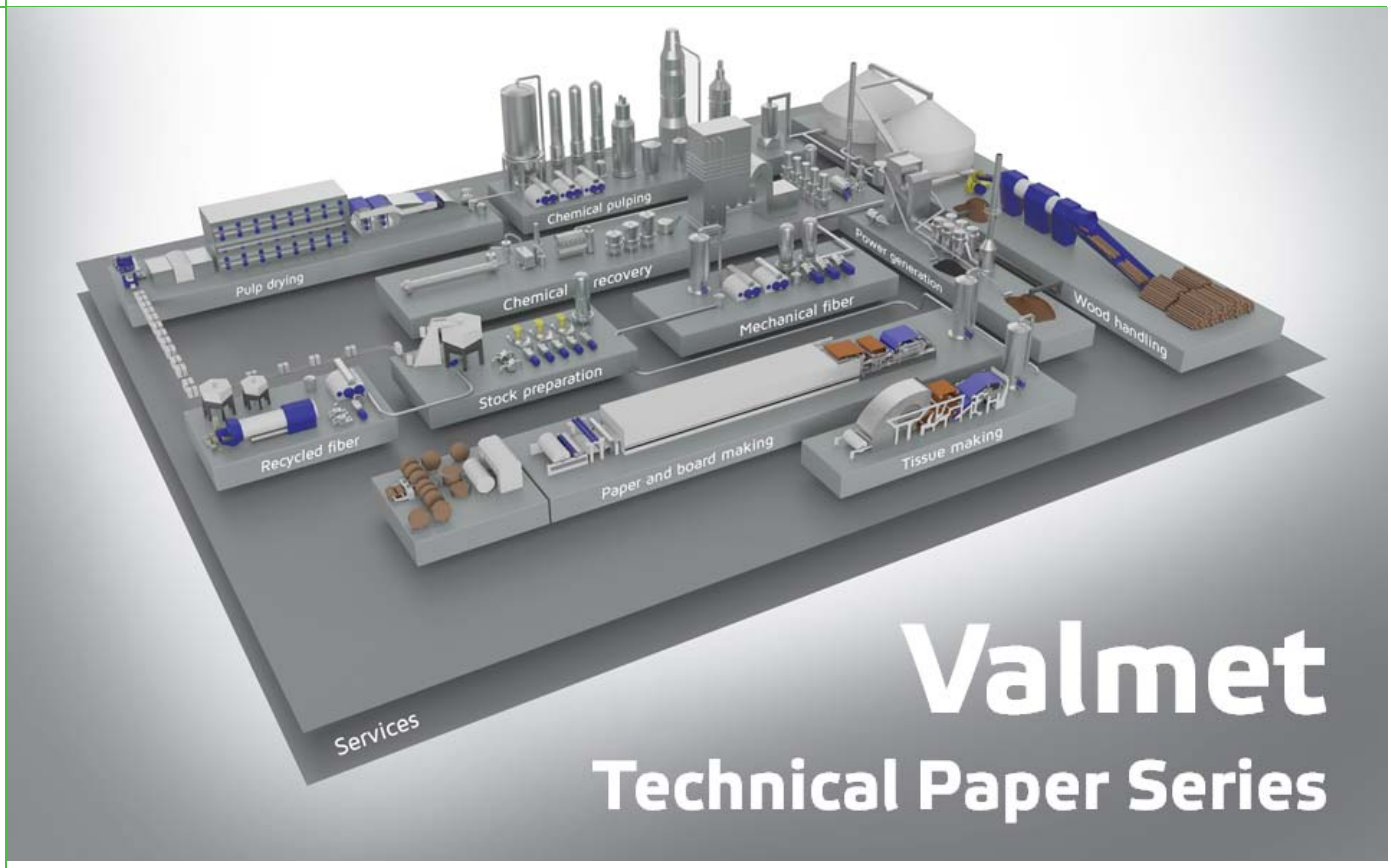


Advanced Belt Winding for Tissue

Executive Summary

The performance of a high-speed tissue machine depends greatly on the performance of the dry end. At the dry end, the sheet is transferred from the creping blade to the winding nip on the reel. There are different demands on the dry end and equipment used depending on the type of tissue being produced on the machine.

Valmet offers a wide range of different reel types; the latest of these is the Advantage™ SoftReel B which winds the tissue roll on a belt.

Winding on the belt results in gentler winding, improving the control of the winding process and enabling production of large diameter parent rolls while keeping a uniform caliper throughout the entire roll. The belt together with blow boxes also improves sheet control before the winding nip and reduces the length of free sheet draw in the dry end.

