Spinning Tension on Ring Spinning Frame

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Abstract

The purpose of this study is to devise a practical method to reduce tension variation on the ring spinning frame by measuring spinning tension. The results of the study are summarized as follows:

1. The variable speed drive of spindles is useful for reducing the tension variation for chases in which the winding angle varies during the vertical motion of the ring rail. It is possible to keep tension uniform if the speed of the spindle is properly adjusted with consideration given to the balloon height and the winding angle, and if the balloon-control ring is fixed.

2. The smaller the winding angle, the larger the spinning tension. A winding angle smaller than 23 degrees is undesirable.

3. Use of the antinode ring reduces the spinning tension level by an average of 15% and the variation in the spinning tension by 50%. The position of the control ring should be at 40 – 50% from the bottom of the balloon. A control ring of equal radius with the spinning ring can be used with satisfactory results.

4. The variation in spinning tension can be reduced by proper vertical motion.

Introduction

Theoretical analyses as to the spinning tension of the ring spinning frame have been made by many experts, but few seem to have made a continuous measurement analysis of a whole yarn of a cop.

The author has measured the spinning tension of the ring spinning frame continuously under various conditions and analysed the tension variation curves obtained from those measurements in an effort to keep tension at a constant level.

Guided by the results of these measurements, the author has tried the following methods to reduce the tension level and the tension variation of the ring spinning frame:

1. Adjusting the variable speed drive of a spindle to the vertical motion of the ring rail.

2. Setting a winding angle by using various bobbins and rings.

3. Balloon control by using an antinode ring.

4. Changing the moving distance of the lappet.

1. Apparatus for Measurement

An International General Electric Company tensiometer was used to measure spinning tension. It consists of (1) a tension-measuring section, (2) an adjusting section, and (3) a recording section.

Figure 1 shows the measuring section attached to the ring spinning frame. The following two kinds of spinning frames were used in our experiments: Howa’s ring spinning frame (made in Japan) which has a variable speed drive mechanism with a variable pitch, and Spinnbau’s Perfect ring spinning frame (made in Germany) which has a vertical movable spindle rail.

2. Diagram of Tension Curve

Figure 2 shows a diagram of the tension curve of a whole yarn of a cop. The abscissa shows a lift (time) and the ordinate values of tension. The belt-like black area on the left shows the difference in tension arising from the vertical motion of the ring rail. The right-hand side of the diagram shows the beginning of winding; tension is the highest at this stage.
3. Results of Measurement

3-1. The Variable Speed Drive of Spindle

The speed of the variable speed drive of the spindle was slowed down at the beginning of winding; was gradually stepped up as the amount of the wound yarn increased; and was fixed at a certain rate at a point about one-third from the bottom of the lift. The speed was increased at the bottom of each chase and lowered at the top in a continuing process until the bobbin was full.

Figures 3 and 4 show the condition of the variable speed drive of the spindle. Figure 3 is a poor example of the variable speed drive of the spindle. Figure 4 is a good example.

Figure 5 shows a diagram of the tension curves when 30's spun rayon yarn is spun by a fixed-speed drive. The tension level during a lift is the highest at the beginning of winding, being 27% higher than at the end of winding. The reason is that the balloon height is high and the winding angle small.

The difference in tension between the bottom and the top of each chase is due to the winding angle; this difference increases as the bobbin increases in the degree of fullness.

There are cases, however, where, if the balloon height is too short, the value of the tension level rises even at the beginning of winding and the number of yarn breakages is about the same as at the beginning of winding.

Figure 6 shows a diagram of the tension curves during the variable speed drive of a spindle. The mean speed of the variable speed drive of a spindle is an average of 7% above the speed of the fixed-speed drive.

Consequently, the tension level increases by about 14% and the difference in tension between the bottom and top of a chase is about 2.5 times larger than for the fixed-speed drive. The conceivable reason is that the method of the variable speed drive is unsuitable.

Figure 7 shows that the tension variation can be reduced by changing the spindle speed as shown in Figure 4, by changing the balloon height, by adding an antinoide ring, etc. By these means the mean speed can be increased by 12% over the speed of the fixed-speed drive of a spindle.
3-2. Effect of Winding Angle

Table 1 shows the relation between the winding angle and spinning tension. The tension level and the difference in tension between the bottom and top of a chase decrease as the winding angle increases.

Figures 8 and 9 show a winding angle and the types of bobbins. The difference in tension between the bottom and top of a chase in bobbin (c) is about half the difference for bobbin (a).

Figure 10 shows a diagram of the tension curve of Spinnbau's Perfect ring spinning frame. Since this frame keeps the balloon height uniform except at the beginning of winding, the variation of the tension level is extremely small and the effect of the winding angle is clearly recognizable.

In view of the close co-relation between tension and the winding angle keep within the limits of safely, the author recommends a winding angle of over 23-degree, considering the difference in tension between the bottom and top.

<table>
<thead>
<tr>
<th>Diameter of ring (mm)</th>
<th>Size of bobbin (mm)</th>
<th>Winding angle (°)</th>
<th>Tension level (g)</th>
<th>Difference in tension between bottom and top (g)</th>
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</thead>
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<tr>
<td>50.8</td>
<td>Top 17.8</td>
<td>21.17.6</td>
<td>6.5</td>
<td></td>
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<tr>
<td></td>
<td>Bottom 25.7</td>
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<td>&quot; Top 19.8</td>
<td>23.17.0</td>
<td>4.6</td>
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<tr>
<td></td>
<td>Bottom 28.1</td>
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<tr>
<td></td>
<td>&quot; Top 21.6</td>
<td>25.16.6</td>
<td>4.5</td>
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<td></td>
<td>Bottom 26.4</td>
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<td>&quot; Top 25.6</td>
<td>31.15.4</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bottom 27.0</td>
<td></td>
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</table>

Conditions of test

Yarn count 30's
Traveller GS 5/0
Ring Type N 50.8 mm (diameter)
Spindle 10,000 — 10,850 r.p.m.
Antinode ring 50 mm (diameter)
Lift 8 inches
Temperature 32.5°C
Humidity 56%
top of a chase and the number of yarn-breakages.

