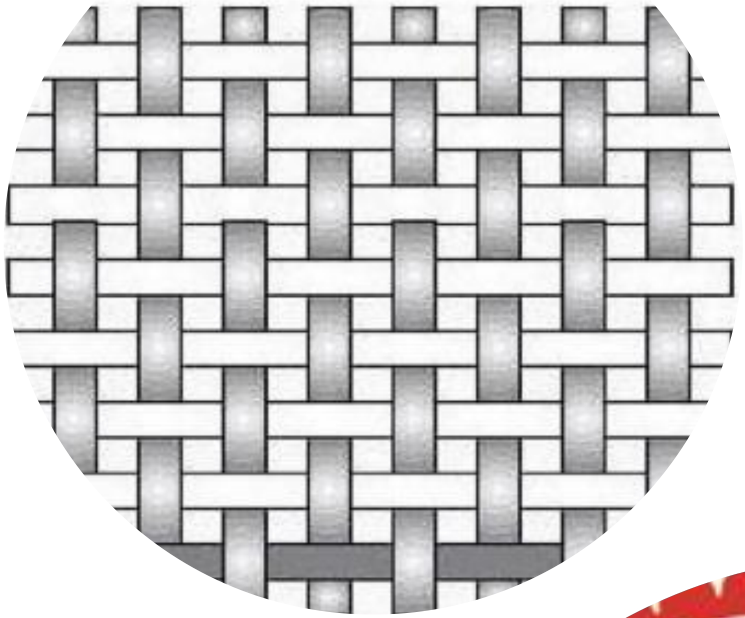
Fabric Manufacturing I (TXL231)



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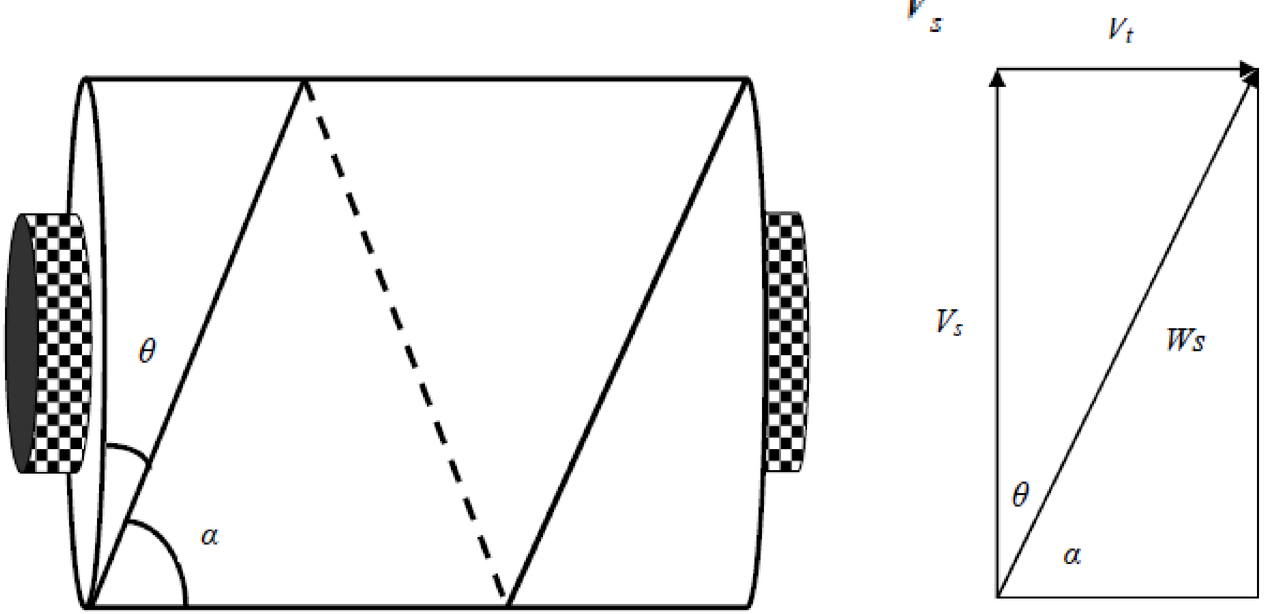
Some Definitions in Winding

- **Wind:** It is the number of revolutions made by the package (i.e. number of coils wound on the package) during the time taken by the yarn guide to make a traverse in one direction (say from left to right) across the package
- **Angle of wind (θ):** It is the angle made by the yarn with the sides of the package
- **Coil angle (α):** It is the angle made by the yarn with the axis of the package. The coil angle and angle of wind are complementary angles as they add up to 90^0

