web material winds, tension builds inside the roll which is known as inwound tension or residual stress. If these stresses becomes greater as the roll is wound, then the inner wraps towards the core will loosen. This is what causes the rolls to dish while winding or telescope when they are handled or when they are being unwound in your customer’s production operation. To prevent this, the rolls want to be wound tight at the core and then wound with less tightness as the roll builds in diameter as shown below. The larger the finished rewind diameters, the more critical the roll hardness profile is.



Roll hardness is developed in different ways on different types of winders but the basic principles of how to build roll hardness are always the same. To remember these principles, just remember that to consistently wind Dynamite Rolls you need T.N.T.

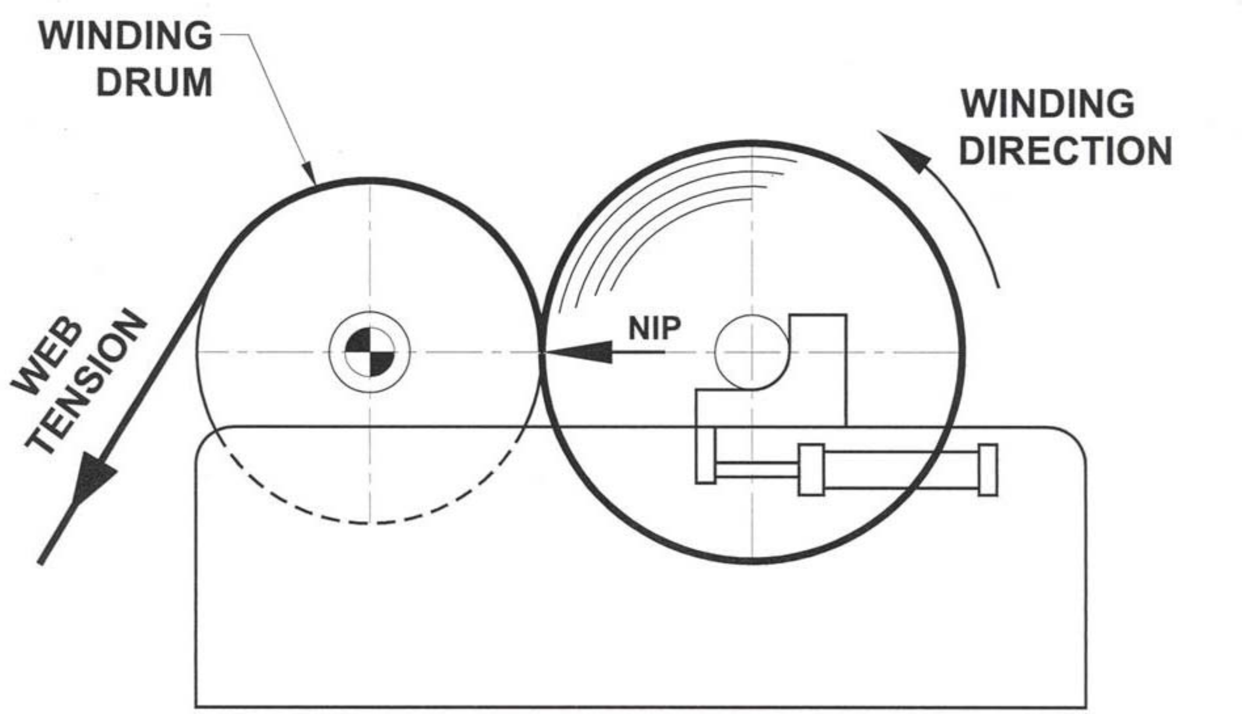
- **T ension - The Winding Web Tension**
- **N ip - The Nip of the Pressure Roll or Drum**
- **T orque - From the Center Drive or Torque Drum**

The three basic types of winders are:

1. **Center Winders**
2. **Surface Winders**
3. **Center/Surface Winders**

<u>Single Drum Surface Winders</u>

The Single Drum Surface Winders are the simplest and least expensive type of winders. As shown below in, these will use Web Tension and Nip. Because of the amount of wrap that is normally around the driven winder drum, web tension is isolated from the winding roll. On non-extensible products such as heavy board, web tension has little effect on roll hardness. Basically roll hardness is affected only by the control of the nip pressure. On extensible products such as extensible films and nonwovens, roll hardness is controlled through both web tension and nip.