Advantage SoftReel B is a valuable tool for producing and preserving high quality tissue paper properties such as high bulk, softness and caliper, while minimizing broke and improving the production efficiency of converting operations. This gives a competitive advantage to premium tissue and towel producers.

Introduction

The performance of a high-speed tissue machine depends greatly on the performance of the dry end. At the dry end, the sheet is transferred from the creping blade to the winding nip on the reel. There are different demands on the dry end and equipment used depending on the type of tissue being produced on the machine.

A prerequisite for efficient operation is production of paper of the correct properties on the tissue machine. Another is passing these properties on to the converted end product. It is a known fact that the more delicate the tissue properties are, such as high softness, bulk and low tensile strength, the more difficult they are to produce efficiently.

Valmet has developed multiple types of reels for producing various types of tissue at different machine speeds. The Advantage SoftReel B employs a completely new tissue winding technology and is the new member of the reel family.

With Advantage SoftReel B, the B stands for Belt. In this new tissue winding technology, a belt replaces the reel drum found in conventional winding systems. Winding with a belt allows tissue makers a competitive advantage.

This innovative system gives producers and converters of premium tissue and towel grades a competitive edge in an industry where greater efficiency and minimum broke directly affect the productivity.

The challenges of winding premium quality tissue

Winding of tissue products at high speeds is challenging. The difficulty increases when running products of high bulk and low tensile strength. The initial winding on the reel spool and the control of the linear load are critical operations, which when performed properly, minimize waste on the roll.

Different types of reels offer tissue makers a wide range of options for producing various types of tissues at different machine speeds (**Figure 1**).

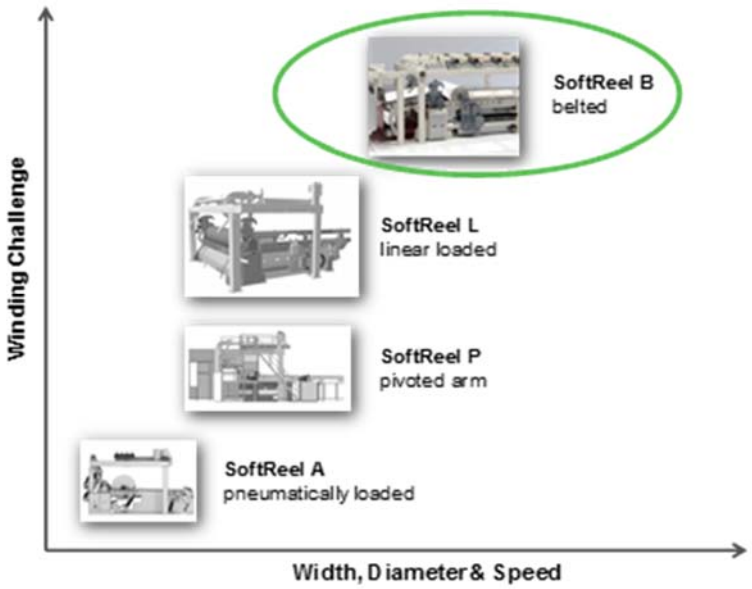


Figure 1. Valmet provides different reels for different winding challenges.

The standard reel for a dry crepe tissue machine is a reel with pivoting arm with a hydraulic loading system. The most advanced of the standard reels utilize a linear loading system with CWA (Center Wind Assistance). All of these reels are based on winding on the reel drum.

In recent years, the tissue industry has demanded improved control of the winding process to enable producing large diameter parent rolls while achieving uniform caliper throughout the whole roll. In response to this demand, Valmet developed a new reel, the belted reel, which is based on winding on a belt instead of the reel drum (**Figure 2**).

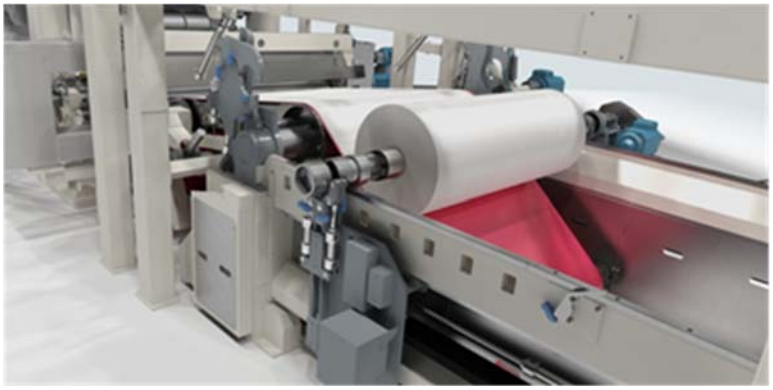


Figure 2. The Advantage SoftReel B for tissue incorporates a belted reel for gentle winding.

