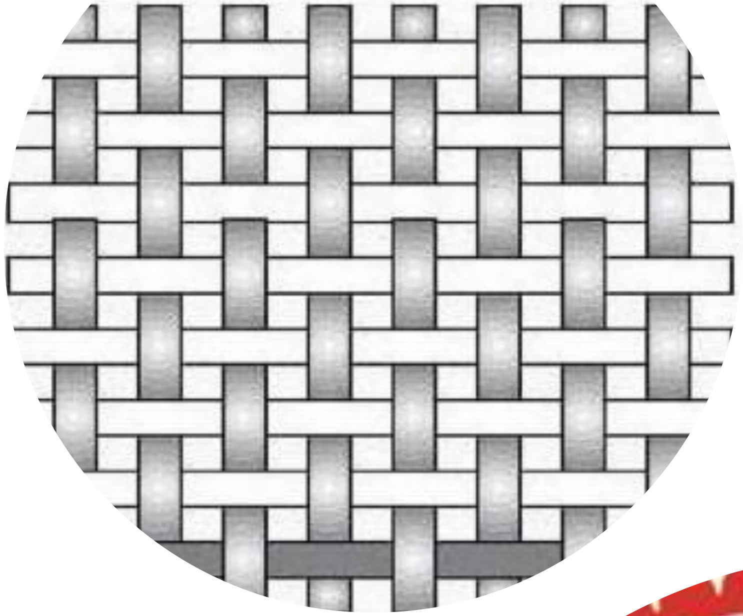
Fabric Manufacturing I (TXL231)