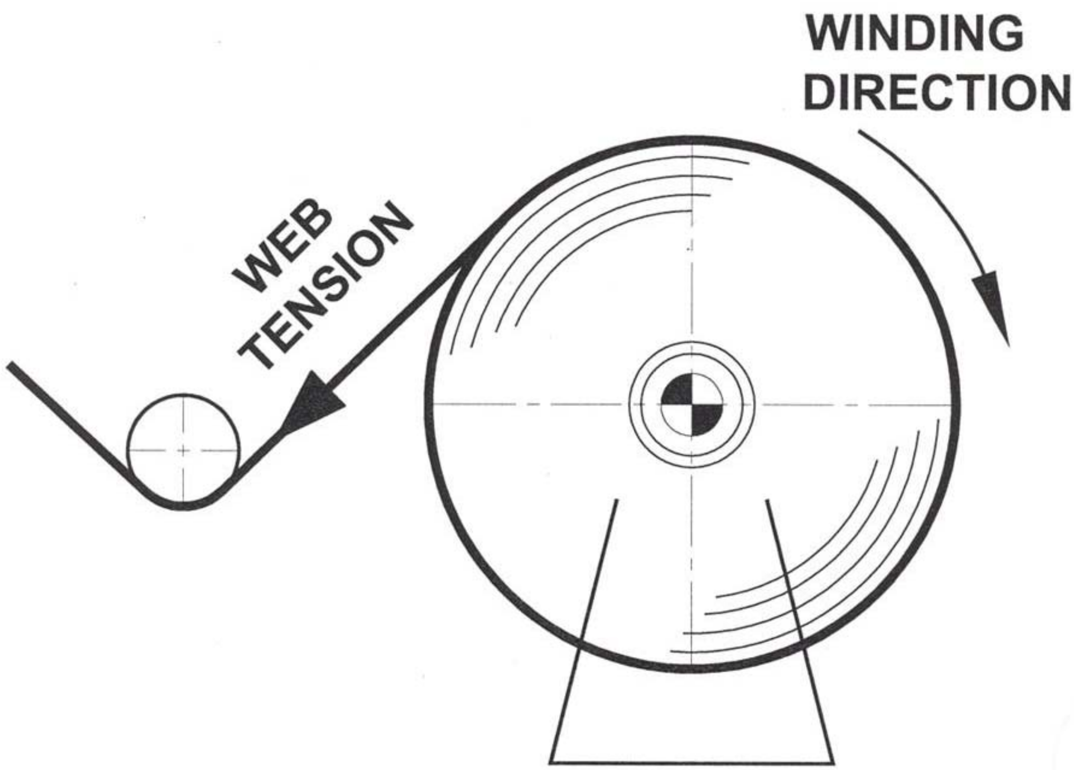


<u>Drum Type Surface Winder</u>

The advantage of this type of surface winder is that the roll's weight does not affect the amount of nip load. The disadvantage is that the Single Drum Surface Winder has limited control of roll density and must be a shafted operation. A single drum winder requires much less horsepower than a center winder and is normally used on as a continuous type winder for heavier grade products and extensible nonwovens.