Winding principle

One of the benefits of the belted reel technology, compared to conventional winding, is the fact that it permits producing large parent rolls of uniform caliper throughout the roll (**Figure 3**). As mentioned earlier, replacing the reel drum in conventional winding systems with a belt is what makes the difference.

For the past 60 years, tissue paper and towel grades of low density and low tensile strength have been wound in the same way as "flat-grade" paper of high density and high tensile strength. That is to say both types of paper have been fed into a nip consisting of a reel drum and the parent roll.

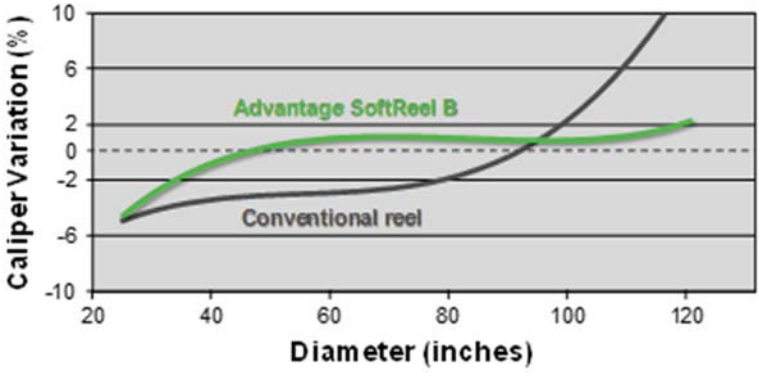


Figure 3. The belted reel provides more uniform winding during the winding process, preserving caliper throughout the roll.

The indentation caused by the nip load in the case of "flat-grade" paper of high density is small and tends not to vary much in size as the diameter of the parent roll increases. Consequently, these parent rolls can be wound with an acceptable uniform caliper throughout the roll (**Figure 4, next page**).

Using this conventional technology for winding premium tissue and towel grades does not produce the same good results as when winding high-density paper because the indentation caused by the nip load is larger than with high-density paper and becomes even larger as the diameter of the parent roll increases (**Figure 5, next page**).

When low-density paper such as tissue and towel grades are fed into a nip consisting of a reel drum and the parent roll, the length of contact, "A" of the parent roll being wound becomes longer as the diameter of the roll increases, making it difficult to control the wound-in tension in the roll. Consequently, these parent rolls are not of uniform caliper throughout the roll, which limits the diameter and the speed at which they can be wound, but also unwound in converting lines (**Figure 6, next page**).

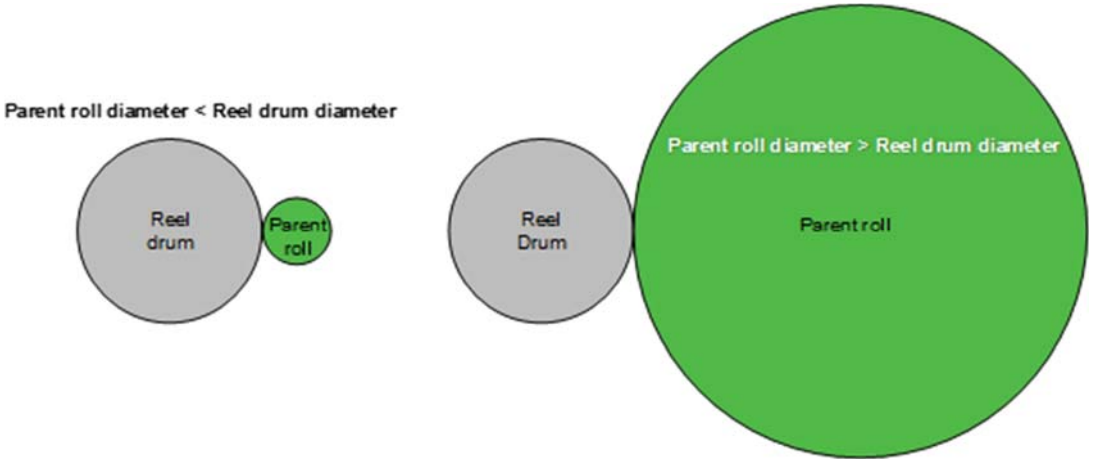


Figure 4. Winding high density paper on conventional winding system – little or no indentation.

