Winding parameters for Drum-driven Winders

Let us consider that the diameters of the driving drum and package are ***'D'** and **'d'** respectively.*

The r.p.m. of drum and package are ***'N'** and **'n'** respectively.*

D is constant whereas d increases with time due to the building of the package (formation of layers of coils).

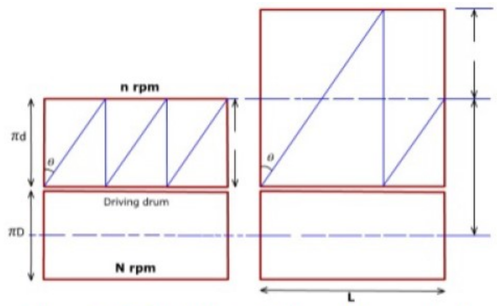


Figure 2.8: Principles of drum-driven winder

Winding parameters for Drum-driven Winders

Considering no slippage between the drum and the package

$$\boxed{N \times D = n \times d}$$

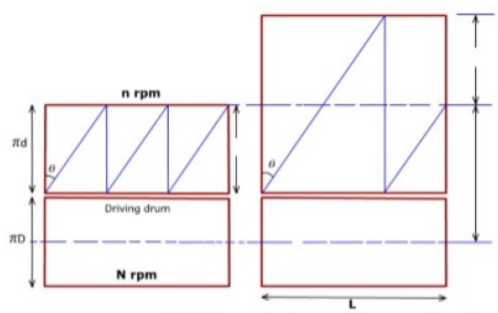


Figure 2.8: Principles of drum-driven winder

The drum r.p.m. N is constant as it getting drive from gear systems and thus n reduces with time.

Therefore, for drum-driven winder, traverse speed and surface speed are also constant.

Winding parameters for Drum-driven Winders

Let, L is the length of the drum and package

Distance covered in one double traverse= 2L

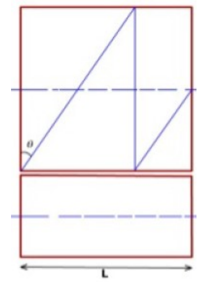
Number of revolution required for drum for double traverse=S

N revolution of drum takes 1 minute

S revolution of drum will take S/N minute

S revolution of drum is equivalent to one double traverse

So, time for one double traverse = S/N minute



$$\text{Traverse speed} = \frac{\text{Distance covered in one double traverse}}{\text{Time for one double traverse}} = \frac{2L}{\frac{S}{N}} = \frac{2LN}{S}$$

$$\tan\theta = \frac{V_t}{V_s} = \frac{\frac{2LN}{S}}{\pi DN} = \frac{2L}{\pi DS} = \text{constant (as } L, D \text{ and } S \text{ are constant for a gievn drum)}$$

So, in drum-driven winder, angle of wind remains constant with the increase in package diameter.

Winding parameters for Drum-driven Winders

Now, if the package r.p.m. is n, same (n) number of coils (wind) will be laid on the package in every minute.

So, traverse ratio= wind/double traverse

$$= \frac{\text{wind/min}}{\text{double traverse/min}} = \frac{n}{\left(\frac{N}{S}\right)} = S.\frac{n}{N} = S.\frac{D}{d}$$

So, in drum-driven winder, traverse ratio reduces with the increase in package diameter.

<u>This leads to a 'patterning' problem in case of drum-driven winder.</u>

Winding parameters for Drum-driven Winders

$$\text{Winding speed} = \sqrt{\text{Surface speed}^2 + \text{Traverse speed}^2}$$

