

5-29-2021

## Analysis of the Residual Yarns in the Doffed Packages from Warp Creel.

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### Recommended Citation

Shahin, A. (2021) "Analysis of the Residual Yarns in the Doffed Packages from Warp Creel.," *Mansoura Engineering Journal*: Vol. 13 : Iss. 2 , Article 22.

Available at: <https://doi.org/10.21608/bfemu.2021.173279>

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with increasing the press force between package and drum, but the relation between package density and yarn tension is linear in the range between 10 and 24 gr.

Ref. /2 and 3/ show the relationship between number of winding per double package stroke and package diameter. For drum winding the number of winding per double package stroke decreases with increasing package diameter and for precision winding the number of winding per double stroke remains constant with increasing package diameter.

In ref. /4/ it was found that the normal force to yarn element on package surface is proportional to yarn tension and inversely proportional to package diameter. In this work the doffed packages from warp creel were statistically analysed. Also the effect of the following parameters on package density was measured:

- degree of contact between package and drum
- yarn tension due to adjustment of yarn brake.

In addition to this experimental work a theoretical analysis of the factors affecting package density is made

#### EXPERIMENTAL

##### a) Statistical Analysis of the Doffed Packages From Warp Creel.

###### Specifications of warp creel :

- Benninger warp creel (v - shape)
- Creel capacity 645 ends
- Actual number of packages 615
- Yarn count : cotton Ne 14
- Total net weight of full packages = 1146,98 kg
- % eg weight of residual yarns = 8.8 %

Table (1): Statistical analysis of the doffed packages

weight of the yarn on the doffed packages (gr)	number of packages	calculations
0 - 40	56	
41 - 80	60	
81 - 120	90	n = 615
121 - 160	93	$\bar{x}$ = 165
161 - 200	94	$\sigma$ = 88,77
201 - 240	106	
241 - 280	67	c.v = 53,7%
281 - 320	16	
321 - 360	19	
361 - 400	10	
401 - 440	3	
441 - 480	1	

As shown in Table (1) the mean value of yarn weight is 165 gr and the coefficient of variation for these packages is 53,7%.

These doffed packages must be unwound again and need to excess costs to form another full packages, or it can be used for other textile processes.

b) Effect of the Adjustment of Yarn Brake on Package Density During Winding Process.

On a Schlafhorst winding machine four packages were produced with the same dimensions and at different adjustments of yarn brake.

Specification of winding machine :

- machine mark : Schlafhorst Autoconer
- yarn withdrawal speed : 940 m/min.
- type of winding : drum winding
- yarn material : cotton Ne 20
- angle of winding :  $14^\circ$
- conicity angle of package  $9^\circ 15'$

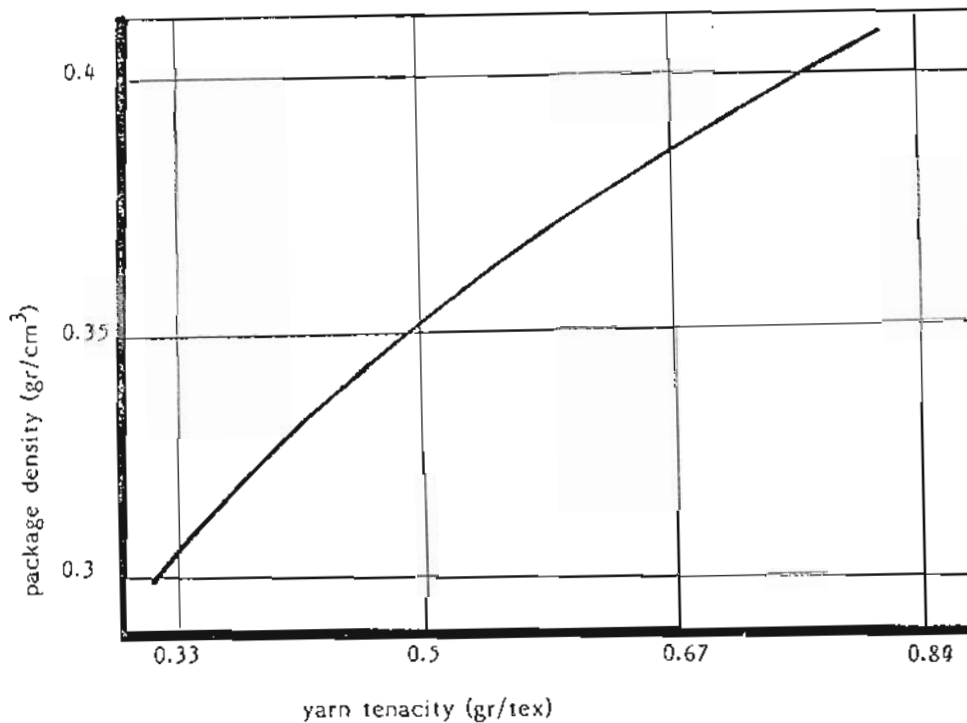


Fig. (1) Yarn tenacity versus package density .