$$\tan\theta = \frac{V_t}{V_s}$$



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

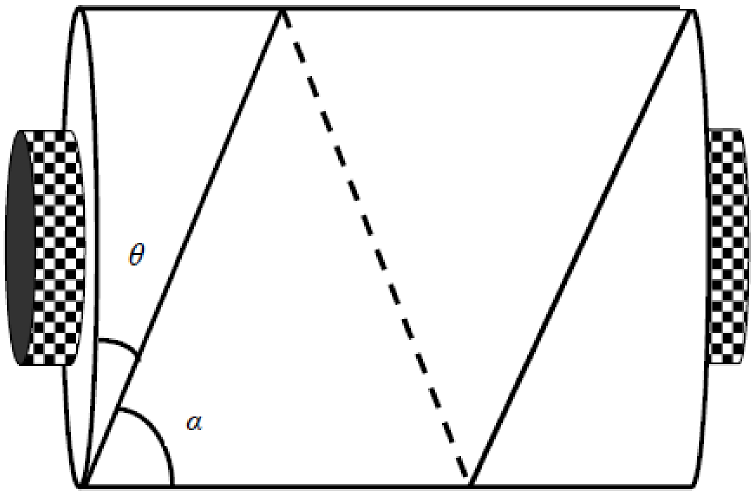
Some Definitions in Winding

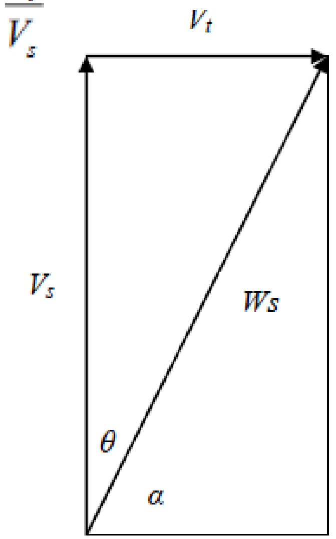
- **Traverse length:** is defined as the distance between extreme positions of a reciprocating thread-guide in one cycle of its movement

- **Gain:** Gain is the angular displacement of the yarn at the beginning of a double traverse, with respect to the corresponding position for the previous double traverse. The new yarn coil should fall slightly to one side or the other of the first coil. The gain to be used is a minimum gain if the coils are to be laid side by side so as to increase winding density.

- **Ribboning:** If yarn is repeatedly laid on top of or along the same path as the previously wound yarn, this duplication of yam path on the package creates a defect known as ribboning or patterning

$$\tan\theta = \frac{V_t}{V_s}$$





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

$V_S = \pi * D_P * N_P$

D_P- Package diameter

N_P- Package rotational speed (rpm)

$V_T = 2.L.N_d/k$

L – Traverse length

N_d-Rotational speed of the driving roller or cam drum (rpm)

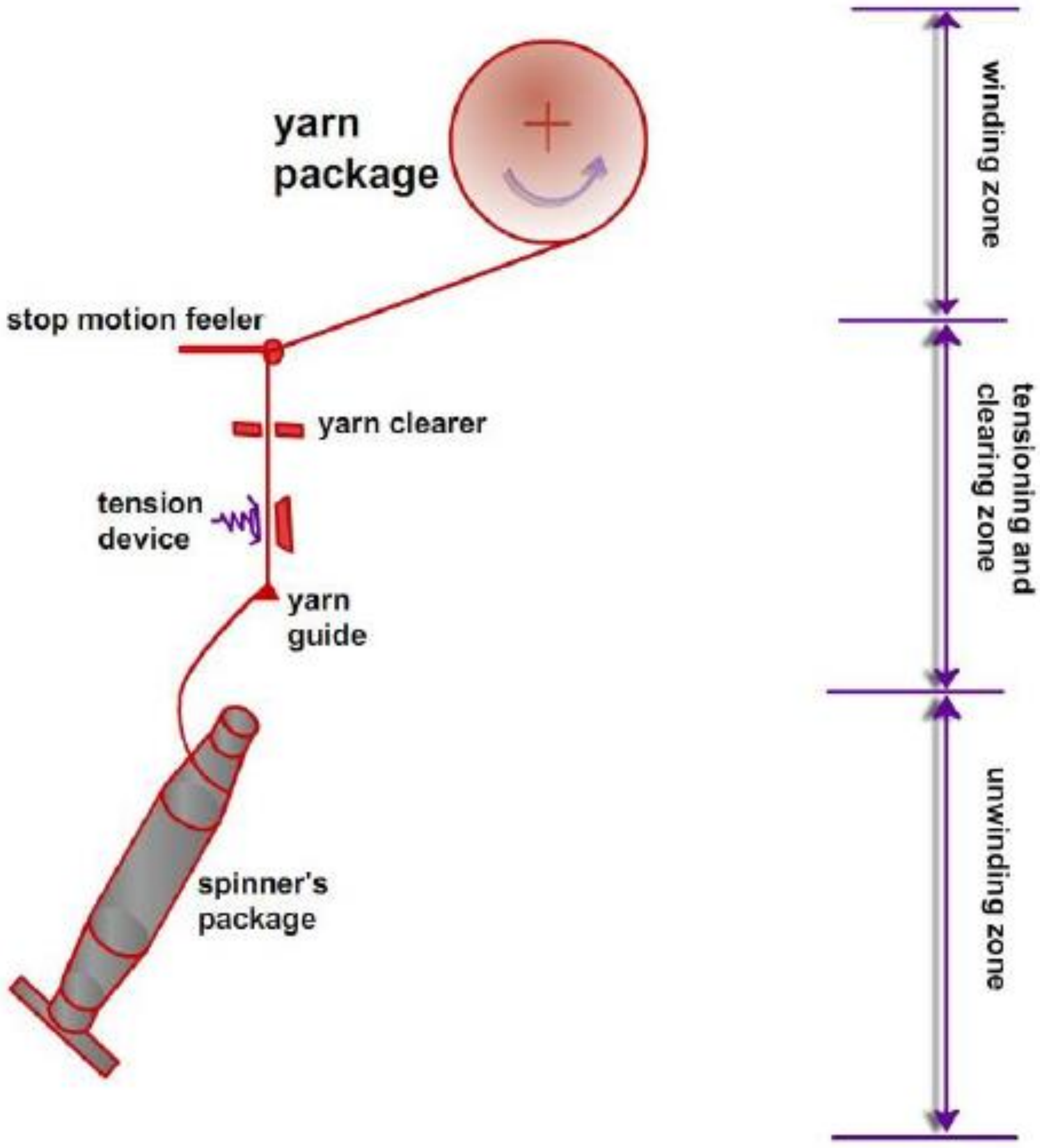
k-driving roller revolutions per double traverse