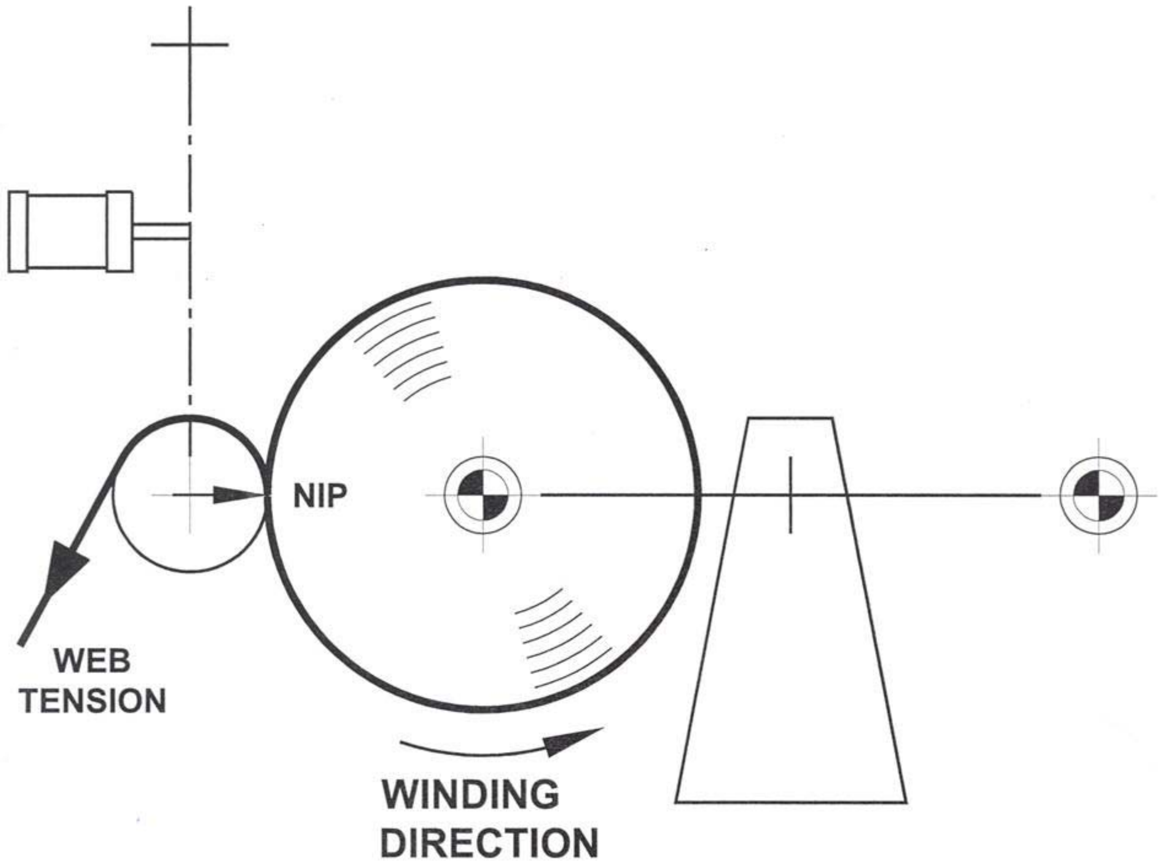
Pure Center Winders

Pure Center Winders use web tension or, when combined with a pressure roll, can use nip and web tension to control roll hardness as shown in below. Note that on this type of winder, torque produces web tension.



Single Position Pure Center Winder

A Pure Center Winder may be single position or continuous operation turret winder and may be a shafted or shaftless operation. Often this type of winder provides flexibility of gap or contact winding to control amount of air being wound into roll and roll hardness.



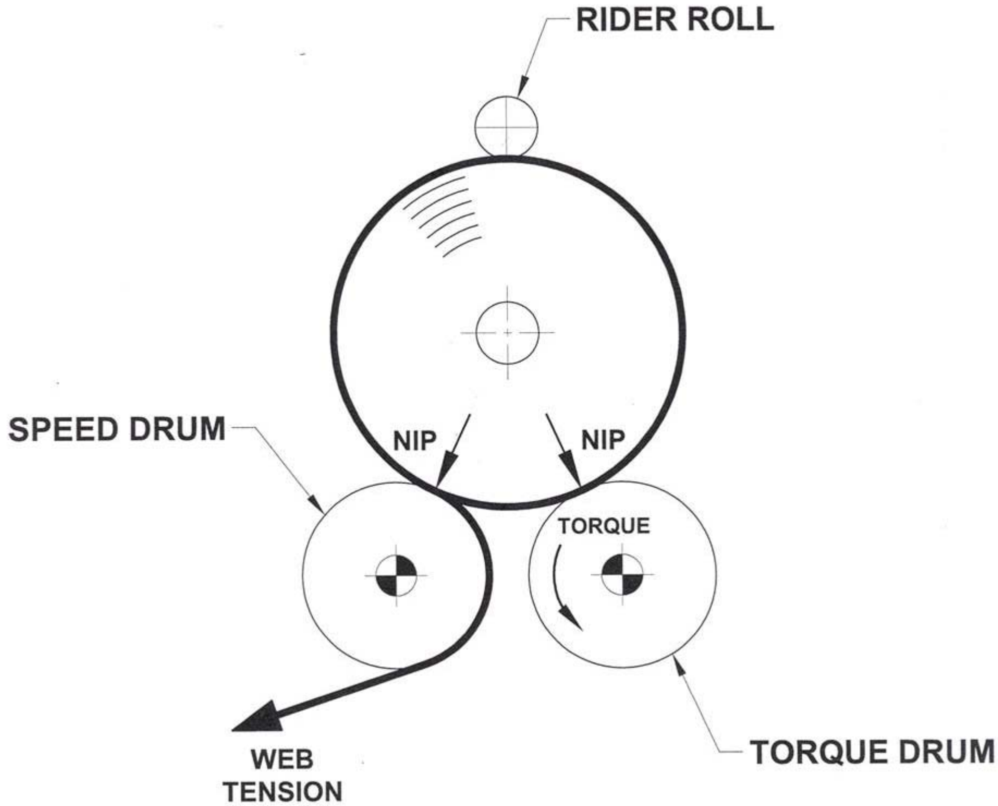
Continuous Turret Winder With Nip Roll

Pure Center Winders have the ability to wind softer rolls than a Single Drum Winder and have better inwound tension control. Still they only use one or two of the principles to control roll hardness.