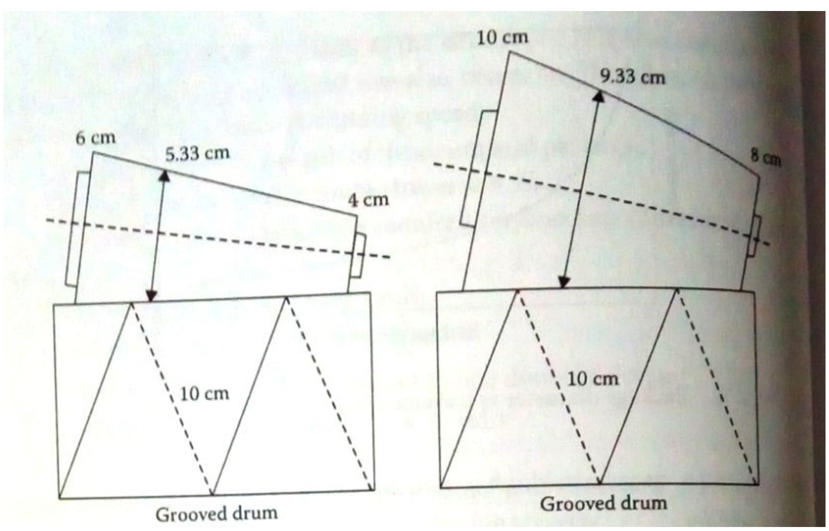
$$= \sqrt{(\pi DN)^2 + \left(\frac{2LN}{S}\right)^2}$$

$$= \sqrt{(\pi dn)^2 + \left(\frac{2LN}{S}\right)^2} \quad \text{(no slippage between drum and package)}$$

It is evident from the above expression that **the winding speed remains constant** during package building in case of drum-driven winder.

Cone winding

Surface speed of cone and drum equal at 1/3rd of distance from cone base



Cone winding

Difference in surface speed between drum and cone is always higher at tip than at the base, therefore more yarn abrasion at tip.

TABLE 2.1 Change in Parameters during Cone Winding and Tip and Base

Parameter	Empty Cone	Semi-Full Cone
Number of cone revolution per drum revolution	$\frac{10}{5.33} = 1.88$	$\frac{10}{9.33} = 1.07$
Surface movement of the drum per revolution	$\pi \times 10 = 31.4$ cm	$\pi \times 10 = 31.4$ cm
Surface movement at the cone tip per drum revolution	$\pi \times 4 \times 1.88 = 23.61$ cm	$\pi \times 8 \times 1.07 = 26.87$ cm
Surface movement at the base per drum revolution	$\pi \times 6 \times 1.88 = 35.42$ cm	$\pi \times 10 \times 1.07 = 33.60$ cm
Ratio of surface speed between cone tip and drum	0.75	0.86
Ratio of surface speed between cone base and drum	1.13	1.07

Limitation of Drum-driven Winders : Patterning

- In case of drum-driven winders, the traverse ratio value reduces with the increase of package diameter.
- When, the value becomes integer, the package becomes susceptible to patterning (ribbon formation).

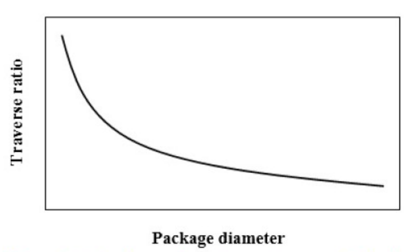
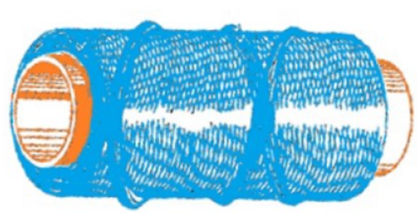


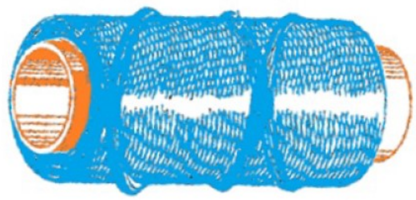
Figure 2.9: Package diameter vs traverse/ wind ratio



Limitation of Drum-driven Winders : Patterning

If the traverse ratio (wind per double traverse) value is an **integer**, then the yarn comes back to the **same position** on the package surface after one double traverse.

Therefore, in the next double traverse, the yarn is laid **just over the yarn** which was laid in the previous double traverse



Patterning: Path of Yarn On Cheese

Here occurrence of patterning explained when wind per double traverse is 2.