As shown in Fig.(1) the package density increases non-linearly with increasing the degree of adjustment for yarn brake.

c) Effect of press force between package and drum on package density :

On the same winding machine as mentioned in part (b) four packages were produced at different values of press force between package and drum

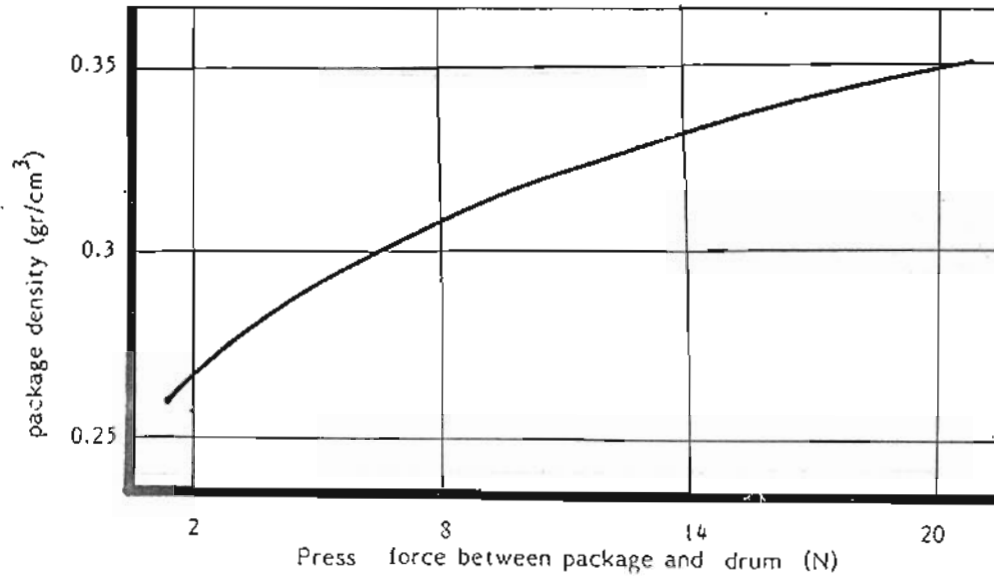


Fig. (2). Press force between package and drum versus package density

As shown in Fig.(2) the package density increases non-linearly with increasing the press force between package and drum

d) Effect of the adjustment of package diameter on yarn length

On the same winding machine as mentioned in part (b) four packages were produced under the same conditions on four winding units and the following data for cotton yarn Ne 20 were recorded :

Table: (2) Specifications of package weights and lengths

mean package diameter (cm)	package weight (gr)	yarn length (m)
17,45	1294	43766
17,65	1395	47182
18,75	1492	50463
18,75	1492	50463

As shown in Table (2) for the same package characteristics and the same setting of the winding units any small variation in package diameter gives a great difference in yarn length on the package.

DISCUSSION

- 1- The total doffed packages have a yarn weight of 101.3 kg. To form a new package from these residual amounts of yarns, this needs a winding time 3,42 Hr on a winding machine with the following data :

- winding units per machine = 50
- yarn speed 940 m/min

- machine efficiency = 70%
- yarn count Ne 40

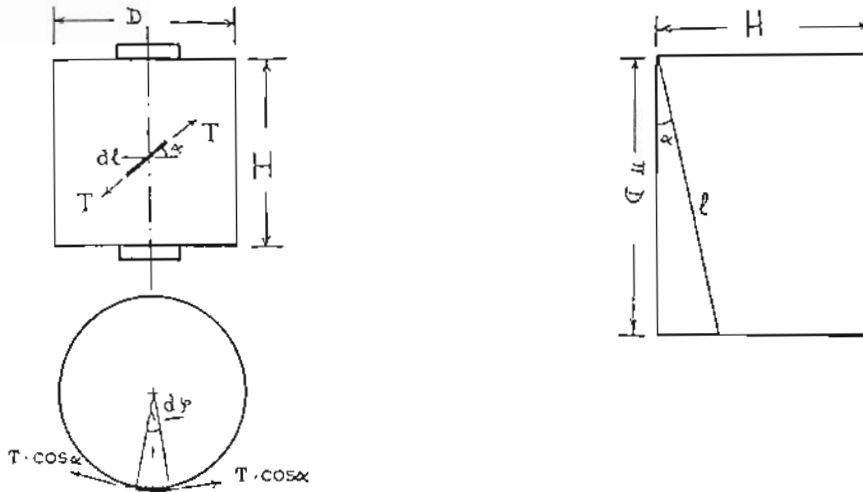


Fig.(3): Arrangement of yarn length per one wind on package surface and analyses of yarn tension on yarn element

