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Study Of Dynamics Of The Twisting Process In Pneumomechanical Spinning In The Presence Of

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Abstract:

For the modern textile industry, one of the characteristic trends remains the desire to increase the productivity of technological machines by increasing speed, which sets the task of reducing the cost of electricity in pneumatic mechanical spinning, the successful solution of which requires systematizing the accumulated information on new methods of shaping yarn and structures of shaping and twisting devices to clarify a number of problems in the development of the yarn forming method.

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This paper work presents the results of a study of the dynamics of the process of torsion of a yarn of pneumomechanical spinning (rotor spinning) in the presence of double false torsion, there were constructed dynamic mathematical models of the process of yarn twisting of pneumomechanical spinning in the presence of double false twisting in unsteady start modes and stopping of the forming-twisting device.

Keywords: Pneumomechanical spinning (rotor spinning); yarn; twist; rated twist; twist direction; spinning process; double false spinning; transient mode; start; stop; analytical dependence.

Introduction

Studies have shown the fundamental possibility of creating a design with double false torsion. Figure 1. shows the design scheme of such a forming and twisting device (FTD). [1], [2]

Due to the fact that when the number of yarn sections exceeds, the construction of mathematical models becomes very difficult, we accept additional assumptions:

1. The start-up process will be investigated from the moment the yarn moves in the forward direction.

2. The frequency of rotation of an additional organ of false torsion q is assumed to be a constant value.[3], [4]

3. We accept the spin of the yarn in the steady state:

in the first section $K_л = \frac{p}{v}$,

in the second section $K_p = \frac{n-q}{v}$,

in the third and fourth sections: $K_H = \frac{n}{v}$.

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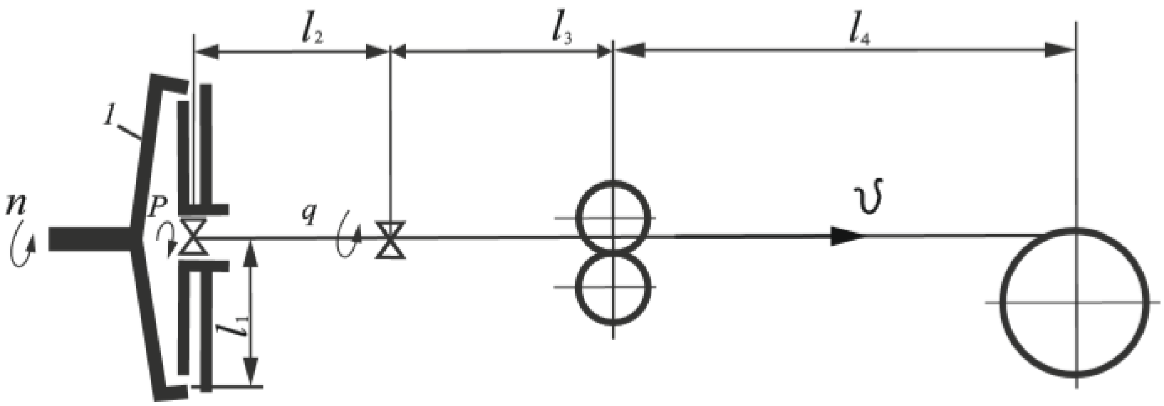

Fig. 1. Calculation scheme in the presence of double false torsion.

As we agreed, the start time corresponds to the beginning of the movement of the yarn in the forward direction with the simultaneous beginning of the action of both spinning organs of false twisting.[5], [6]

We will solve the problem in sections of the technological scheme. During dt the 1st yarn section receives the number of torsions equal to pdt. At the same time, this section loses, together with the leaving yarn, the number of torsions equal to $K_{n1}vdt$. On this basis, we write the differential equation:

$$dK_{n1} = \frac{p - K_{n1v}}{l_1} dt \tag{1}$$

Under appropriate initial conditions: at t=t_0 $K_{n1} = K_H$ this equation has a solution:

$$K_{n1} = \frac{p}{v}\left[1 - \left(1 - \frac{K_H v}{p}\right) e^{-\frac{vt}{l_1}}\right] \tag{2}$$

We proceed to consider the twist changes in the second section. We assume that during the time dt, the site, together with the outgoing yarn, loses the number of torsions equal to $K_{n2}vdt$.

During this same time, this section receives the number of torsions equal to $(K_{n1}v + n - p - q)dt$ together the incoming yarn, from the action of the chamber, the organ of false twisting and the additional organ of false spinning.[7], [8]

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Bearing in mind that the ratio of the increment of the number of twists of yarn to its length is an increment of twist, we can leave the differential equation for II sections of yarn:

$$dK_{n2} = \frac{K_{n1}v - p + n - q - K_{n2}v}{l_2}dt \qquad (3)$$

moreover, $K_{п1}$ is determined by expression (2). We have the initial conditions: at t=0 $K_{п2} = K_{H}$

The equation has a solution in the form:

$$K_{n2} = K_H e^{-\frac{vt}{l_2}} + \frac{n-q}{v}\left(1 - e^{-\frac{vt}{l_2}}\right) - \omega_2 \frac{n-p}{v}\left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_1}}\right) \qquad (4)$$