Yarn has covered half of the package periphery when it has traversed half of the package height (L/2) (solid line)

The yarn has made one complete coil (wind) when it has traversed the full height of the package (L) (broken line)

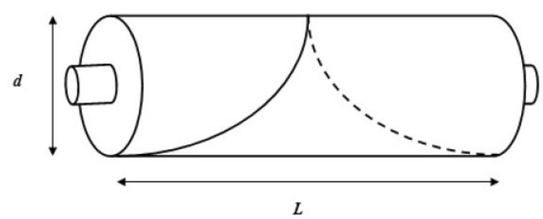


Figure 2.10: Path of yarn on cheese package

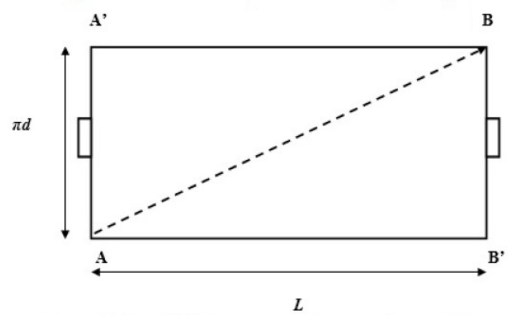


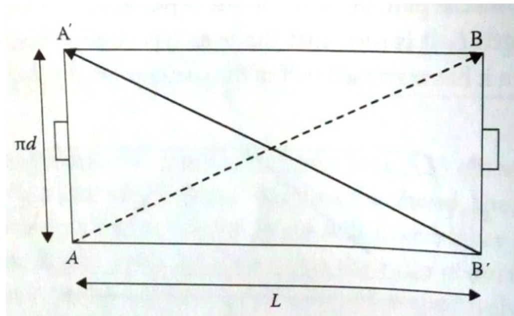
Figure 2.11: Path of yarn on cheese after cutting

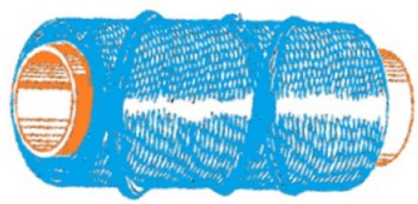
Patterning: Path of Yarn On Cheese

➢Path of the yarn in one double traverse can be simply written as ABB'A'.

➢After one double traverse, the yarn has returned to the same position on the package from where it started its journey.

➢This will lead to the formation of ribbon on the package (patterning problem)





Drawing the Path of yarn on Cheese

For any value of traverse ratio (wind per double traverse), the path of yarn on the cheese can be drawn and analysed by following steps.

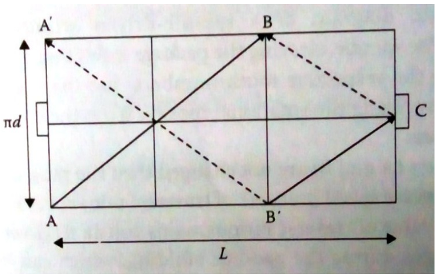
1. Traverse ratio (wind per double traverse) = *x (integer)*
2. Wind per traverse = *x/2*
3. Traverse per wind = 2/*x*
4. Divide the opened package in two equal parts (as the numerator is 2) in the vertical direction and *x number of equal* parts in the horizontal directions.
5. Draw the diagonals for the small rectangles.
6. When one coil is complete, shift the winding point from upper parallel line to lower parallel line and vice-versa.
7. Reverse the direction of traverse when the one traverse is complete.

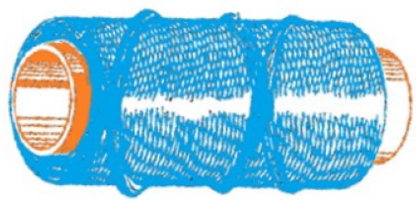
Patterning: Path of Yarn On Cheese

Here occurrence of patterning explained when wind per double traverse is 3

Therefore, value of wind per traverse is 3/2 and value of traverse per wind is 2/3.

Opened package divided into two parts in vertical direction and three parts in horizontal direction.



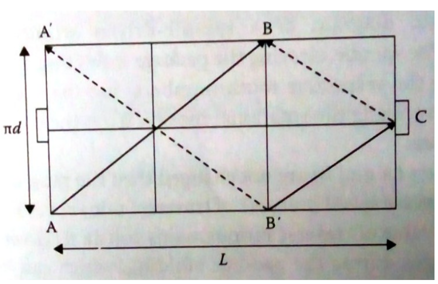


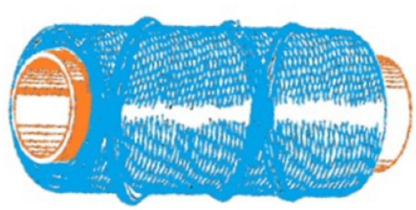
Patterning: Path of Yarn On Cheese

The yarn will move from A to B to complete one coil. B and B' are the same point on the package. The yarn will then move from B' to C to complete one traverse.