Pure Center Winders are normally used on lighter grades which are wound at lighter tensions and to smaller roll diameters. They require much higher horsepower than Surface Winders as the tension horsepower needs to be multiplied by the ratio of the maximum speed at core to the maximum speed at full roll to obtain the horsepower required at the full roll.

Two Drum Surface Winders

Two Drum Surface Winders are normally used for stop/start slitting and rewinding operations and use all three principles for maximum control of roll hardness.



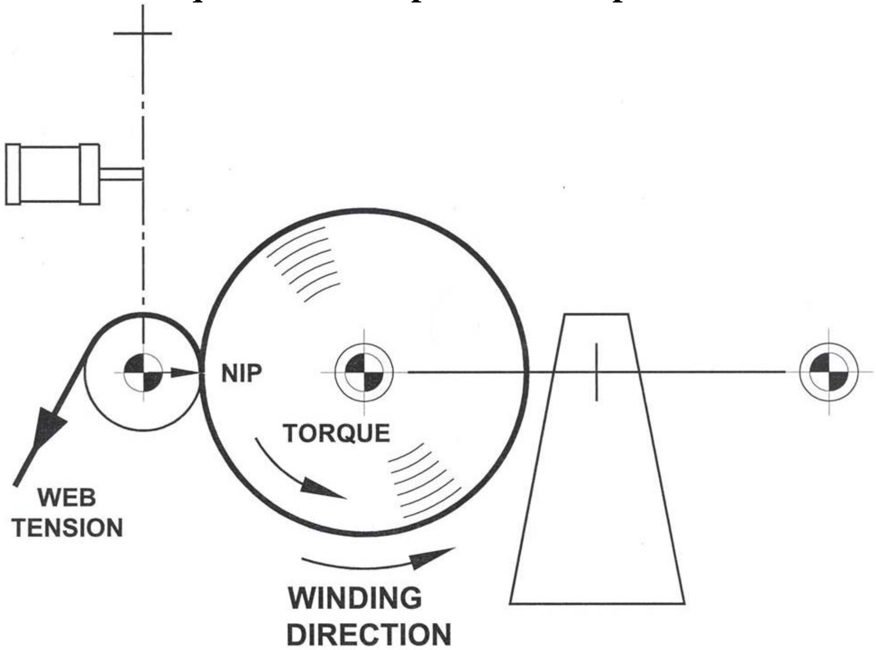
Two Drum Surface Winders

This type of winder normally has sufficient wrap on the drum that the web tension has little effect on the roll hardness when winding non-extensible grades. Roll hardness and profile are achieved by programmed nip control of the rider roll pressure and programmed torque control from the torque drum. Today these winders are normally shaftless operation and are high speed and very productive. The disadvantage is that this type of winder typically builds hard rolls as the winding roll's weight produces the winding nip. This requires high rider roll pressure at the start which is relieved proportional to the winding roll's weight as it winds. Programmed torque control is the most effective tool in controlling roll hardness which also requires a hard nip to transmit the torque into the roll without slippage.

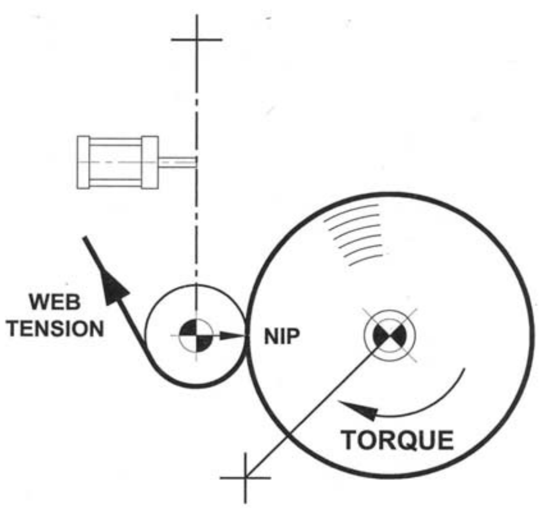
Two Drum Surface Winders are used as high speed slitter rewinders for light density grades such as nonwovens or heavier paper, board or laminate grades that can tolerate being wound hard.

