YARN TWISTING

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Abstract

The mechanism of twist insertion to the strand during ring spinning has been studied. The twisting of the strand occurs not only due to the rotation of twisting elements, but also due to the winding of yarn on the package. When the yarn is wound on a stationary cop by gripping and winding the yarn by hand, for every coil of yarn wind one turn of twist to the yarn is inserted. But the same yarn is over-end withdrawn from the cop, and all twists inserted during winding are removed during unwinding. Over-end unwinding rotates the yarn in the opposite direction. Since the yarn from the cop is over-end withdrawn during winding, the spindle speed is taken for calculating the twist in the yarn, whereas the flyer speed is taken for calculating twist in the roving due to the parallel unwinding of roving during spinning.

Key words:

flyer lead, over end unwinding, traveller, twisting, winding

Introduction

Twisting is a very essential process in the production of staple yarn, twine, cord and ropes. Twist is inserted to the staple yarn to hold the constituent fibres together, thus giving enough strength to the yarn, and also producing a continuous length of yarn. The twist in the yarn has a two-fold effect; firstly the twist increases cohesion between the fibres by increasing the lateral pressure in the yarn, thus giving enough strength to the yarn. Secondly, twist increases the helical angle of fibres and prevents the ability to aooly the maximum fibre strength to the yarn. Due to the above effects, as the twist increases, the yarn strength increases up to a certain level, beyond which the increase in twist actually decreases the strength of staple yarn. The continuous filament yarn also requires a small amount of twist in order to avoid the fraying of filaments and to increase abrasion resistance. However, twisting the continuous filament yarn reduces the strength of the yarn [1-2]. Yarn is often ply-twisted in a direction opposite to a single yarn twist to improve evenness, strength, elongation, bulkiness, lustre and abrasion resistance, and to reduce twist liveliness, hairiness and variation in strength [3].

The twisting of fibres strands are carried out on a roving frame, ring frame, rotor spinning and DREF spinning machines etc. This twisted strand has to be wound on the delivery package in a certain form for easy withdrawal of these strands in the next process. Since the open end of the yarn is rotated in the rotor and DREF spinning systems, the delivery package has to be rotated axially to wind the yarn. The twisting and winding operations are separated in the open-end spinning [4]. However, this is not possible on a roving frame or a ring frame.

There should be two rotating elements (the spindle and traveller or flyer and bobbin) in order to twist and wind the strand on the package. The winding rate should be equal to the delivery rate from the drafting device. As the winding on the diameter of the package varies continuously throughout the process, the difference in speed between the two elements also has to be varied continuously. Since the delivery rate is constant, the product of winding on diameter and the speed difference between the two rotating elements should be kept constant. On a roving frame, this is achieved by adjusting the bobbin speed continuously and keeping the flyer speed constant, whereas in ring spinning, only the spindle is rotated at a constant rate and the traveller is dragged around the ring by the yarn. Due to the frictional force between the ring and traveller, the required speed difference between the spindle and traveller is automatically adjusted. In both the ring and roving frame of the short-staple spinning system, the bobbin lead is used. For calculating twist in the roving, the flyer speed is taken into account, whereas in ring spinning, the spindle speed is considered [5-6].

Twist/cm in the roving = flyer speed in rpm)/ delivery rate in cm/min

Twist/cm in the yarn = spindle speed in rpm/ delivery rate in cm/min

The reasons for the above, and the mechanism of twisting strands on a roving frame and ring frame are not explained in textbooks or literature. In the present paper, the mechanism of twisting strands on a roving frame and ring frame is explained.

Mechanism of twist insertion to the strand

Twist insertion to the yarn when the spindle is stationary

We assume that the spindle is stationary and the traveller rotates in the ring frame. Each revolution of the traveller winds one coil of yarn onto the cop. This is similar to gripping and winding the yarn on a cop by hand. The yarn will rotate 360^0 per coil wind while winding the yarn onto a stationary cop by hand; hence the winding causes yarn twisting.

Length of yarn wound per revolution of traveller $= \pi d$

Turns/cm due to winding $= 1/\pi d$

where

d – Winding on diameter of cop or bobbin in cm.

If the yarn is unwound in parallel from the cop, the yarn will retain all the twists present in the yarn, whereas if the yarn is over-end unwound, unwinding a coil removes one turn of twist. The unwinding causes twisting. So, the twists inserted into the yarn during winding are removed during over-end unwinding. The over-end withdrawal may be from any side of the cop. If the traveller rotates in a clockwise direction to wind the yarn onto the cop, each coil of wind inserts one turn of 'Z' twist to the yarn. When the same is over-end unwound, every unwinding coil inserts one turn of twist in an 'S' direction, and so the resultant yarn will not have any twist.

Twist insertion into the yarn when the traveller is stationary

We assume that the traveller is fixed on a stationary ring and that the spindle is rotating at a constant speed. Every revolution of spindle winds one coil of yarn onto the cop. Here winding does not cause twisting, and hence the yarn in the cop will not have any twist. But if the yarn is over-end unwound, every unwinding of a coil of yarn inserts one turn of twist into the yarn.