Winding Machine

Yarns are wound on the package by means of rotational motion of the package and traverse motion of the yarn guide

Tensions are applied on the yarns by using tensioners so that yarns are wound on the package with proper compactness

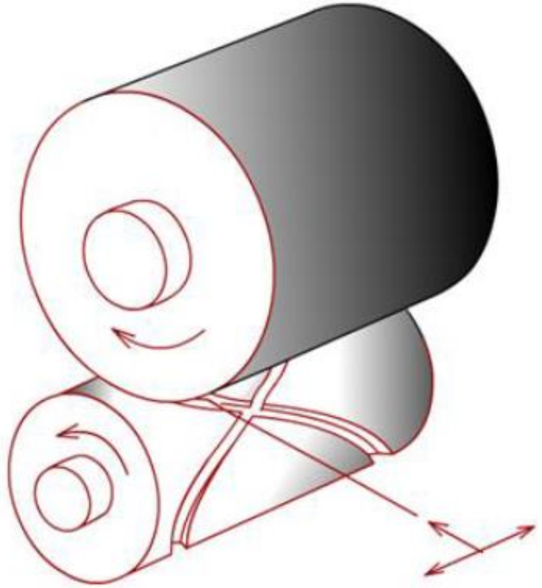
Yarns are unwound from the supply package which is ringframe bobbin in most of the cases. Yarn balloon is formed due to the high-speed unwinding of yarn from the supply package.