Center/Surface Winders

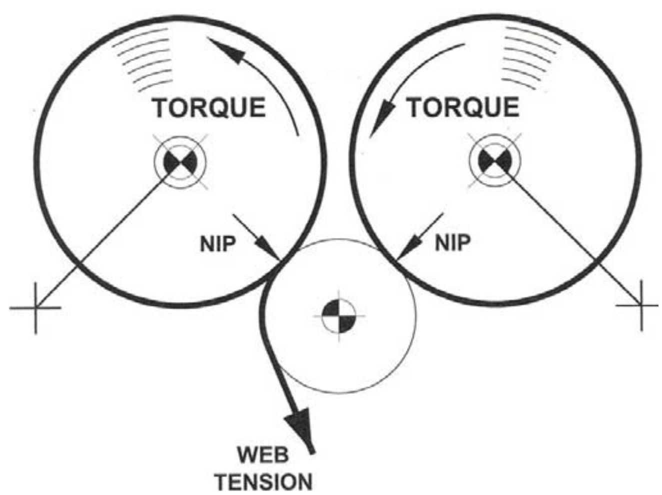
The Center/Surface type winders used all three principles in controlling roll hardness and may either be configured in a continuous turret type winder or a center/surface single shaft "simplex" or dual shaft "duplex" type slitter winder. The surface drive produces the web tension while the nip pressure of the pressure roll and the torque from the spindle drive produces the roll hardness.



Continuous Center/Surface Turret Winder



Simplex Center/Surface Rewinder



Duplex Center/Surface Rewinder

By programming these nips and torques, the desired roll hardness and profile can be achieved. The nip can be controlled independent of the roll's weight. The disadvantage of winders of this type is the cost, complexity, & lower production due to the shafts required when slitting and rewinding.

Measuring Roll Hardness

The setting and programming of the tension, nip and torque to produce the desired roll hardness will vary depending on:

a) **The type and design of the winder**
b) **The type of web material being wound**
c) **Width of the rolls being wound**
d) **The speed of the winding operation**

Different web products and different applications for these products will dictate the roll hardness desired. Once the desired roll hardness profile is determined, it needs to be measured and then reproduced on a consistent basis. The measurement tools need to be hand held and available on the winder so an operator can check roll hardness being obtained and make adjustments accordingly to insure that the roll hardness is within the acceptable range for that product.

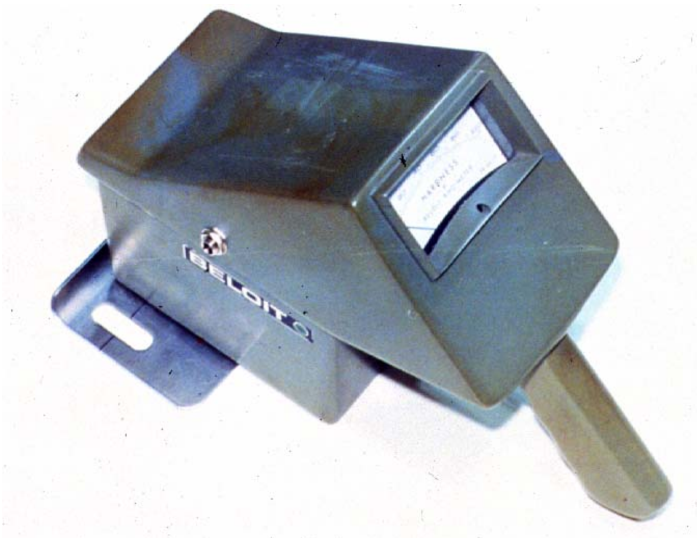
To measure the roll hardness across the outer surface of the roll, it is suggested that either a Rhometer or a PAROtester be used. Both of these are impact based devices for measuring relative roll hardness on a relative scale. The Rhometer is an instrument that measures the peak deceleration of a small hammer as it strikes the outer surface of the roll. The PAROtester is similar to the Schmidt hammer. The Schmidt Hammer was developed for concrete hardness testing and has been borrowed for use of roll hardness testing. The PAROtester has developed specifically for evaluation of hardness of rolled-up paper, foils and films. The PAROtester is considerably more sensitive, has less impact energy and is less operator dependant due to its more defined direction of impact then the Schmidt hammer.

A Smith meter is an instrument that can be used to measure the hardness profile from the core to the outer wraps of the roll. The Smith meter measures the penetration of a small needle as it is inserted in the wraps of the web along the roll's sides.

With the computerized data acquisition systems now available such as the Black Clawson AccuWind systems, it is now possible to calculate the Roll Density Factor (RDF) and plot the relative roll density from core to full roll as

the roll winds. These systems compare the actual winding roll's diameter with the theoretical diameter and plot the ratio as a function of the winding roll's diameter. The RDF is displayed to the operator on the Operator Interface Terminal (OIT) at the winder as shown below.

The operator needs to have a means to measure the roll hardness from both core to full roll and across the roll available on the winder.