Turns/cm due to over-end unwinding $= 1/\pi d$

The direction of twist insertion during over end unwinding depends on direction of yarn winding. If the spindle rotates in an anticlockwise direction to wind the yarn onto the cop, during over-end unwinding a 'Z' twist will be inserted into the yarn. But if the same yarn is unwound in parallel, the yarn will not receive any twist.

Twist insertion onto the yarn when both spindle and traveller rotate in opposite direction

It may be wondered why it should be necessary to rotate the traveller and spindle in the opposite direction, and also how to rotate the traveller in the opposite direction. This is only to enable the reader to clearly understand the mechanism of twisting. When both the spindle and traveller rotate in the opposite direction, each revolution of the spindle and traveller winds one coil each. The length of yarn wound per min and twist/cm can be calculated.

Length of yarn wound per min $= \pi\, d\, (N_S+N_T)$

Twist/cm due to winding $= - N_T/ \pi\, d\, (N_S+N_T)$

where

N_S – spindle speed in rpm,
N_T – traveller speed in rpm.

If the spindle and traveller rotate in clockwise and anticlockwise directions respectively, the direction of twist insertion due to winding would be ‘S’. But during over-end unwinding, the direction of twist insertion would be ‘Z’. + and - signs are used to represent the Z and S twist directions respectively.

Twist/cm due to over-end unwinding = $(N_T/ \pi\ d\ (N_S+N_T)) + (N_S/ \pi\ d\ (N_S+N_T))$

Twist/cm in the yarn after over-end withdrawal = $(N_S/ \pi\ d\ (N_S+N_T)$

Twist insertion onto the yarn when the spindle leads the traveller

In ring spinning, both the spindle and traveller rotate in the same direction. However, the spindle rotates at a higher speed than the traveller. If both rotate at the same speed, only the twisting of yarn takes place without winding. Due to the difference in their rotational speeds, the winding of the yarn takes place on the cop.

Length of yarn wound on the cop per min = $\pi d\ (N_S - N_T)$

Due to rotation, both spindle and traveller insert twists onto the yarn. If both the spindle and traveller rotate in a clockwise direction, a ‘Z’ twist is inserted to the yarn.

Turns/cm in the yarn = $N_T/\pi d\ (N_S - N_T)$

The winding rate should be equal to the delivery rate.

Length of yarn delivered (cm/min) = $\pi d\ (N_S - N_T)$

Here winding takes place in similar conditions to when the traveller is stationary and the spindle is rotating; hence winding does not insert any twist onto the yarn. On the other hand, during over-end unwinding one turn of twist is inserted for every unwound [[*]] of coil.

Turns/cm for unwinding = $1/\pi d$

Total twist present in the yarn after over-end unwound $= N_T/\pi d(N_S - N_T) + 1/\pi d$
$= N_S/\pi d(N_S - N_T)$

Since yarn from the ring cop is normally over-end withdrawn during the winding process, the spindle speed is taken for calculating the turns/cm in the yarn instead of using traveller speed. However, turns/cm in the roving is calculated by taking the flyer speed into account. This is due to the parallel withdrawal of roving during spinning.

Twist insertion onto the strand when flyer leads bobbin

Due to the difference in the speeds of the flyer and the bobbin, the winding of roving takes place on the bobbin.

Twist/cm due to twisting = $N_B / \pi d(N_F - N_B)$

Twist/cm due to winding = $(N_F - N_B)/ \pi d(N_F - N_B)$

Twist/cm in the roving = $N_F / \pi d(N_F - N_B)$

where

N_F - flyer speed in rpm,
N_B - bobbin speed in rpm.

If the roving is unwound in parallel, the roving will have the same amount of twist as in the bobbin, but if it is over-end withdrawn, it will lose a certain amount of twist during unwinding.

Turns/cm due to over-end withdrawal = $-(N_F - N_B)/ \pi d(N_F - N_B)$

Turns/cm in the roving after over-end withdrawal = $N_B/\pi d\ (N_F - N_B)$

Summary and conclusion

1. Yarn will rotate 360^0 per coil wound while winding yarn onto a stationary cop by hand. When it is over-end unwound from the cop, all twists present in the yarn are removed. Hence both winding and over-end unwinding cause twisting, but in opposite directions.

2. If the yarn is wound onto the cop by feeding the yarn perpendicular to the cop and rotating it, winding the yarn will not cause any twisting. But if the yarn is over-end withdrawn, the yarn will receive one turn of twist per coil unwound.
3. If the flyer leads the bobbin in the roving frame, twisting of the roving takes place due to both twisting and winding.
4. Since the yarn from the cop is over-end withdrawn during winding, the spindle speed is taken for calculating the twist in the yarn, whereas the flyer speed is taken for calculating the twist in the roving, due to parallel unwinding of the roving during spinning.
5. The over-end unwinding of yarn helps in getting extra twist to the yarn, and the parallel unwinding of roving will not introduce any extra twist to the roving. If the roving is over-end withdrawn during spinning, every coil unwound will insert one turn of twist onto the roving. Hence the break draft and the setting of the back roller have to be increased to facilitate the breakage of the twist present in the roving. Otherwise, undrafting of the strand will occur during drafting. Hence the roving is normally unwound in parallel from the bobbin during ring spinning.

References

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