Then the direction of traverse will change and the yarn will move from C to B. Finally the yarn will complete the double traverse by moving from B' to A'.

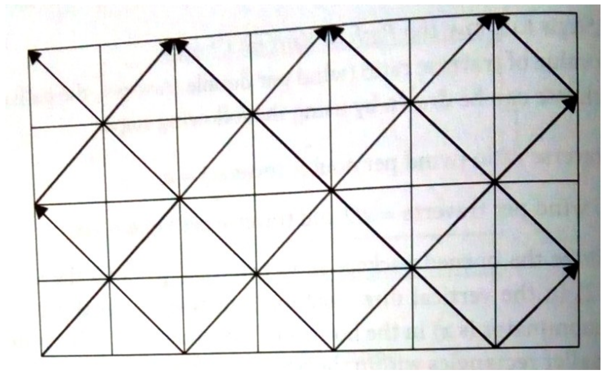
Here, the yarn comes back to the starting position (A) after only one double traverse.





Patterning: Path of Yarn On Cheese

Figure depicts the path of yarn for traverse ratio of 3.5 (or 7/2). Here yarn comes back to the starting position after two complete double traverses and laying 7 coils



Similarly, if the traverse ratio value is 3.75 (or 15/4), then the yarn will come back to the starting position after four double traverse and laying 15 coils

Patterning: Path of Yarn On Cheese

This showed increase in the number of double traverse values before yarn comes back to same position with non-integer values

Therefore, number of coils formed on the package also increased which leads to the increase in package diameter.

So, the yarn actually comes back to a different point precluding the possibility of patterning.

Otherwise, patterning is prevalent when the traverse ratio is integer or having values like 1.5 or 2.5 etc.

Winding parameters for Spindle-driven Winders

The spindle carrying the package is rotating at *n* r.p.m.

A and B are the two gears responsible for transmitting the rotational motion from the spindle to traverse mechanism.

If these gears (A and B) are not changed then the ratio of spindle speed and traverse speed remains same and therefore the value of **traverse ratio remains constant.**

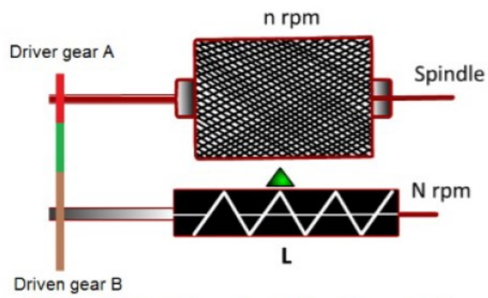
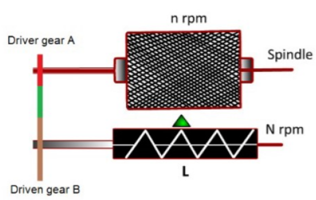


Figure 2.15: Drive of spindle-driven winder

Winding parameters for Spindle-driven Winders



$$\text{Double traverse/ minute} = R = \frac{N'}{S} = n\,\frac{A}{B}\cdot\frac{1}{S}$$

$$\tan\theta = \frac{\text{Traverse speed}}{\text{Surface speed}} = \frac{V_t}{V_s} = \frac{2LR}{\pi dn}$$

Let R is the number of double traverse made by the traversing device per minute.

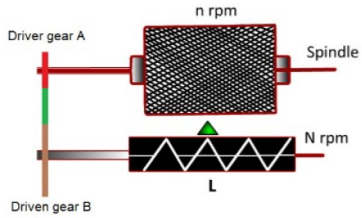
If the traverse is given by a groove drum which requires S revolutions for one double traverse

$$\text{So, } \tan\theta = \frac{2LR}{\pi dn} = \frac{2L}{\pi d} \times \frac{n \times \frac{A}{B} \times \frac{1}{S}}{n}$$

$$= \frac{2L}{\pi d} \times \frac{A}{B} \times \frac{1}{S} \propto \frac{1}{d}$$

As, d increases with the package building, the angle of wind decreases.