3-3. Antinode Ring

One of the current tendencies in the textile industry is to use higher and higher-speed spindles for ring spinning frames. The higher the spindle speed, the higher the spinning tension. The need arises, then, for a device to reduce spinning tension and tension variation. Balloon control is one means to that end.

3-3-1. Position of the maximum expansion of balloon

The position of the maximum expansion of the balloon is detectable by a theoretical formula. The author has taken a photograph of the balloon curve and found that the position of maximum expansion is $h/S = 30 - 40\%$ (where $S$ is the balloon height, and $h$ the height of the maximum expansion).

Figure 13 shows the relation between the height of the maximum expansion and the balloon height.

3-3-2. Diameter of an antinode ring and its fixed position

An antinode ring reduces the centrifugal force of ballooning yarn and stabilizes the running of a traveller. The author has made six kinds of antinode rings (diameter of the spinning ring being $74 - 106\%$), and set them at seven points in the balloon height.

Figure 14 is an illustration of the effect produced by the use of an antinode ring. The suitable diameter of an antinode ring is $74\%$ and the suitable setting position, considering the safety of the balloon, is at $50\%$ of the balloon height. The greater the balloon height,
the smaller the tension level. On the whole, tension level lessens by 15%. Figure 15 shows a relation between the balloon height and the best position for setting an antinode ring.

3-4. Balloon Height and Vertical Motion of a Lappet

The balloon height influences spinning tension greatly. The tension level increases as the balloon height increases. Again, spinning tension increases if the balloon height is too short, presumably because: (1) The balloon becomes a cone and its expansion prevents adjusting action even by the instantaneous tension variation of yarn; (2) When the balloon becomes a cone, the traveller inclines to the interior; (3) Besides, spinning tension at the end of winding, more than at any other time, is affected by mechanical defects, such as vibrations of a spindle and cops and irregularity of snail wire gauges.

Obviously, then, a desirable tension is obtainable if the balloon height is kept uniform as on Spinnbau’s Perfect ring spinning frame.

Figure 16 shows the tension diagram obtained from a vertical motion of a lappet in a larger range than on a conventional ring spinning frame.

Figure 17 shows the relation between the vertical motion of a lappet and the spinning angle. The range of the vertical motion is much larger than on the conventional ring spinning frame. The figure shows that it is impossible to keep the balloon height 8 inches high. The spinning angle also puts a limit on the balloon height. The author would limit the minimum balloon height at the end of winding to 5-1/2 inches.

To reduce the balloon height at the beginning of winding, it will be all right to suspend the vertical motion of the lappet—a “gradual lifting motion” and an “up and down motion”—until the bobbin bottom shape is formed at the beginning of winding.

The spinning angle at the beginning of winding had better be more than 19°. If it is less than 35°, yarn breakages increase, because the yarn contacting the front-bottom roller is poorly twisted. In other words, the smaller the spinning angle is, the larger the amount of yarn that comes into contact with the front-bottom rollers.

The spinning angle at the end of winding should desirably be less than 35°. If it exceeds 35°, yarn breakages increase, because it is difficult to twist the yarn between the nip point of the front roller and the snail wire. That is, the larger the spinning angle at the end of winding is, the larger the friction between snail wire and the yarn. Accordingly, the spinning angle must not be increased or reduced without limit.

Figure 18 is an example of how the lappet works. The lappet motion at the beginning of winding is stopped by the set of adjusting screws, (A) in Figure 18.

When a bobbin has been wound in a predetermined amount, the motion transferred out of the lifter is led through the accessory device (B) to the rocking arm (C), which latter moves the lappet vertically.

The lappet motion can always be controlled by replacing the shaper wheel (B). Also, since the maximum balloon height at the end of winding is designed to be 5-1/2 inches, a spinning angle within a safety range is obtainable.

![Fig. 15 Relation between the balloon height and the best position for setting an antinode ring](image1)

![Fig. 16 Diagram of tension curve obtained by our ring spinning frame which is an improvement on conventional frame](image2)

![Fig. 17 Diagram showing the vertical motion of lappet](image3)
A system which works the ring rail, the lappet and the antinode ring work at the same time is possible.

**Conclusions**

(1) While tension can be controlled only by the variable speed drive of the spindle, this necessitates a wide range of variable speed driving. The author considers that tension can be effectively controlled by any of the following steps—and most effectively by a combination of all three:

(a) Keeping the winding angle within the safety range.
(b) Use of an antinode ring.
(c) Improvement of the lappet motion.

(2) The winding angle, to be within the safety range, had better be over $23^\circ$.

(3) An antinode ring reduces the tension level and the tension variation between the bottom and top of a chase. The diameter of an antinode ring had better be smaller than usual. The spinning tension decreases by an average of $15\%$. It is desirable that an antinode ring be smaller in diameter than the spinning ring. Both may be of an equal diameter, however, if operating conditions require. The recommended setting position is at $40 \sim 50\%$ of the balloon height.

(4) The range of the vertical motion of the lappet must be as large within the range of $19^\circ \sim 55^\circ$ of spinning tension as is possible.

**Literature cited**