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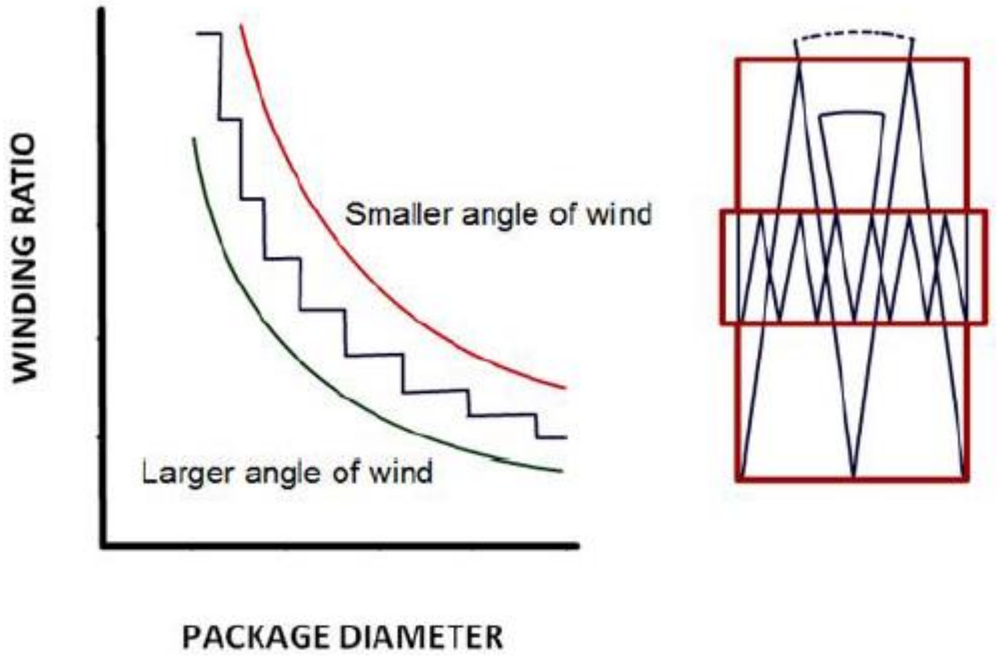
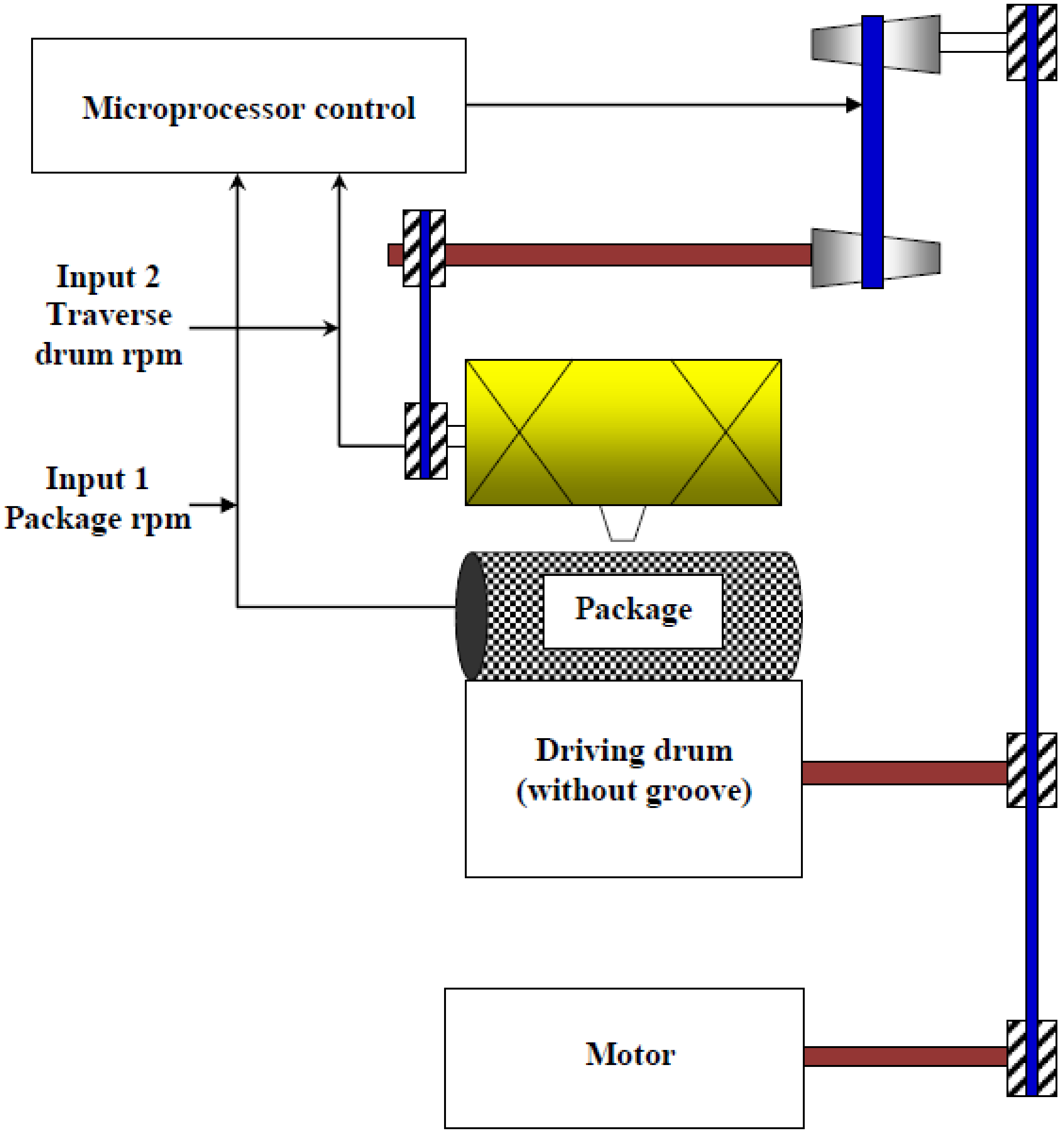
Step Precision Winder or Digicone Winder