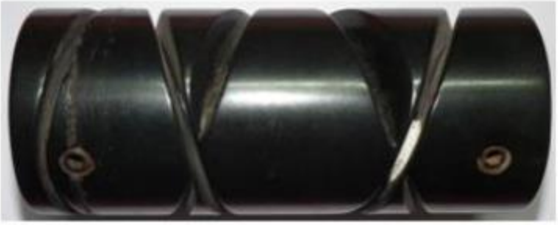


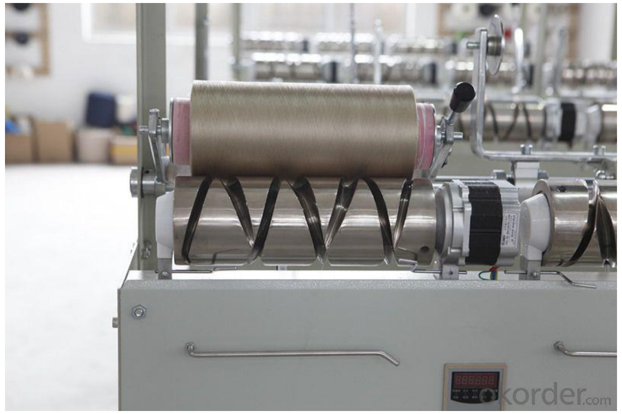
Winding Principles- Drum-driven

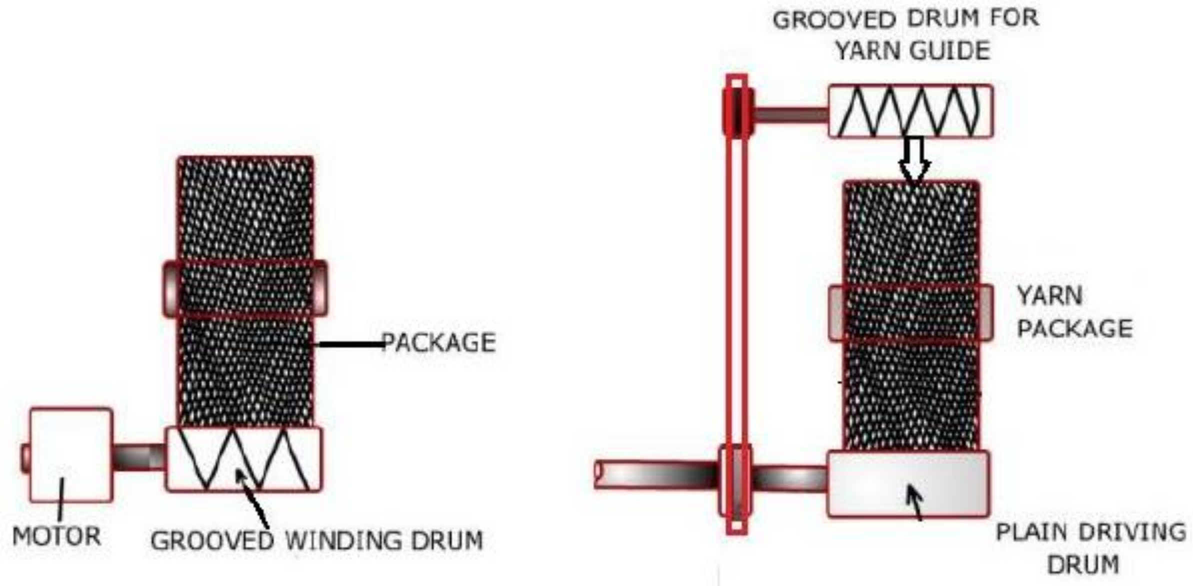
In drum-driven winder, the package is driven by a cylinder by surface or frictional contact

Traverse of yarn is given either by the grooves cut on the or by a reciprocating guide





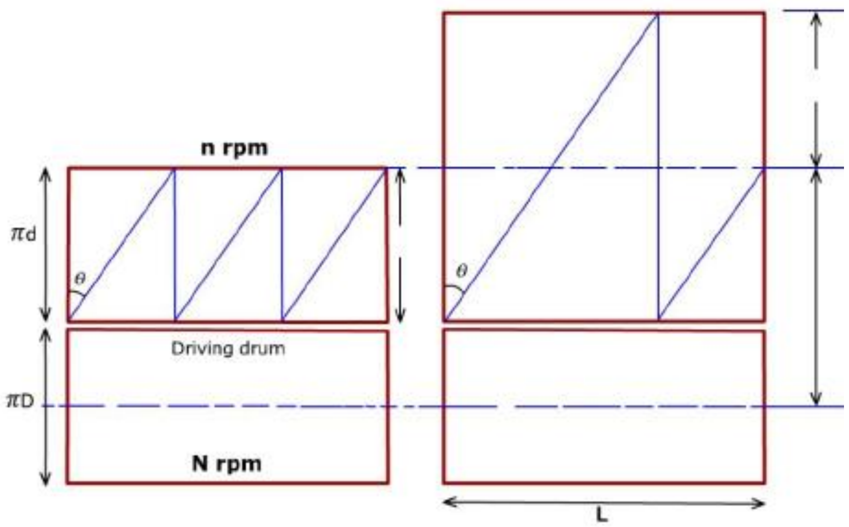




(a) (b)

Winding Principles- Drum-driven

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).



For no slippage- N×D = n×d, but N is constant, so n should reduce with increasing d.

Reminder- For drum-driven winder, traverse speed and surface speed are also constant. Therefore, it gives constant angle of wind and winding speed

Winding Principles- Drum-driven

Let, L is the length of the drum and package.