Rhometer **PAROtester**

Hardness Devices for Measuring Roll Hardness Across Roll

Smith Needle **AccuWind Roll Density Curve**

Hardness Devices for Measuring Roll Hardness From Core to Full Roll

<u>Visual Roll Defects</u>

So far, we have concentrated on the importance of roll hardness and how it is produced and measured. We have discussed roll defects that are caused by roll hardness which are:

Out of Round Rolls
Internal Web Bursts
Ridges
Baggy Paper
Corrugations or Rope Marks

Now let's turn to other visual defects that need to be avoided in order to consistently wind good rolls. These defects include:

Poor Starts
Core Offsets
Splices
Offsets and Interweaving
Dished and Telescoped Rolls
Starred Rolls
Trim Wound In Rolls
Slitter Rings
Other Slitter Defects such as:
- **Excessive Slitter Dust**
- **Nicked Blades**
- **Scalloped Edges**
- **High Edges**

<u>Poor Starts</u>

Poor starts are defined when there is obvious differences in appearance between the paper near the core and the remainder of the roll.

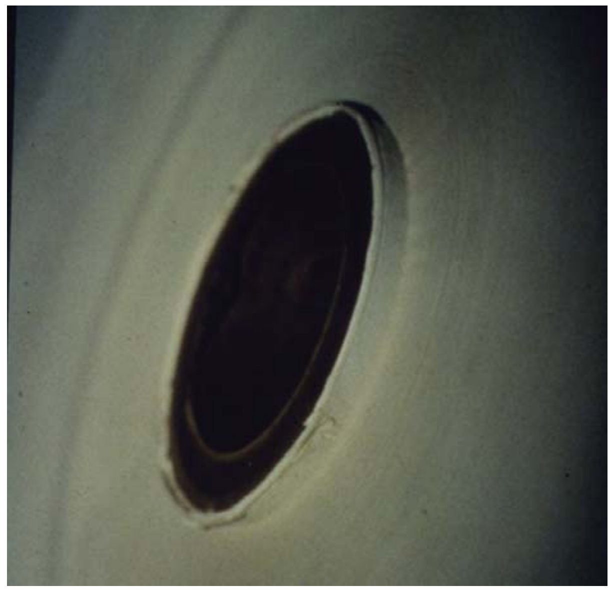
Causes of Poor Starts:

a) Starting to wind with slack in the web
b) Web wrinkling at the start of the wind
c) Poor quality cores
d) Loose winding near the core

Poor Start Remedies:

a) **Tighten web before fastening to core**
b) **Start with web straight on cores**
c) **Use good quality, properly stored cores**
d) **Start with proper tension, nip and/or torque**

Poor Start



Core Offset

Core Offsets

Core offsets is defined when the cores extend inside or out of the sides of the rolls.

Causes of Core Defects:

a) **Cores not aligned with slit webs**
b) **Web not securely fastened to the core**

Core Slips Remedies:

a) **Be sure cores are aligned with slitters**
b) **Securely retain cores and fasten webs securely to the cores**

Splices

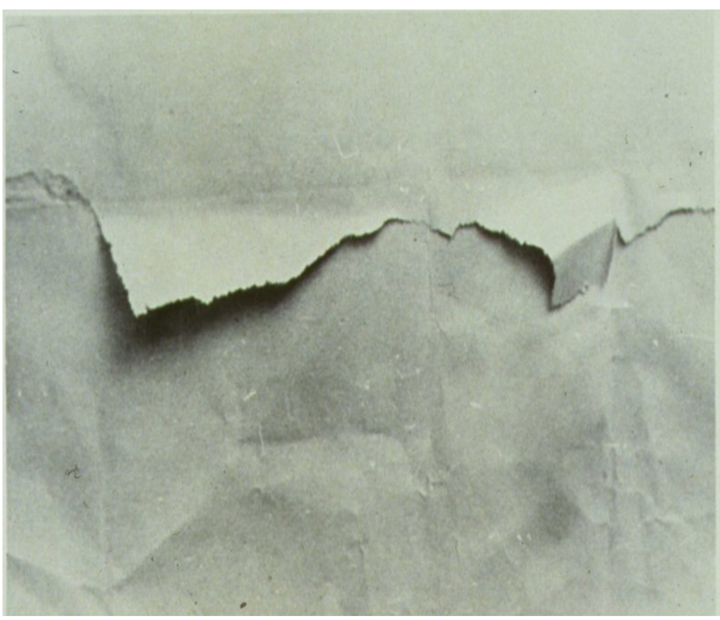
Splices in a roll are necessary evils. Splices are normally due to web breaks or cutting out defective material in a parent roll. Most customers will allow up to 3 splices in a roll of wound material but will not allow rolls with splices near the core or near the full roll. They also insist that splices be properly made and properly marked. Bad rolls contain numerous splices or poorly made splices or contain unmarked splices.