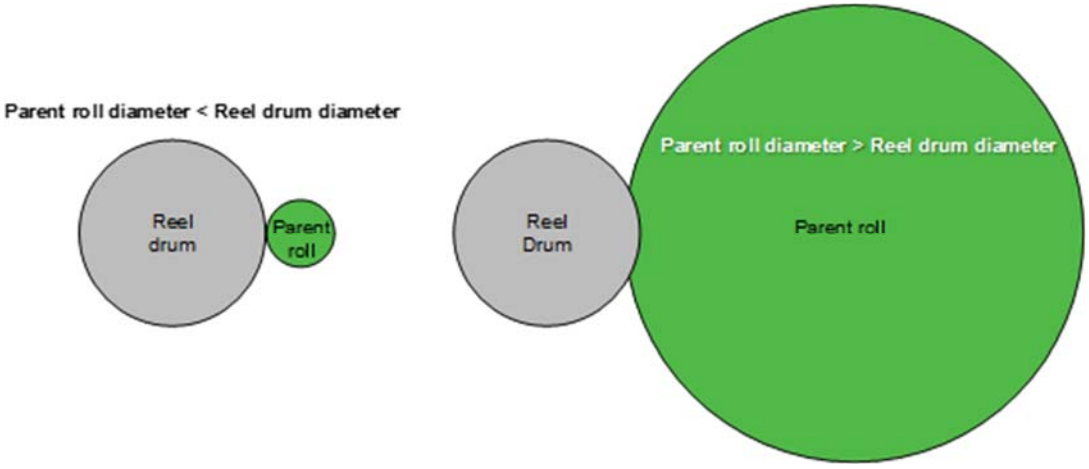


Figure 5. Winding low density paper such as tissue on conventional winding system - drum indents into parent roll.

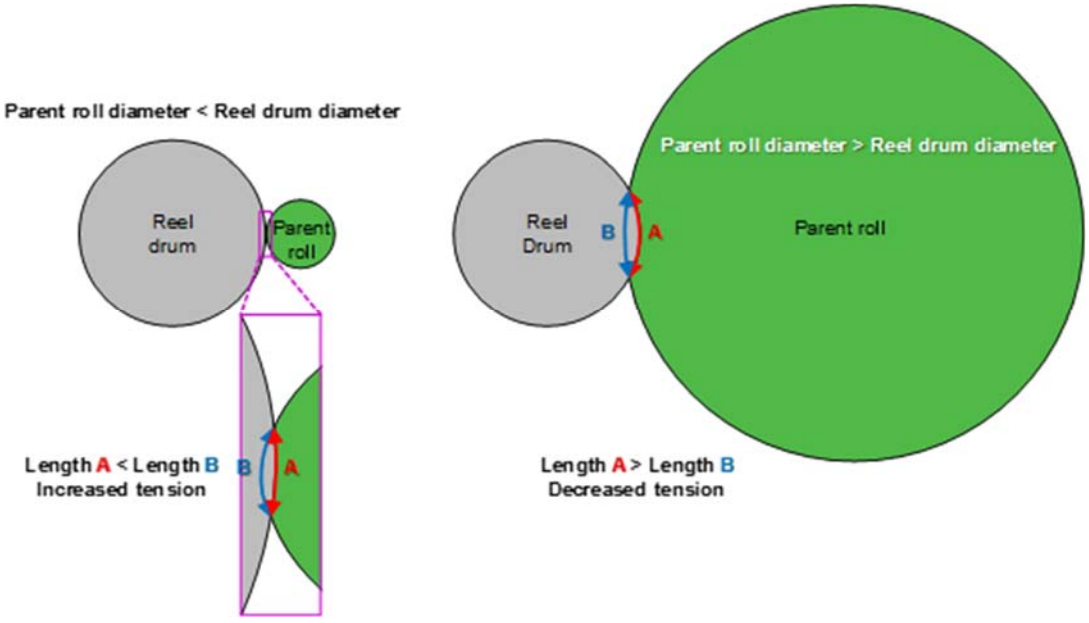


Figure 6. Geometry of indentation for low density paper. Tension decreases when roll is larger than reel drum.

How the belted reel works

Replacing the reel drum with a belt changes the physical nature of the nip. Instead of a round, hard-surfaced reel drum and parent roll, the belted reel technology enables the tissue and towel grades to meet a flat, soft-surfaced belt in the nip.

In other words, the length of contact **A** is always shorter than the arc **B** even as the diameter of the roll increases. When the tissue exits the nip the sheet is elongated and thus tension is generated inside the roll. The result is consistent control of the wound-in tension. And this is why the belted reel is able to produce uniform large parent rolls of premium tissue and towel grades – at high speeds (**Figure 7**).

The nip pressure against the belt is significantly lower than the nip pressure in a conventional reel. This reduction preserves the caliper of the sheet during winding. **Figure 8** compares the nip pressure for a conventional reel and the belted reel with a typical indentation setting.