2- By Considering yarn element on package surface as shown in Fig.(3) and by analysing the static yarn tension in axial and normal to axial direction of the package,

$$\begin{aligned} \text{in axial direction} &= T \sin \alpha \\ \text{normal to axial direction} &= T \cos \alpha \end{aligned}$$

and by analysing the value  $T \cos \alpha$  in the radial direction of the package, then the radial component is:  $2 T \cos \alpha \sin \frac{dy}{2}$ , and for small value of  $dy$   $\sin \frac{dy}{2} \approx \frac{dy}{2}$ , the radial component becomes,

$$T \cos \alpha \cdot dy$$

Assuming  $P$  is the radial force per unit length due to yarn tension,

$$\begin{aligned} \text{then } P dl \cos \alpha &= T \cos \alpha dy \\ P dl &= T dy \end{aligned}$$

$$\text{and } \int_0^l P dl = \int_0^l T dy$$

where  $l$  = yarn length per one wind of yarn on package surface

$$Pl = 2 T T$$

$$P = \frac{2 T T}{l}, \quad l = \pi D / \cos \alpha \text{ for drum winding} \quad (1)$$

From eq.(1) the radial force per unit length is proportional to yarn tension and inversely proportional to yarn length per one wind.

The package density increases with increasing the radial force per unit length. The type of winding (drum-or precision-winding) affects on the value of radial force.

By considering:

$n$  = number of windes per double package stroke for precision winding

then,  $L = \frac{\pi \cdot D}{2} \cdot \frac{1}{n}$  for precision winding (2)

where  $L$  = total yarn length per package stroke

and  $p = pL = \frac{2 \pi T T \cdot L}{1}$  (3)  
 $p$  = total radial force per yarn length  $L$ ,

for drum winding:

$L_1 = \frac{H}{\sin \alpha}$  and  $p_1 = \frac{2 \cdot \pi \cdot T \cdot H}{\pi \cdot D \cdot \tan \alpha}$  (4)

for precision winding

$L_2 = \frac{\pi \cdot D}{2} \cdot \left[ (\pi \cdot D)^2 + (2 \cdot H/n)^2 \right]^{1/2}$  (5)

and  $p_2 = \pi \cdot T \cdot n$

Example

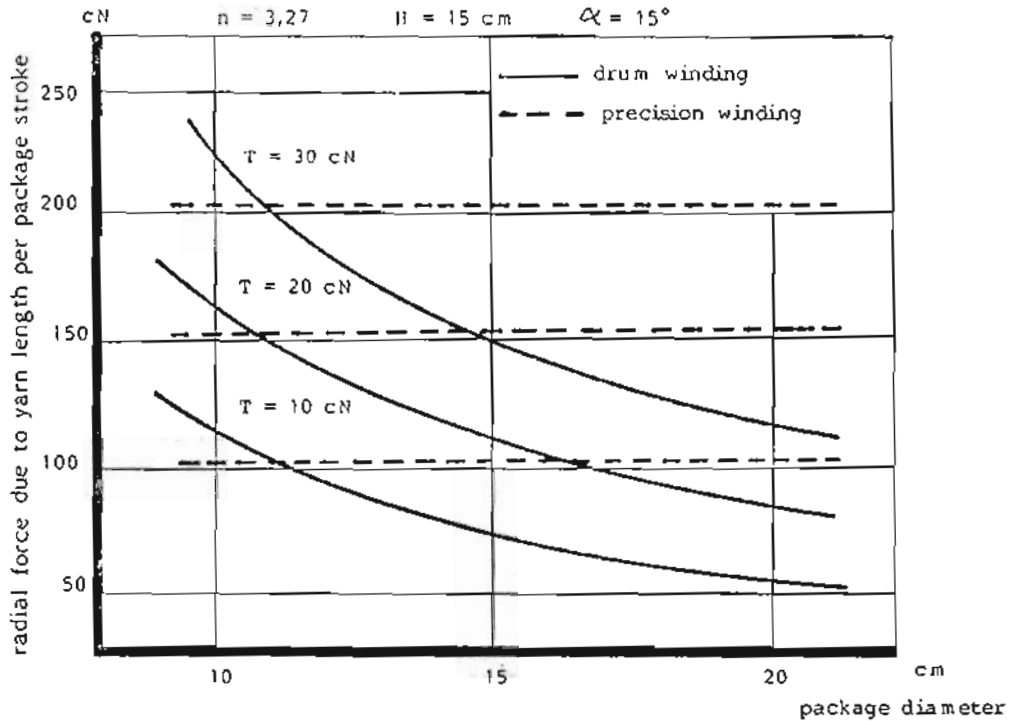


Fig. (4) : Radial force versus package diameter for drum-and precision-winding.