Distance covered in one double traverse $= 2L$

Number of revolution required for the drum for double traverse $= S$

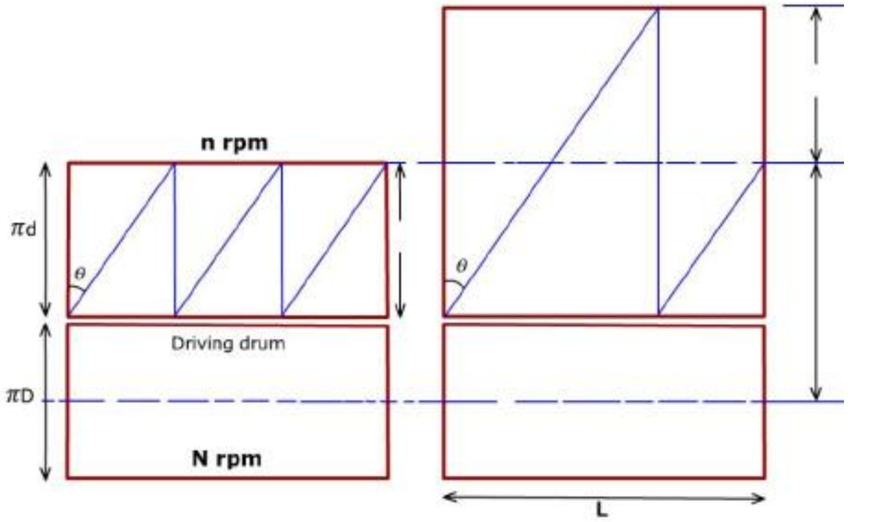
N revolution of drum takes 1 minute

S revolution of drum will take $\dfrac{S}{N}$ minute

S revolution of drum is equivalent to one double traverse

So, time for one double traverse $= \dfrac{S}{N}$ min

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



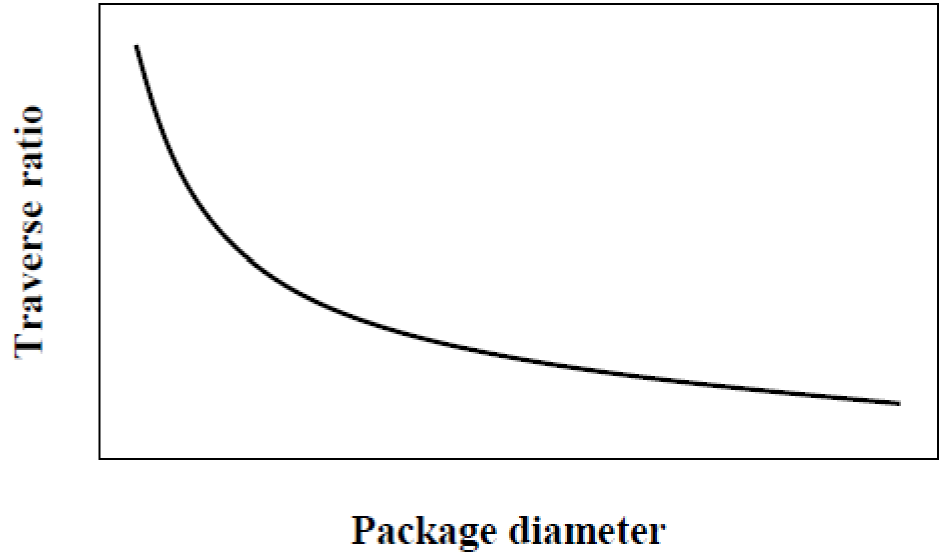
$$\tan\theta = \frac{V_t}{V_s} = \frac{\frac{2LN}{S}}{\pi DN} = \frac{2L}{\pi DS} = \text{constant (as } L, D \text{ and } S \text{ are constant for a gievn drum)}$$

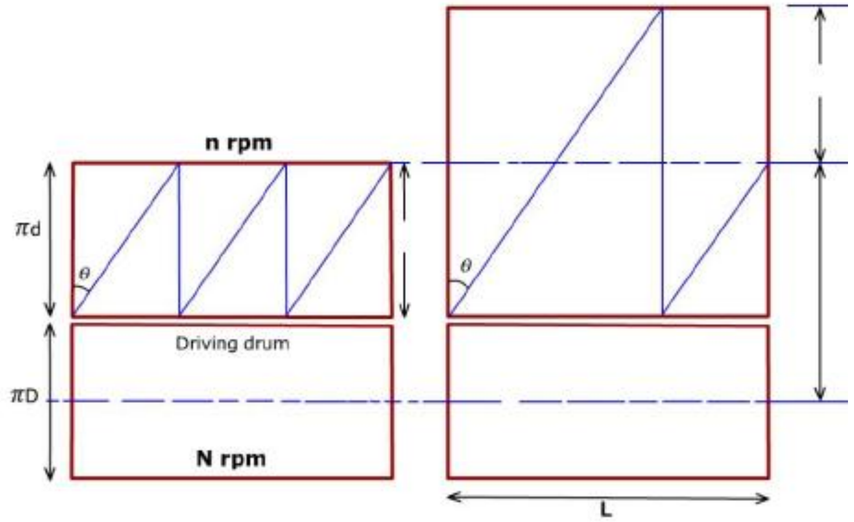
So, in drum-driven winder, angle of wind remains constant with the increase in package diameter

So, Traverse Ratio= wind/double traverse= (wind/min)/(double traverse /min)= n/(N/S)=S(D/d)

This leads to a 'patterning' problem in case of drum-driven winder.

Winding Principles- Drum-driven





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

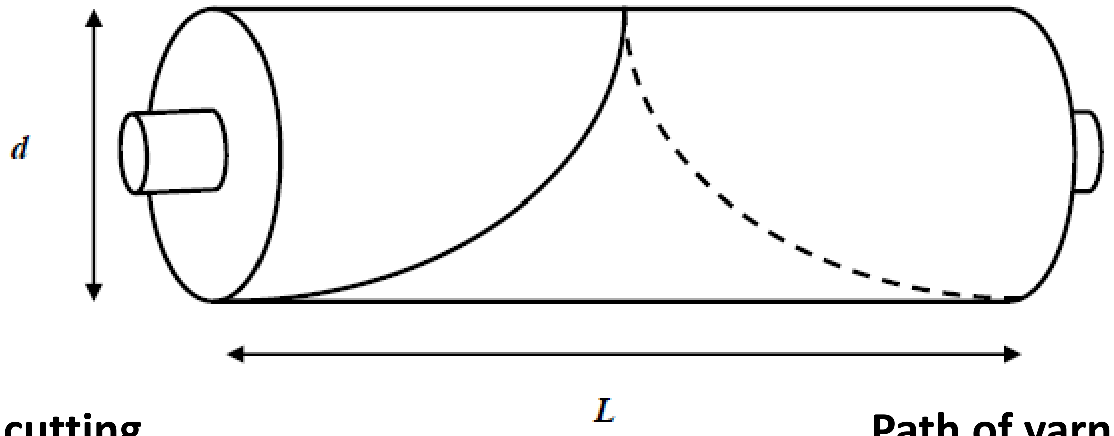
$$= \sqrt{(\pi DN)^2 + \left(\frac{2LN}{S}\right)^2}$$