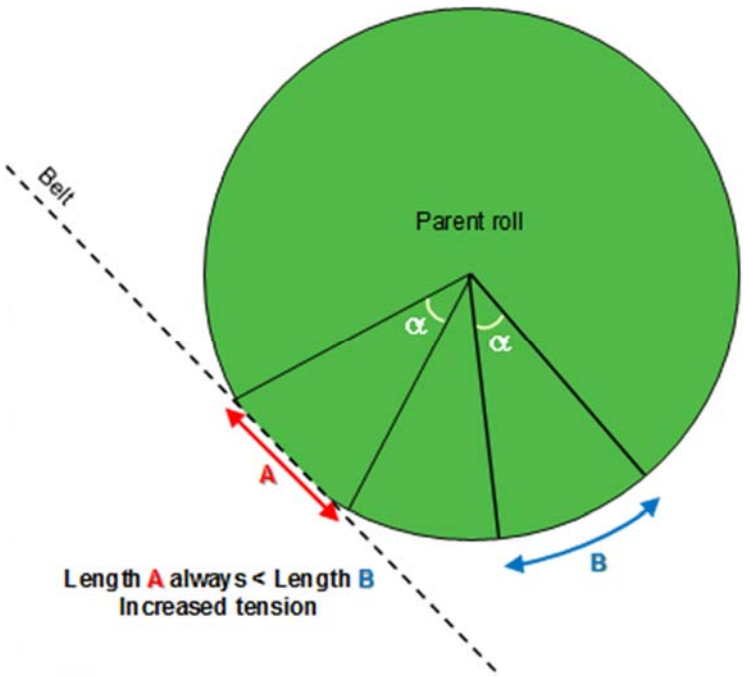


Figure 7. With belt winding A is always less than B, which results in increased wound-in tension throughout the roll.

A good start of a new roll

Using belted reel technology in the tissue machine reduces broke when threading and turning up tissue of low-tensile strength. Compared to conventional winding, its nip is soft and forgiving rather than hard and uncontrollable, which often causes sheet breaks at turnups and contributes to low operating machine efficiency. The belt nip is soft and it deflects if, for instance, the core surface is not perfect.

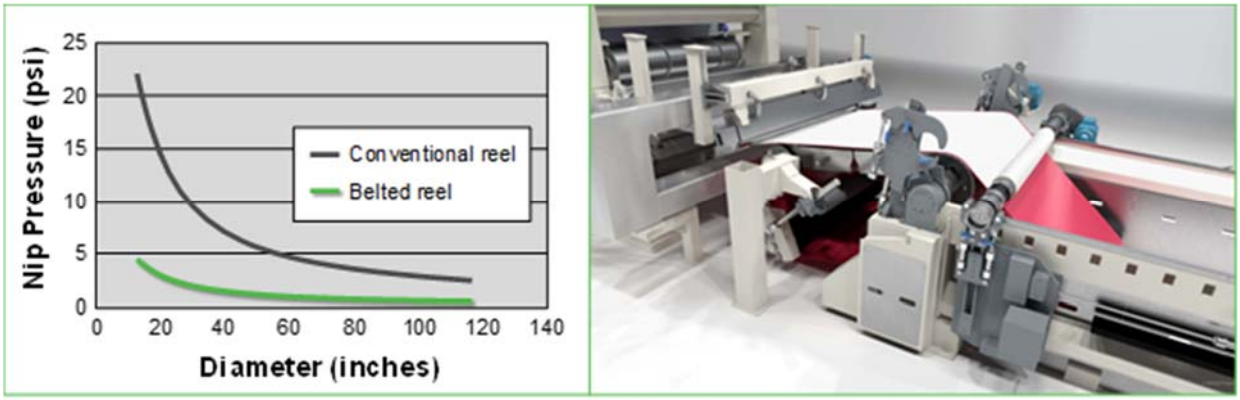


Figure 8. Nip pressure in a conventional reel vs. the belted reel. Belted winding provides a better start, with only 1/5 of the nip pressure required by conventional reels. Lower nip pressure preserves bulk.

The benefits of large parent rolls

The belted reel allows producing large parent rolls of minimal caliper variation throughout the roll. This means paper of consistent caliper is fed into the machines in converting operations, which translates into better control of these operations.

A converting plant that handles large diameter rolls enjoys greater efficiency than one handling smaller rolls. For example, the broke each parent roll generates decreases, which, of course, increases overall efficiency (**Figure 9**).