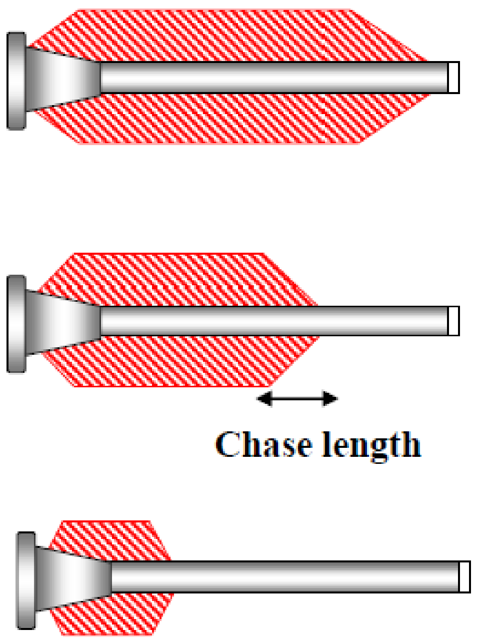
In step precision winder the problem of patterning is prevented by changing the traverse speed proportionately with the package speed (r.p.m.) so that the traverse ratio value remains constant over a period of time.



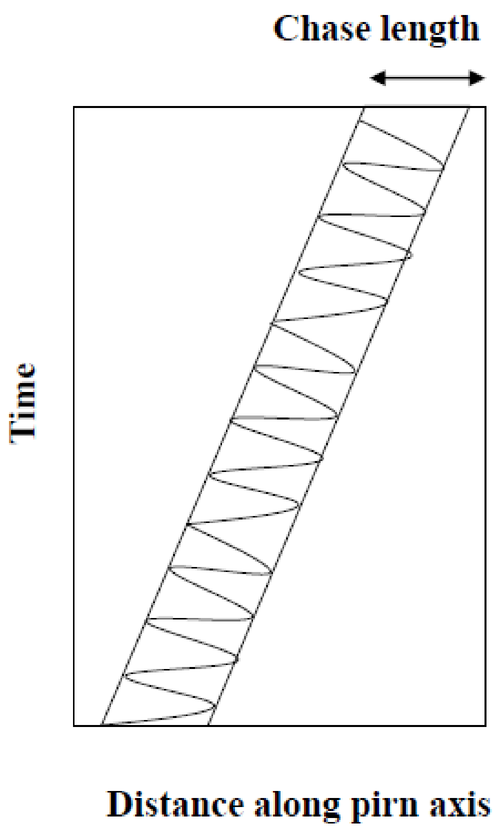


Pirn Winding

Pirns are the yarn packages used within the shuttle to supply the yarns for pick insertion during weaving. In contrast to cone winding, where the supply packages (ringframe bobbins) are small and the delivery packages are big, the supply packages are bigger than the delivery package (pirn) in pirn winding.