Winding parameters for Spindle-driven Winders



Traverse ratio= wind/double traverse

$$= \frac{\text{wind/min}}{\text{double traverse/min}} = \frac{n}{R} = \frac{n}{n \cdot \frac{A}{B} \cdot \frac{1}{S}} = \frac{B \times S}{A} = \text{Constant}$$

So, for spindle-driven winders, traverse ratio remains constant during the package building.

$$\text{Winding speed} = \sqrt{(\pi dn)^2 + (2LR)^2} \quad \text{(generally increases with 'd')}$$

Limitation of Spindle-driven Winders

Figure depicts the two situations with low and high package diameters.

The traverse ratio is same but the angle of wind reduced from θ to α.

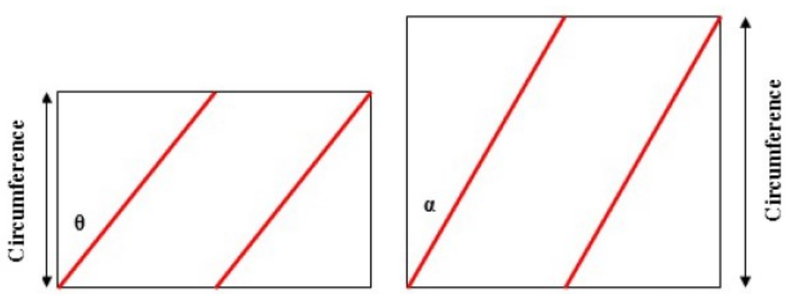


Figure 2.16: Change in angle of wind in precision winder

Limitation of Spindle-driven Winders

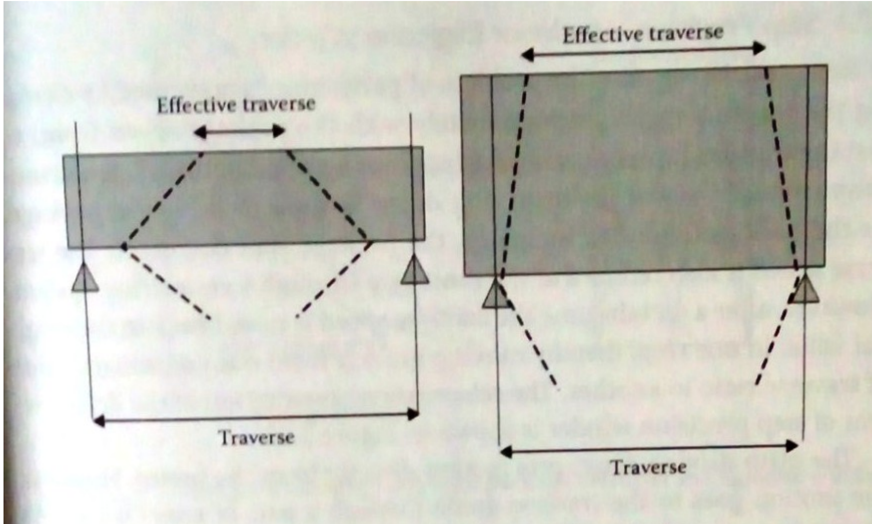
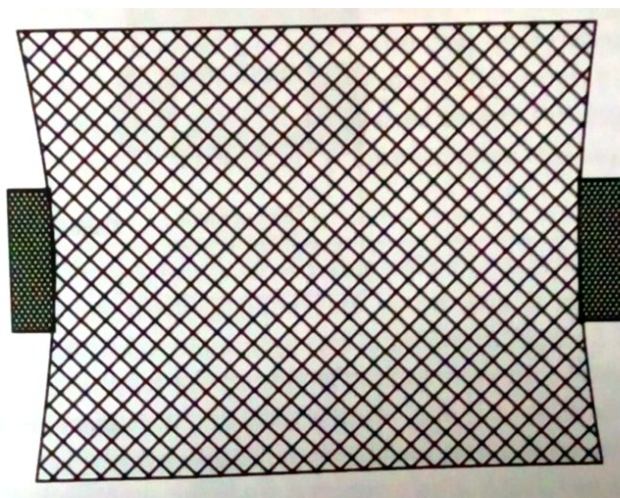


FIGURE 2.21 Change in effective traverse in precision winding.

Limitation of Spindle-driven Winders



22 Sides of a precision wound package.