Causes of Splices:

a) Poor product in parent roll
b) Web breaks

Splice Remedies:

a) Reduce bad material in parent roll to a minimum
b) Determine if web breaks are due to defects in material or winder and correct problem



Poor Splice

Web Offsets

Offsets and Interweaving

Offsets are defined as an abrupt change in the position of the edge of the web.

Causes of offsets:

a) **Shifts in the core shaft or cores**
b) **oscillation speed too fast**
c) **Quick change in web tension**
d) **Quick change in nip load**
e) **Web slippage inside of the roll**

Offset Remedies:

a) **Be sure that core shaft and cores are securely retained**
b) **Check oscillation speed relative to web speed or binding in oscillation mechanism**
c) **Correct abrupt changes in speed or tension**
d) **Check for binding or other reasons for abrupt changes in nip load**
e) **Do not increase Tension, Nip or Torque during the winding operation**

Interweaving is often caused by severe offsets in the rolls that are wound side by side on a winder. In addition to the above causes, interweaving may also be caused by improper spreader device adjustment, too low of winding tension, or uneven cross machine web tension.

Dished and Telescoped Rolls

Dished rolls are defined as rolls which are wound with progressive edge misalignment that may be convex or concave. Dished rolls are ones that this curvature occurs while the rolls are winding. Telescoped rolls are rolls that this curvature occurs while handling or unwinding the rolls of web material.

Causes of Roll Dishing:

a) **Cores that are not held stationary during winding**
b) **Winding "soft" and then winding tighter at the outer wraps**
c) **Misalignment causing the web to enter the winding roll non-parallel to the core axis**

Remedies of Winding Dished Rolls:

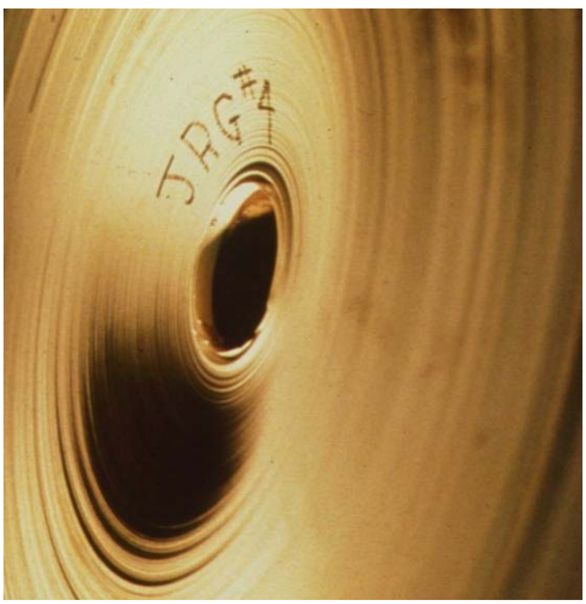
a) **Make sure cores are firmly retained during winding**
b) **Achieve a good, hard start at the core**
c) **Insure the roll hardness does not increase during winding**
d) **Check for machine misalignment**

Causes of Roll Telescoping:

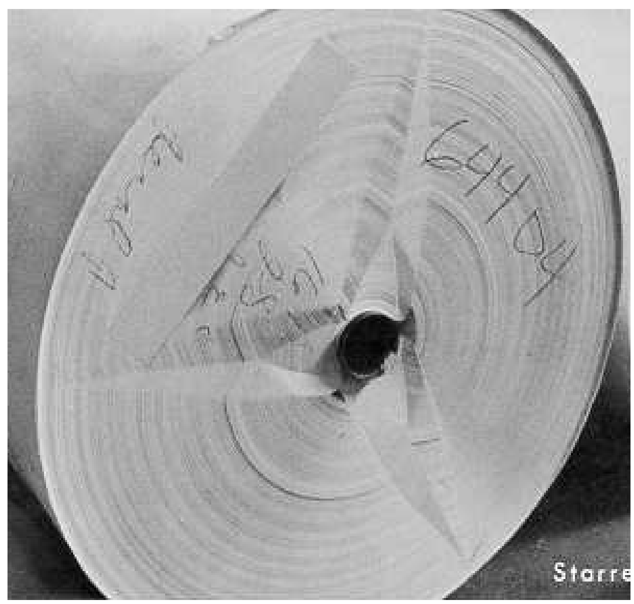
a) **Soft start of winding**
b) **Winding a soft roll**
c) **Unwinding at higher tension than the roll was wound**

Remedies of Roll Telescoping:

a) **Wind tighter rolls with a good, hard start and decreasing roll hardness**
b) **Unwind with less tension**



Dished Roll



Starred Roll

Starred Rolls

Starred rolls are defined as rolls in which the ends have a star pattern due to the shifting of the layers of web in localized bands starting at or near the core and continuing out towards the outer wraps. These localized shifts cause a star pattern which is symmetrical but frequently one or more rays of the star are missing.