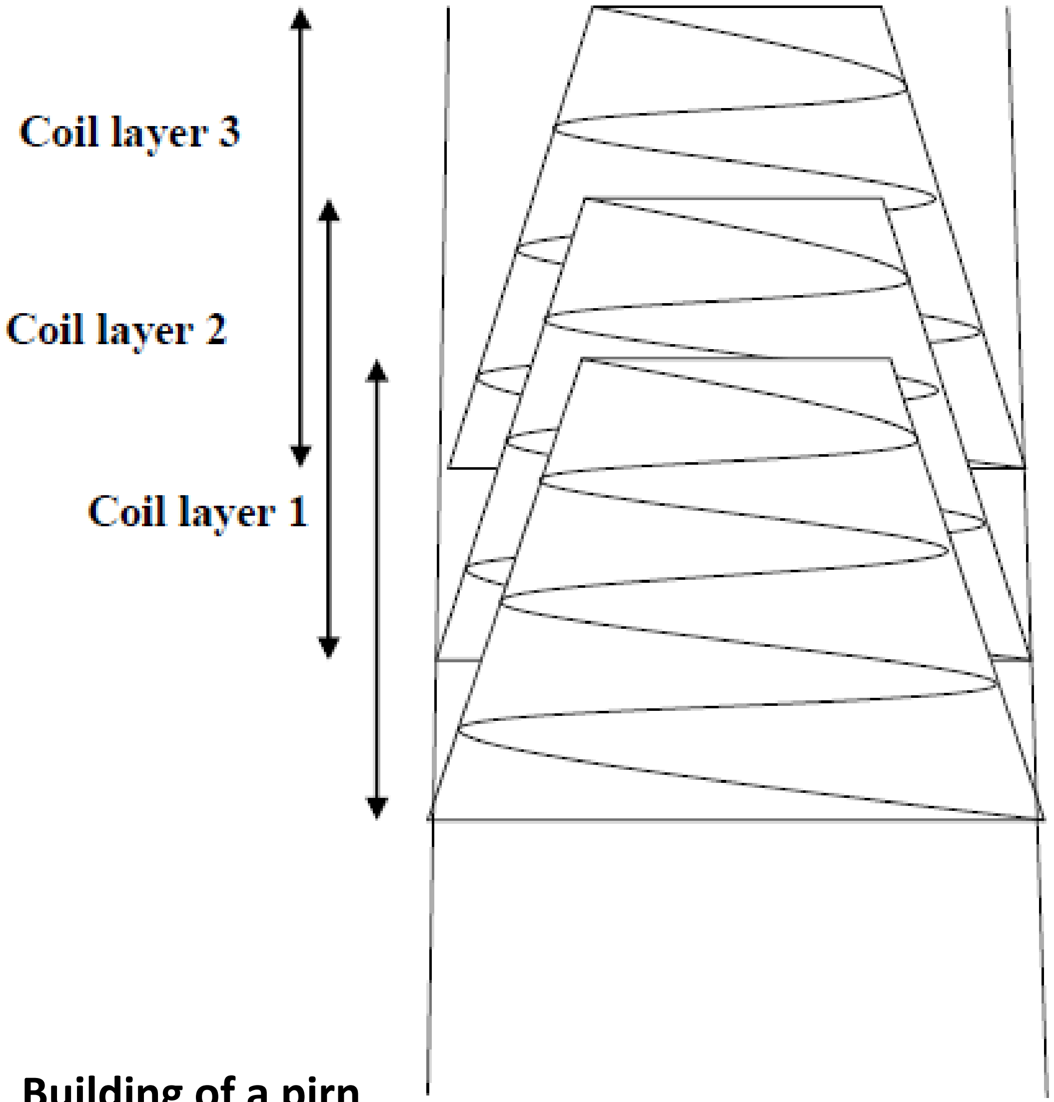


Stages of pirn winding



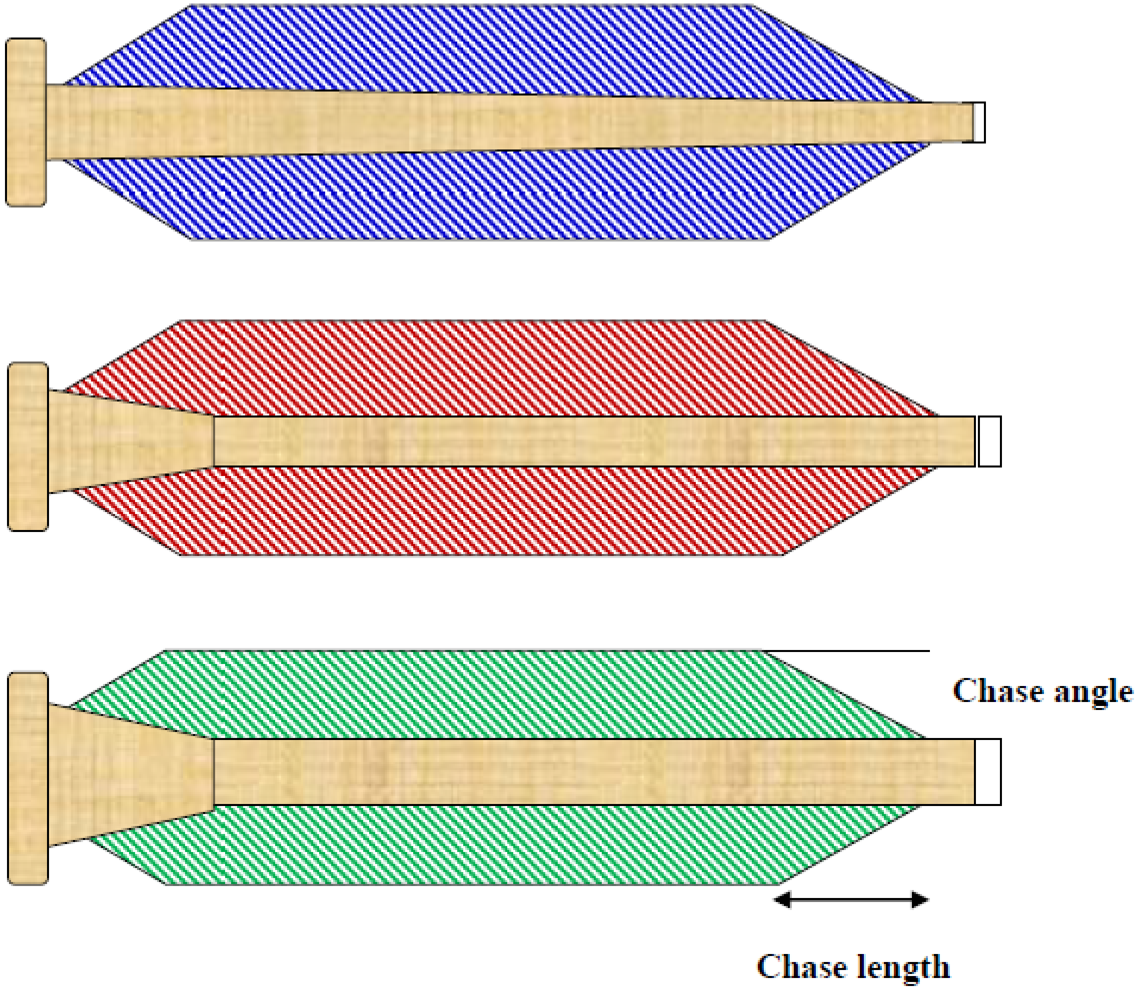
- The pirn winding starts from the conical base and progressively proceeds towards the tip of the pirn. The distance travelled in one stroke of traverse is known as **chase length**
- One layer of coils are laid on the conical base during the forward and as well as during the return movement of the traverse mechanism. Thus, the conicity of the package is maintained and thus the tip of the cone formed by the coils of yarn slowly proceeds towards the tip of the pirn.