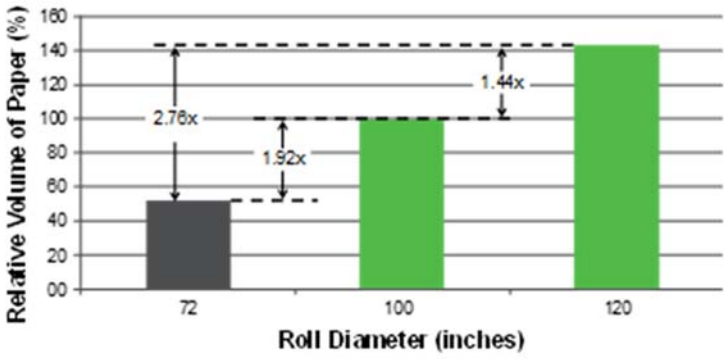


Figure 9. The relative volume of paper increases dramatically as the roll diameter increases.

If the diameter of the parent rolls produced on a tissue machine is increased from 100 to 120 inches, the amount of tissue paper on each parent roll will increase by 44% (1.44 times), and therefore larger rolls benefit not only tissue making but also converting operations.

Note: The belted reel is capable of winding up to 140" diameter with excellent winding result, but this large diameter would require special designs for buildings and roll handling, instead for the example shown in Figure 9 we have used 120" diameter for the comparison.

Less parent roll handling to converting plant

If a converting plant unwound 30,000 tpy of parent rolls in diameters of 120 inches (3000 mm) instead of 100 inches (2500 mm), it would unwind 30% fewer parent rolls, or approximately 6,000 fewer parent rolls each year would need handling leading to logistics savings (clamp truck costs, labor savings, etc.).

Waste/broke reduction

Each parent roll has two types of waste, strip waste generated by moving the parent reel and core waste which is the paper left on the core at the end of the reel. Depending on how the parent reel is moved and handled, strip waste can be anywhere between 0% (handled by an automatic guided vehicle) to 3-5% (handled by a clamp truck). Core waste is typically 2 to 3%. For a 30,000 tpy converting operation, reducing the number of rolls to be unwound each year by 30% means reducing the amount of strip and core waste by 600 tpy, or conversely 600 tons more of converted product.

Furthermore a more consistent wind throughout the parent roll means there is more useable paper towards the core which can reduce the core waste even further.

Reduction in the number of parent roll cores required

Every time a parent roll core goes through the tissue machine and converting process it suffers wear and tear. By decreasing the amount of parent roll handling by 30% there will be 30% less cycles on each parent roll core saving approximately 30% on replacement parent reel core costs per year. A typical 102 inch (2.5m) wide parent roll core cost is approximately $ 75/ core. In our example of 6000 fewer parent rolls a savings of 600 cores per year can be realized, assuming that a core can be reused 10 times (cycles).

Greater converting line productivity

Parent roll changes contribute between 5% to 12% time efficiency loss on a converting line. Larger diameter parent rolls will mean more running time between reel changes, driving uptime and productivity on the converting line. In our 30,000 tpy example, assuming it takes approximately five minutes to change a parent roll and there are 6,000 fewer parent roll changes per year, there will be an additional 500 hours of additional converting capacity or 1,760 tpy of converted product (**Figure 10**).

	Savings	Rolls/Cores	Tons/year	Saving/Gain $/year
Less parent roll handling	30%	-6000 rolls		
Broke reduction	30%		-600	
Core reduction	30%	-600 cores		
Increased efficiency			+1760	
Total savings and productivity gains				**$,$$$,$$$**

Figure 10. Worksheet for savings and gains achieved with belted reeling at a 30,000 tpy converting plant by unwinding 120" rather than 100" diameter parent rolls.

The benefits for converting operations of consistent caliper control during the winding process.

Minimizing caliper variation through a parent roll is critical for high-speed operation of a converting line. Caliper variation throughout a parent roll will cause converted product roll diameter and density to vary which in turn creates productivity issues.

Equipment such as log saws and high-speed wrappers are set to process rolls of a certain diameter. As the caliper decreases through a parent roll the converted product diameter can decrease and the rolls become soft causing issues at the log saws (long and short rolls) and wrappers (soft and loose packs).

Sometimes the quick fix is to add extra sheets to compensate for this problem which results in adding fibers and consequently adding unnecessary cost to each case of finished product.

The belted reel winding technique reduces this problem due to a more consistent caliper control during the winding process. On the next page we describe how this is achieved with an innovative and patented control strategy and measurement technique.

Mechanical design and control strategy

The belted reel builds on decades of reeling experience by using the same platform as a conventional reel (**Figure 11**).