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

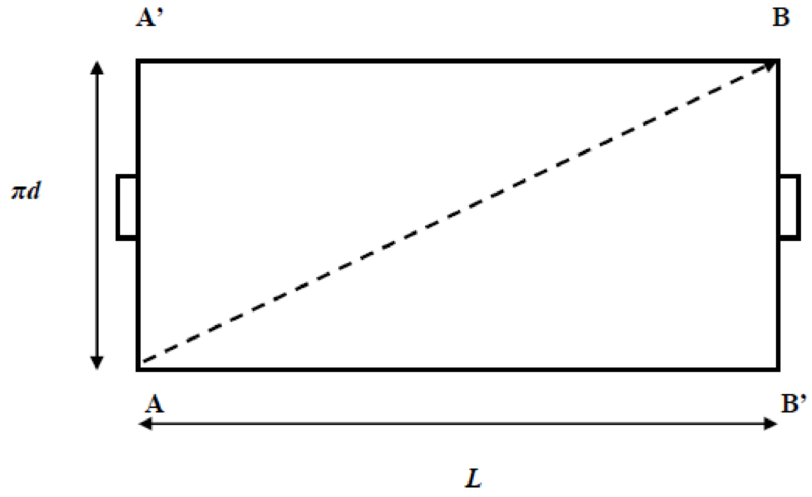
Patterning in Drum-driven Winder

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. As a result, a ribbon develops in the package.

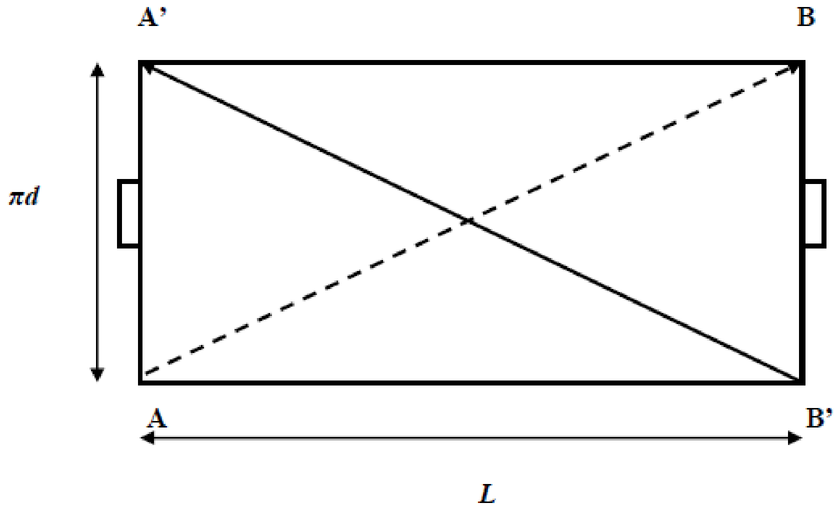
Path of yarn on cheese package



Path of yarn on cheese after cutting



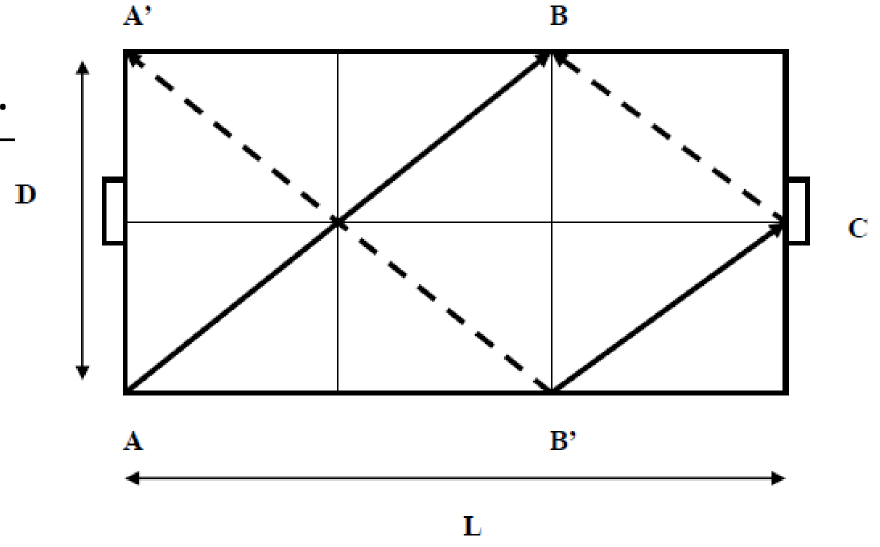
Path of yarn for traverse ratio value 2



Patterning in Drum-driven Winder

For any value of traverse ratio (wind per double traverse) the path of yarn on the cheese can be drawn and analyzed

- ❑ Traverse ratio (wind per double traverse) = x (integer)
- ❑ Wind per traverse = x/2
- ❑ Traverse per wind = 2/x
- ❑ 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. This will create some smaller rectangles within the opened package.
- ❑ Draw the diagonals for the small rectangles.
- ❑ When one coil is complete, shift the winding point from upper parallel line to lower parallel line and vice-versa.
- ❑ Reverse the direction of traverse when the one traverse is complete.