Pirn Winding



Building of a pirn

Plain, half base and full base pirns

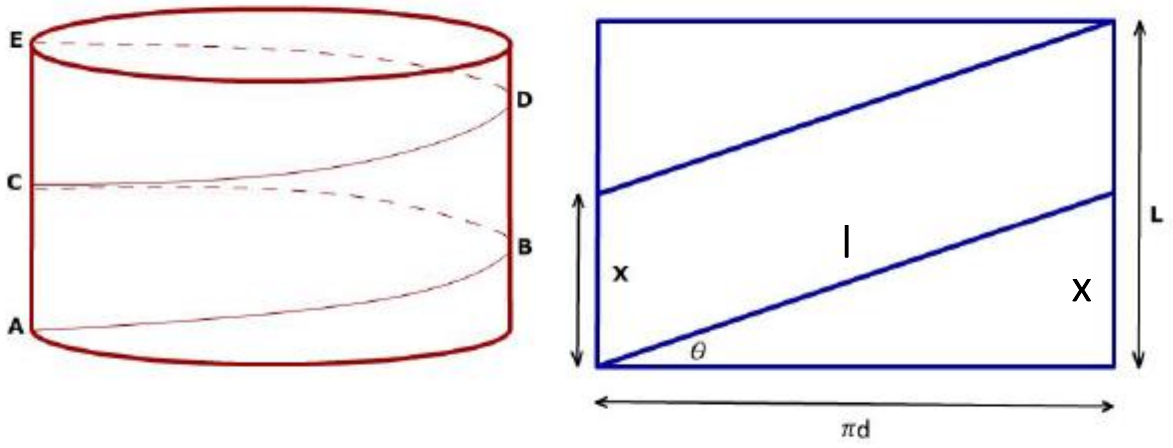


If the full and empty pirn diameter is D and d respectively, L is the chase length and α is the chase angle

$$\tan \alpha = \frac{D - d}{2L}$$

Conditions for Uniform Package (Cheese) Building

Assumption: Length of yarn wound per unit surface area of the package should be constant for uniform building of package



Diameter of package is d and height of the package is L

Legth of one coil= AC= $\dfrac{\pi d}{\cos\theta}$ (θ is angle of wind)

Number of such coils in one traverse $= \dfrac{L}{X} = \dfrac{L}{\pi d.\tan\theta}$

Length of yarn/ surface area

$$= \frac{\text{Total length of yarn wound at diameter } d}{\text{Total surface area of package at diameter } d}$$

$$= \frac{\dfrac{\pi d}{\cos\theta} \times \dfrac{L}{\pi d.\tan\theta}}{\pi d L} = \frac{1}{\pi d \sin\theta}$$

So, $\pi d \sin\theta$ must be kept const for uniform building of the cheese.

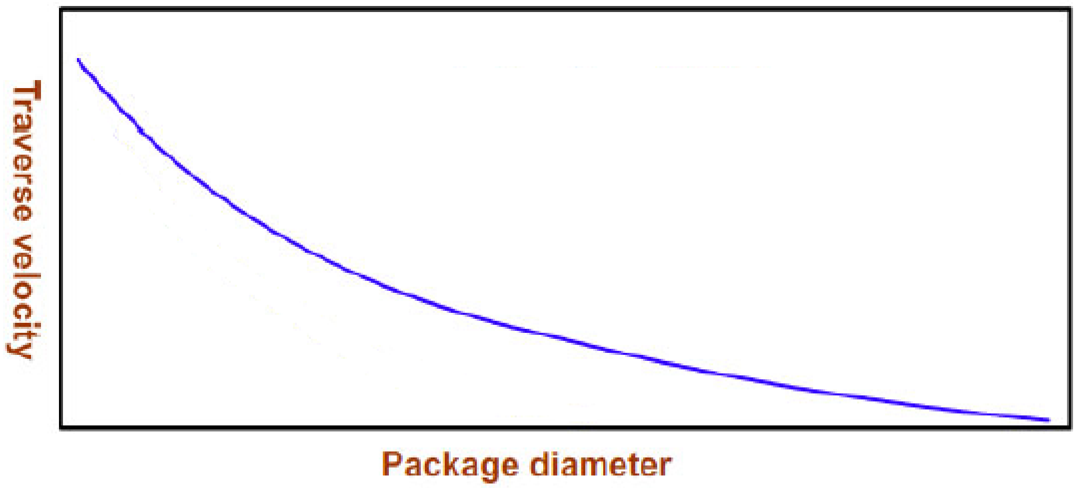
*x= traverse for 1 coil= πd tanθ
*l= 1 coil= πd/cosθ
* Length of yarn= length of one coil x no. of coil

Conditions for Uniform Package (Cheese) Building: Drum-driven

$\tan\theta = V_t/\pi nd$ = Traverse speed/ package speed where d and n are package diameter and r.p.m