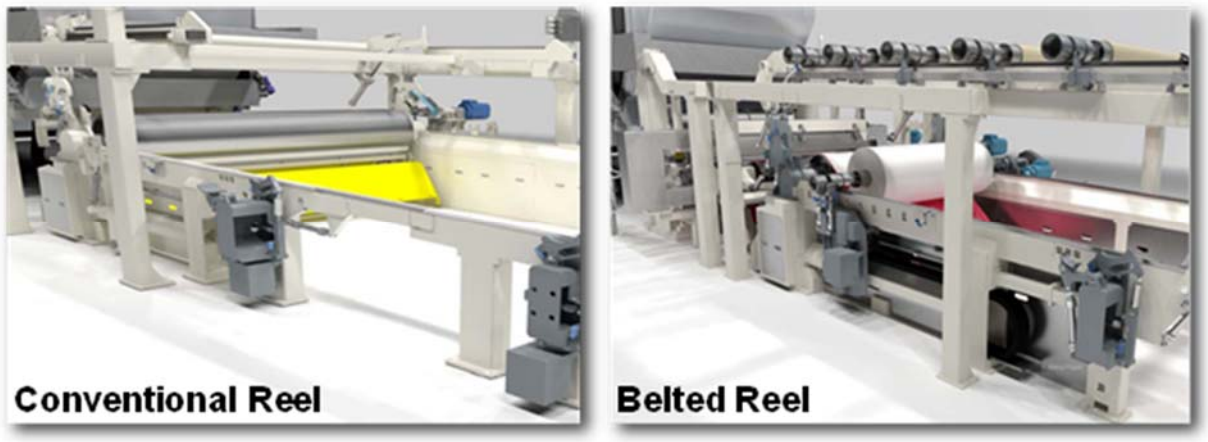


Figure 11. Belted vs. Conventional reel – both use the same mechanical platform.

The belted reel is equipped with linear primary arms and secondary carriages with a center wind assist, a short belt run with a stretcher and guide mechanism (**Figures 12 & 13**).

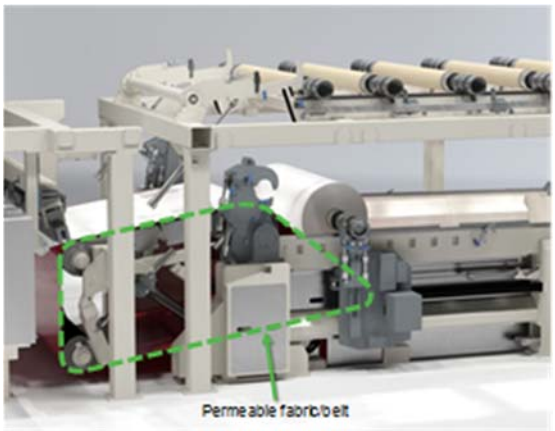


Figure 12. The belted reel design uses a permeable fabric/belt to support the winding parent roll throughout the building of the roll.

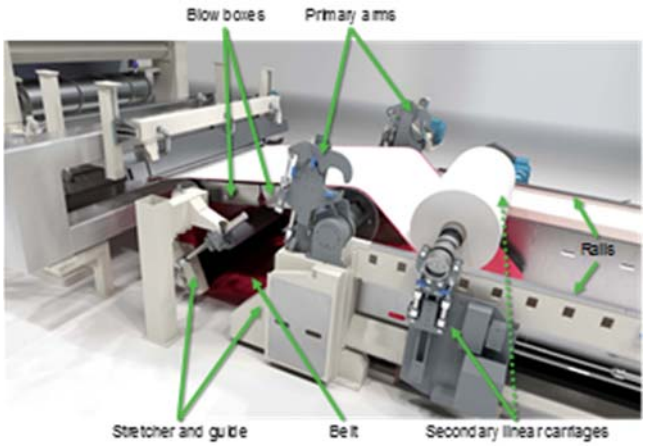
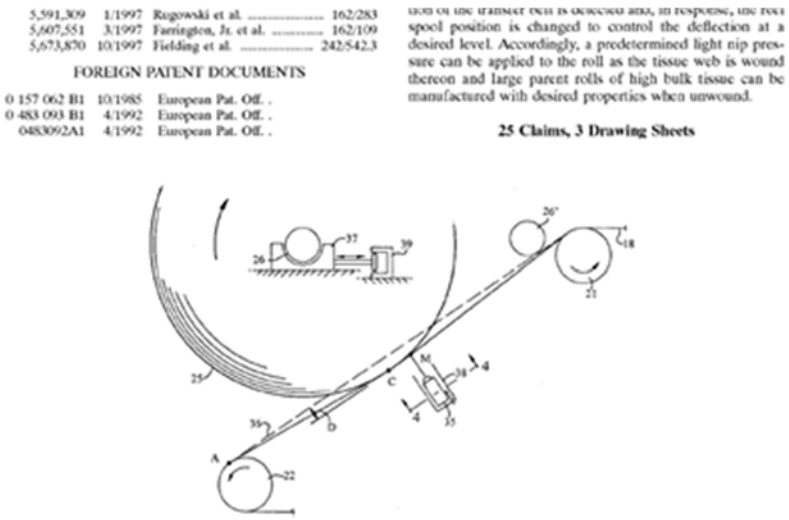


Figure 13. The main components of the belted reel include the belt, blow boxes, stretcher and guide, primary arms and secondary linear carriages.