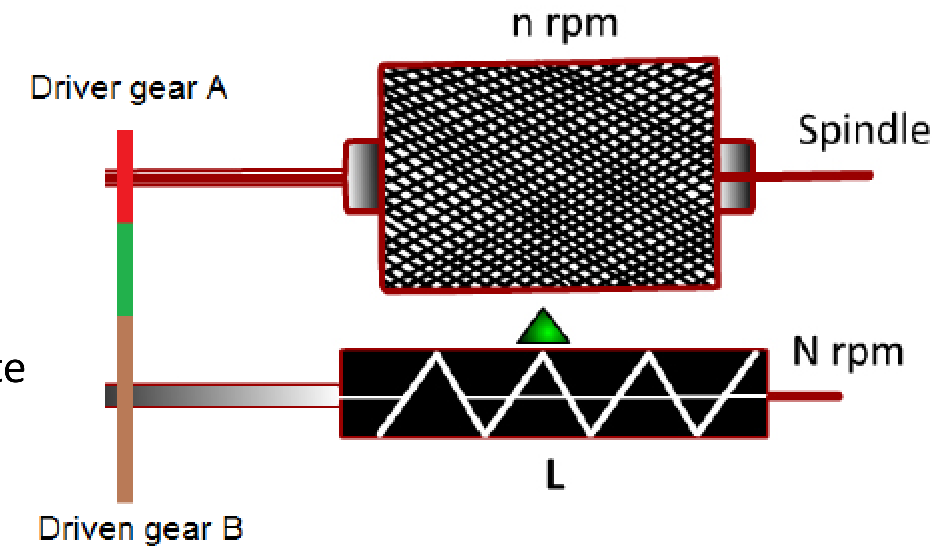


Advantages in Drum-driven Winder

- The simplicity of this arrangement is that a cam type traverse arrangement is not required
- The yarn being wound, due to the winding tension, falls readily into the groove, without the need for any threading action to be carried out
- As the package is driven by frictional contact with drum, the surface speeds of drum and package are equal
- The wind angle of the yarn on the package remains the same at all points, as this is decided by the resultant velocity of yarn on the surface of the package, which is constant. This also contributes to a uniform package density.

Winding Principles- Spindle-driven

If these gears (A and B, both are tooth numbers) are not changed then the ratio of spindle speed (r.p.m.) and traverse speed (number of traverse/ min) remains same and therefore the value of traverse ratio remains constant



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

$$\tan\theta = \frac{\text{Traverse speed}}{\text{Surface speed}}$$

$$= \frac{V_t}{V_s} = \frac{2LR}{\pi d n}$$

RPM of traversing drum, N= n(A/B) and if the grooved drum fives S revolutions for one double traverse, then, R= N/S

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

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

Reminder- As, d increases with the package building, the angle of wind decreases and d x tanθ remains constant for spindle-driven winders.

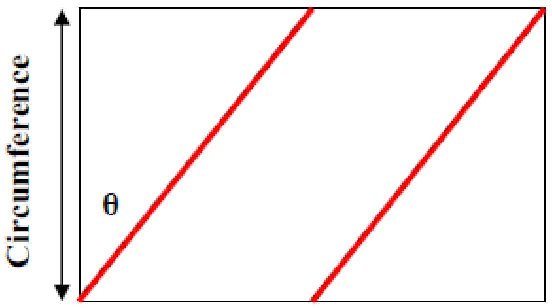
Question- What happens with traverse ratio and winding speed?

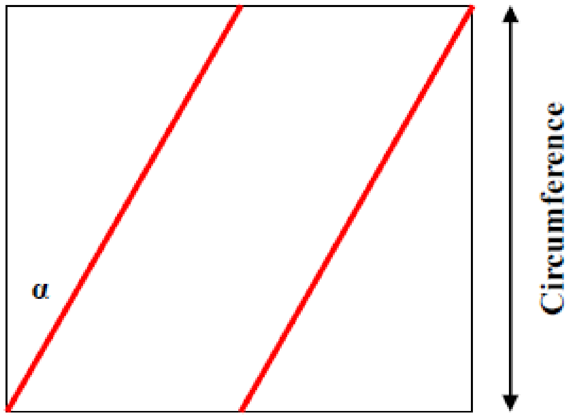
Winding Principles- Spindle-driven

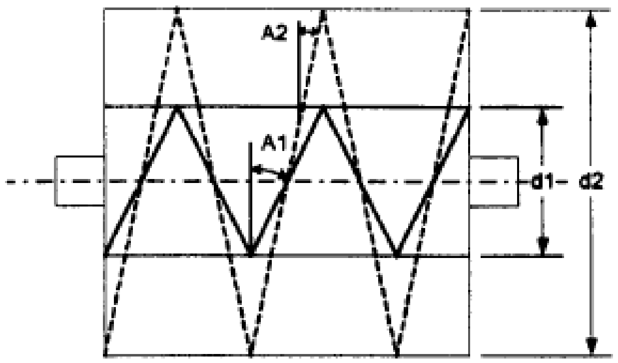
$$\text{Traverse ratio} = \text{wind/double traverse}$$