$V_t \cos\theta = \pi nd \sin\theta$, But $d\sin\theta$ should be constant and for drum driven n x d is also constant. So n is inversely proportional to d

$$V_t \cos\theta \propto n \propto 1/d$$



Conditions for Uniform Package (Cheese) Building: Spindle-driven

For spindle driven machine package r.p.m n is constant

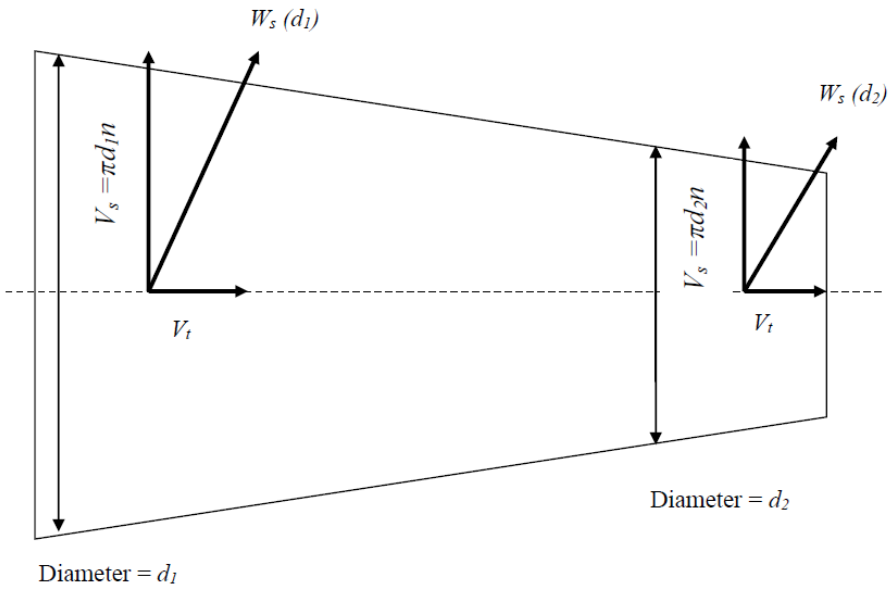
$$\mathbf{V_t \cos\theta \propto constant}$$

Note:

1. For drum-driven winder, θ is constant provided the ratio of Vt and Vs are constant. But if V_t is reduced (keeping V_s constant theoretically, which is possible if traversing mechanism is separate from groove drum), θ will also reduce and Cosθ will increase.
2. In spindle-driven machine, θ reduces (even when V_t is constant) as package diameter (d) increases

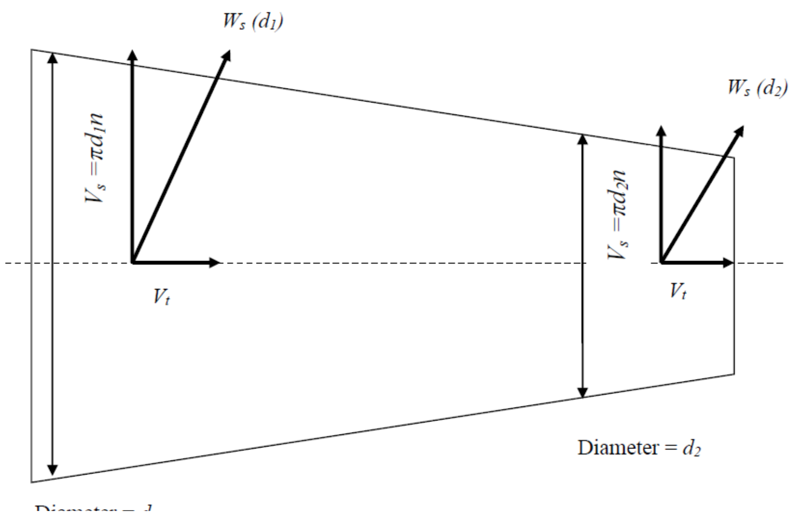
Conditions for Uniform Package (Cone) Building: Spindle-driven

In case of cone, the diameter of package reduces as the yarn traverses from the base to the tip. Therefore, situation becomes more complicated than the cheese winding. It is important to maintain the conditions so that the diameter in the base and diameter at the tip increases at the same rate. Surface speed of the cone is also less in the tip part as compared to that of base part.