The control strategy is completely different than that of a conventional reel. As the parent roll is wound against the belt, the control algorithm calculates the required indentation of the parent roll surface into the belt. **Figure 14 (next page)** shows Valmet's patented strategy for measuring indentation.

This control strategy relies on an absolute distance measurement to measure indentation, as well as measuring the winding speed and the RPM of the parent roll, which provides the output for positioning the secondary carriages. This control strategy is based on position control instead of measuring the linear load between the parent roll and the winding surface.

Measuring linear load with load cells is a well-known technology. In tissue applications this technique has several difficulties because the measured and controlled values are of the same magnitude as friction and hysteresis between the load cell and the nip point. Measuring the indentation provides direct feedback of the variables required for control.


5,591,309 1/1997 Rugowski et al. 162/283
5,607,551 3/1997 Farrington, Jr. et al. 162/109
5,673,870 10/1997 Fielding et al. 242/542.3

FOREIGN PATENT DOCUMENTS

0 157 062 B1 10/1985 European Pat. Off. .
0 483 093 B1 4/1992 European Pat. Off. .
0483092A1 4/1992 European Pat. Off. .

spool position is changed to control the deflection at a desired level. Accordingly, a predetermined light nip pressure can be applied to the roll as the tissue web is wound thereon and large parent rolls of high bulk tissue can be manufactured with desired properties when unwound.

25 Claims, 3 Drawing Sheets

Figure 14. Valmet's patented strategy for measuring indentation

Dry End equipment for high-speed operation

A state-of-the-art dry end incorporates a belted reel as well as a number of components that enhance the overall efficiency of tissue machine operations (**Figure 15**):

- **Wet dust collectors**. Dust collector scrubs dust directly into the water in the collector.
- **Runnability components**. Collects dust directly from the surface of the sheet.
- **Blow boxes**. Stabilizes the sheet on the belt before entering the winding nip.
- **Water jet turnup**. For efficient full width turnups at high speeds.

- **Water jet edge trim**. Cuts trim at the dry end.
- **Water jet slitter**. Splits the sheet into two or more rolls.

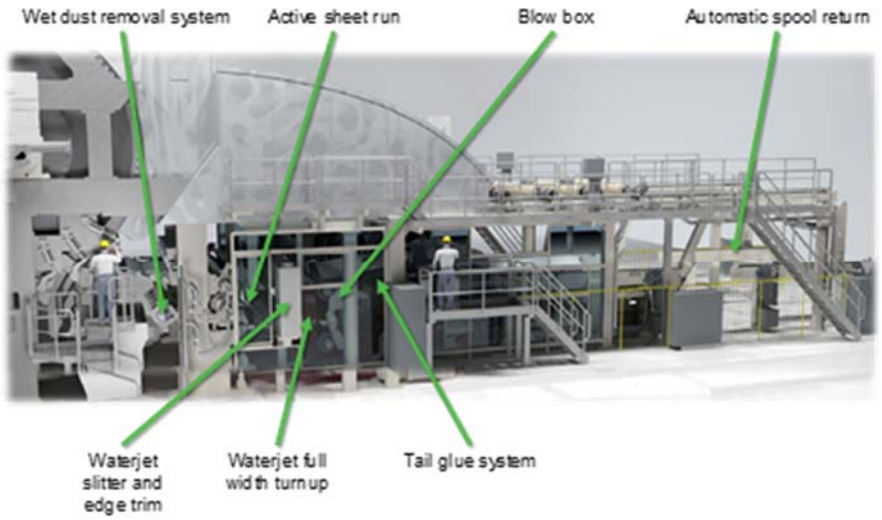


Figure 15. State-of-the-art dry end layout with belted reel

During the past decade numerous reels based on Valmet's belt winding technology have been delivered.

Summary

The belted reel technology is an excellent technology for winding premium tissue and towel grades. It is a valuable tool for producing and preserving high quality tissue paper properties such as high bulk, softness and caliper, while minimizing broke and improving the production efficiency of converting operations. The Advantage SoftReel B is capable of winding large diameter parent rolls up to 140" diameter, while reducing parent roll handling and the number of cores required.

The belted reel technology is a mature technology, developed and refined over a period of more than 10 years. Belted reel winding technology is available as an option for all new and existing tissue machines.

This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.

Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet's pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services.

We are committed to moving our customers' performance forward.