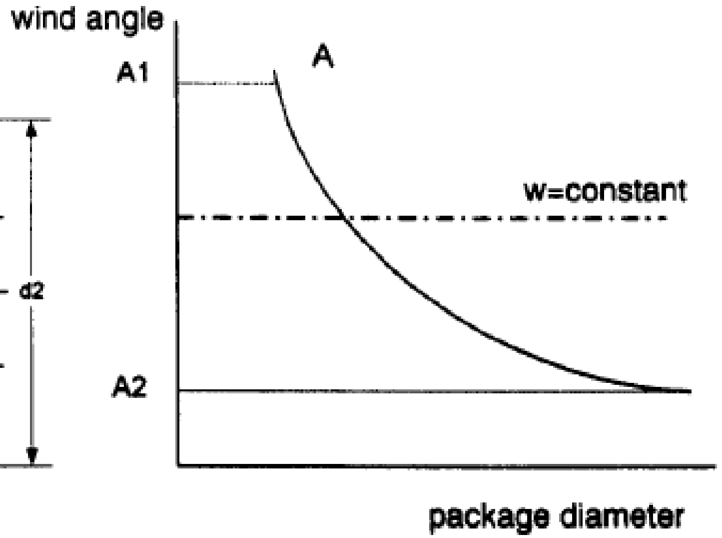
$$= \frac{\text{wind/min}}{\text{double traverse/min}} = \frac{n}{R} = \frac{n}{n.\dfrac{A}{B}.\dfrac{1}{S}} = \frac{B \times S}{A} = \text{Constant}$$

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





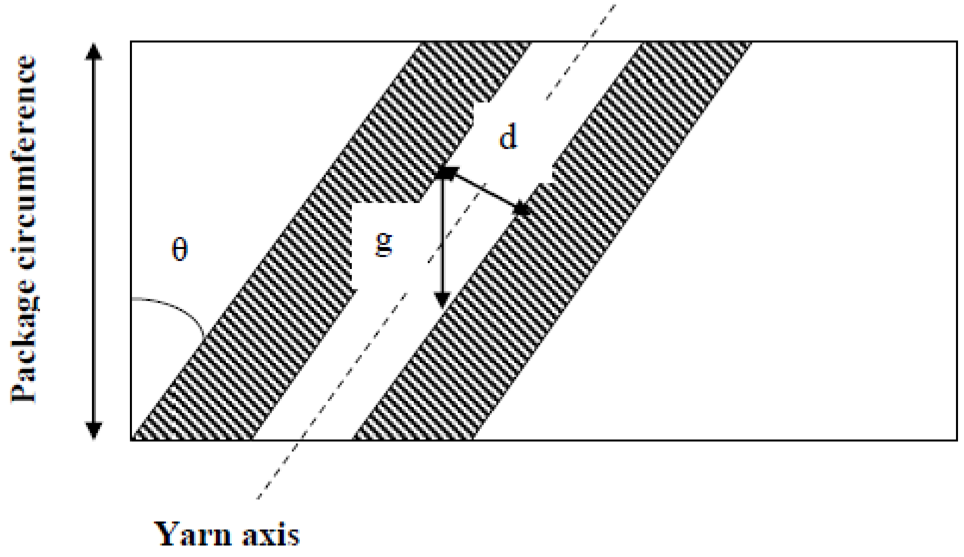




Advantages in Spindle-driven Winder

- The main advantage of precision winding is that the gain in this type of winding is a constant which when adjusted to a suitable value, enables the production of a cross-wound package with no ribboning

What is GAIN?



$$\text{Linear gain} = g = \frac{\text{Yarn diameter}}{\sin\theta}$$

- Gain is the distance by which the winding point must be shifted for avoiding patterning. Linear gain is measured in the direction of perpendicular to the direction of package axis
- linear gain cannot be added or subtracted with the traverse ratio as traverse ratio basically quantifies the number of package revolution within a certain time
- Linear gain can be divided with the package circumference to obtain revolution gain which can be added or subtracted with traverse ratio

Comparison

Parameter	Drum-driven	Spindle driven
Angle of wind	Remains constant	Decreases with increase in package diameter
Traverse ratio	Decreases with increase in package diameter	Remains constant
Winding speed	Remains constant	Generally increases with package building
Package density	Low (very high at ribbons)	High
Pattern zone	Anti-patterning required	Free of patterns
Unwinding	Problem of patterning (poorer than precision winding)	Good unwinding