Let w_1, v_1 and s_1 are the winding, traverse and surface speeds respectively at cone section diameter d_1. Similarly, w_2, v_2 and s_2 are the winding, traverse and surface speeds respectively at cone section diameter d_2. For the analysis, a small-time interval δt is considered

Conditions for Uniform Package (Cone) Building: Spindle-driven



Length wound per unit surface area at cone diameter $d_1 = \dfrac{w_1 t}{\pi d_1 v_1 \delta t}$

Length woundper unit surface area at cone diameter $d_2 = \dfrac{w_2 t}{\pi d_2 v_2 \delta t}$

For uniform increase in cone diameter, the boundary condition is

$$\frac{w_1 t}{\pi d_1 v_1 \delta t} = \frac{w_2 t}{\pi d_2 v_2 \delta t} \quad or \quad \frac{w_1}{w_2} = \frac{d_1 v_1}{d_2 v_2}$$

It is known that $\tan\theta = \dfrac{\text{Traverse speed}}{\text{Surface speed}} = \dfrac{v}{s}$

Therefore, $\tan\theta_1 = \dfrac{v_1}{s_1}$ and $\tan\theta_2 = \dfrac{v_2}{s_2}$

and $w_1^{\ 2} = s_1^{\ 2} + v_1^{\ 2}$ and $w_2^{\ 2} = s_2^{\ 2} + v_2^{\ 2}$

$$\text{So, } \frac{w_1^{\ 2}}{w_2^{\ 2}} = \frac{s_1^{\ 2} + v_1^{\ 2}}{s_2^{\ 2} + v_2^{\ 2}} = \frac{v_1^{\ 2}\left(1 + \dfrac{s_1^{\ 2}}{v_1^{\ 2}}\right)}{v_2^{\ 2}\left(1 + \dfrac{s_2^{\ 2}}{v_2^{\ 2}}\right)} = \frac{v_1^{\ 2}(1 + Cot^2\theta_1)}{v_2^{\ 2}(1 + Cot^2\theta_2)}$$

$$= \frac{v_1^{\ 2} Sin^2\theta_2}{v_2^{\ 2} Sin^2\theta_1}$$

From boundary condition we know that $\dfrac{w_1}{w_2} = \dfrac{d_1 v_1}{d_2 v_2}$

$$\text{So, } \left(\frac{w_1}{w_2}\right)^2 = \left(\frac{d_1 v_1}{d_2 v_2}\right)^2 = \frac{v_1^{\ 2} sin^2\theta_2}{v_2^{\ 2} sin^2\theta_1}$$

or $d_1^{\ 2} sin^2\theta_1 = d_2^{\ 2} sin^2\theta_2$ or $d \sin\theta$ = constant

$$\tan\theta = \frac{\text{Traverse speed}}{\text{Surface speed}} = \frac{V_t}{\pi d n}$$

where d and n are package diameter and r.p.m. respectively

$$V_t \cos\theta = \pi d n Sin\theta$$

Conditions for Uniform Package (Cone) Building: Spindle-driven

Remarks:

1. For uniform increase of diameter, $d\sin\theta$ should be constant. Therefore, $V_t\cos\theta$ should be constant during one traverse from base to the tip of the cone.
2. As we move towards the tip, the d reduces, so θ increases. As θ increases, $\cos\theta$ reduces. So we need to increase V_t such that the $V_t\cos\theta$ remains constant