Causes of Starred Rolls:

a) **Winding Tight wraps after a roll has been loosely wound**
b) **Thin web thickness on the end of a roll causing a soft edge**
c) **Severe impact of a wound roll**

Remedies of Starred Rolls:

a) **Wind tight at the start and then gradually soften roll hardness as diameter increases**
b) **Keep cross caliper variation to a minimum**
c) **Oscillate before slitting**
d) **Provide for proper handling and transporting of rolls**

Trim Wound In Rolls

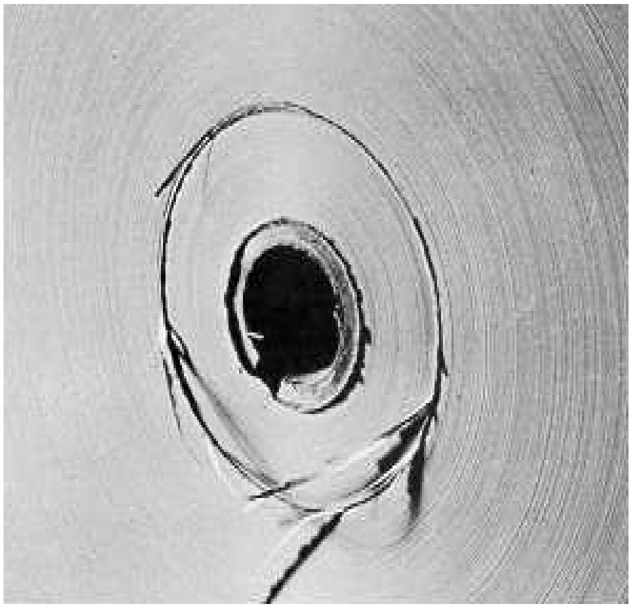
Trim wound in rolls is caused when the winder trim is not collected into the trim removal system and follows the web into the winding roll.

Causes of Trim Wound In Rolls:

a) **Insufficient air velocity at trim nozzle**
b) **Turbulent air flow in the trim removal system**
c) **Web offsets in parent roll greater than trim width**

Remedies of Trim Wound In Rolls:

a) **Check to insure the air velocity at intake of trim removal system is greater than winding speed**
b) **Check to insure laminator air flow at trim nozzles**
c) **Edge guide unwinding roll or be sure that offsets are not greater than trim width**



Trim Wound in Roll

Slitter Rings

Slitter Rings

Slitter rings are defined as concentric ring patterns on the eges of the roll that give the roll edge the appearance of a target. This defect is very common on winders with mandrel mounted bottom knives after the mandrel has been reground on or more times.

Causes of Slitter Rings:

a) Excessive slitter run out
b) Wobble of bottom knife rings
c) Poor fit of bottom knives on mandrel

Remedies of Slitter Rings:

a) Insure that run out of bottom knives after grinding does not exceed the thickness of the webs
b) Check to be sure that bottom knives have a close sliding fit with mandrel
c) On individually driven bottom knives, check run out of drive shafts

Other Slitter Defects

Listed below are our common roll defects caused by slitters:

a) <u>Slitter Dust</u> - Excessive slitter dust is caused by dull slitter blades, excessive overspeed of bottom knifes and/or worn slitter bearings.

b) <u>Nicked Blades</u> - Nicked blades cause roll edges to have small and very short pieces of web protruding from the smooth roll edge. Nicked blades are commonly caused by engaging top blades on top of bottom knives or improper storing or handling of the slitter knives.

c) <u>Scalloped Edges</u> - Scalloped edges are defined as rolls in which the slit web width increases and decreases during the winding process. This is normally caused by excessive slitter run out, insufficient side pressure on shear slitters or slitters that are not securely retained during the slitting process.

d) <u>High Edges</u> - High edges are defined as a slitting defect which results in the edges of the slit rolls flared up. This defect is common when razor type slitting is used and is caused by dull razor slitters. It is corrected by replacing the razor knives or by moving the razor to obtain a new cutting point on the blade. This defect can be minimized by oscillating the razor blade to vary the cutting point on the blade during winding.

In Conclusion

Winding good rolls is the challenge that every slitter winder operator faces. Consistently winding good rolls depends on the consistency of bringing good material to the slitting and rewinding operation. A winder operator's job is not to camouflage poor quality web products into shippable rolls. His or her responsibility is to handle webs with slight imperfections and to produce quality rolls that will run without problems on your customer's process and produce high quality products for their customers. I hope that the information presented will help in meeting this challenge.

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