As shown in Fig.(4) the value of radial force for precision winding remains constant at different package diameters, but for drum winding the value of the radial force decreases with increasing package diameter

- 3- The press force between package and drum acts to change yarn cross section from circular to elliptical shape and this leads to an increase in package density.
- 4- The variation in full package diameter during winding process leads to variation in package yarn length. This variation in yarn length is affected by the type of winding and maximum package diameter (D).

from eq.(4):

$$\frac{d L_1}{d D} = 0 \tag{6}$$

From eq.(6) the rate of increase in yarn length  $L_1$  per package stroke H against package diameter D for drum winding is zero.

from eq.(5):

$$\frac{d L_2}{d D} = \frac{n \pi^2 D}{2 \left[ (\pi D)^2 + (2H/n)^2 \right]^{1/2}} \tag{7}$$

As shown in eq.(7) the rate of increase in yarn length  $L_2$  per package stroke H against package diameter is a function in package diameter, package stroke and number of winds per double package stroke.

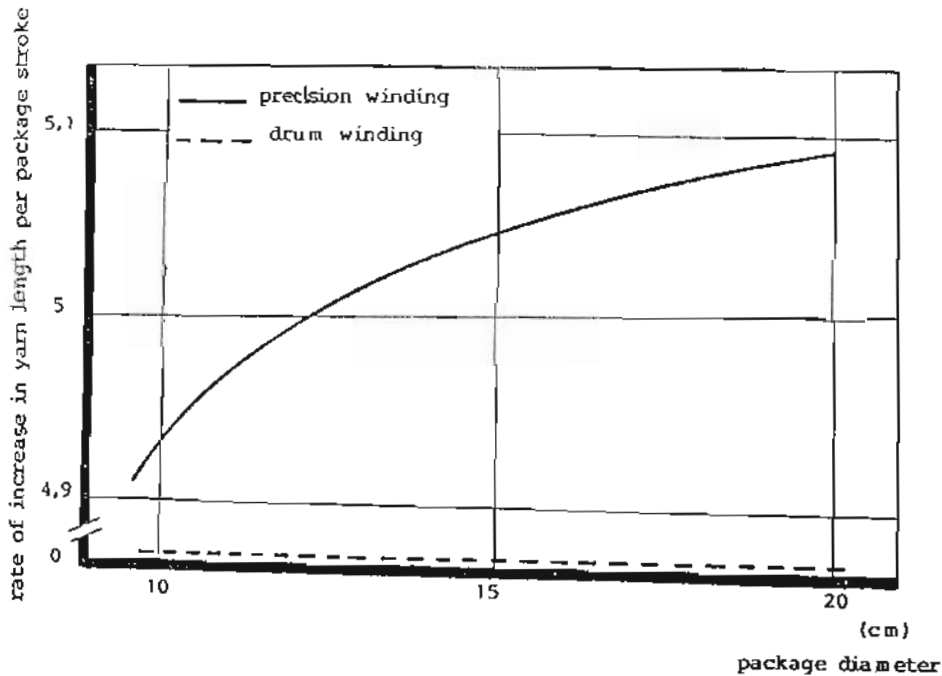


Fig. (5). The rate of increase in yarn length per package stroke versus package diameter



Fig.(5) shows the behavior of the value  $dL/\delta D$  against package diameter  $D$ , the value  $dL_2/\delta D$  (for precision winding) increases with increasing package diameter, but the value  $dL/\delta D$  (for drum winding) against package diameter equals zero. Any variation in the maximum value of package diameter  $\Delta D$  gives high variation in yarn length for precision winding than for drum winding.

#### CONCLUSIONS

- To produce packages for warping process, the conditions for all winding units in the winding machine must be the same. And all the used packages should be wound with the same winding type and winding characteristic
- For drum winding the package density decreases with increasing package diameter. This is due to decreasing the number of windes per double package stroke against the increase in package diameter. But the package density for precision winding remains constant with the increase of package diameter, because the number of winding per double stroke remains constant with the increase of package diameter.
- The used copses for winding the packages must be with the same dimensions and characteristics, because any variation in cops characteristics leads to a variation in yarn tension.
- The resultant radial forces from yarn layers in the package leads to an increase the package density gradually from outer package diameter to the inner diameter.

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