Here the following coefficient is accepted:

$$\omega_2 = \frac{l_1}{l_1 - l_2}$$

Now, we consider the twist of the third section. We accept that during the time dt, the site, together with the outgoing yarn, loses the number of twists equal to K_{13}dt. At the same time, the site receives the number of torsions $K_{п2}$dt together with yarn and qdt due to the action of an additional twisting body.[7], [8]

We compose a differential equation:

$$dK_{n3} = \frac{K_{n2}v + q - K_{n3}}{l_3}dt \qquad (5)$$

Under the initial conditions: t=0 $K_{n3} = K_H$ this equation has a solution in the form of :

$$K_{n3} = K_H e^{-\frac{vt}{l_3}} \frac{n}{v}\left(1 - e^{-\frac{vt}{l_3}}\right) + \omega_3 \frac{n}{v}\left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_3}}\right) +$$

$$+ \frac{n-q}{v}\omega_2\omega_3\left[\left(e^{-\frac{vt}{l_1}} - e^{-\frac{vt}{l_3}}\right) - \left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_3}}\right)\right] + \frac{n-q}{v}\omega_3\left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_3}}\right) \qquad (5)$$

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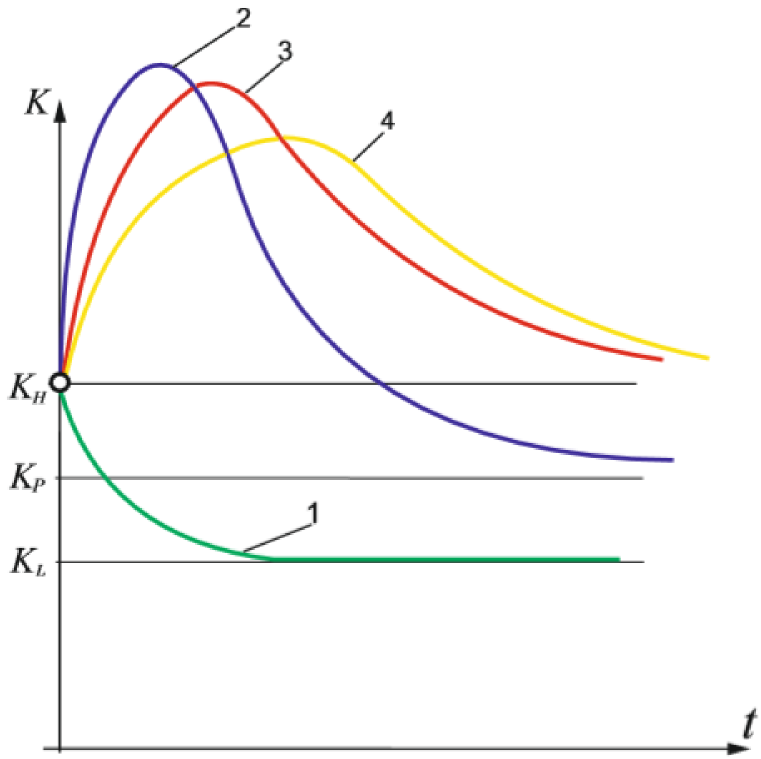

Fig. 2. The dependence of twist on time at startup.

The following coefficient is accepted here:

$$\omega_3 = \frac{l_2}{l_2 - l_3}$$

We proceed to consider the twist of the fourth section. We assume that in the time dt this section receives the number of twists equal to $K_{n3}dt$ together with the yarn coming from the third section. During the same time, the plot loses the number of twists equal to $K_{n4}dt$ the outgoing yarn. We compose a differential equation:

$$dK_{n4} = \frac{K_{n3}v - K_{n4}}{l_4}dt \qquad (7)$$

Under the initial conditions: at t=0 $K_{n4} = K_H$ this equation has a solution in the form of:

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$$K_{n4} = K_H e^{-\frac{vt}{l_4}} + \frac{n}{v}\left(1 - e^{-\frac{vt}{l_4}}\right) + \omega_3\omega_{42}\frac{n}{v}\left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_4}}\right) +$$

$$+ (\omega_{44} - \omega_3\omega_{44})\frac{n}{v}\left(e^{-\frac{vt}{l_3}} - e^{-\frac{vt}{l_4}}\right) + \omega_2^2\omega_{43}\frac{n-p}{v}\left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_4}}\right) -$$

$$- \omega_2\omega_3\omega_{42}\frac{n-p}{v}\left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_4}}\right) - (\omega_2\omega_{21}\omega_{44} - \omega_2\omega_3\omega_{44})\frac{n-p}{v}\left(e^{-\frac{vt}{l_3}} - e^{-\frac{vt}{l_4}}\right) -$$

$$- \omega_3\omega_{42}\frac{n-p}{v}\left(e^{-\frac{vt}{l_2}} - e^{-\frac{vt}{l_4}}\right) + (\omega_{42} - \omega_3\omega_{43})\frac{n-p}{v}\left(e^{-\frac{vt}{l_3}} - e^{-\frac{vt}{l_4}}\right) - \omega_{44}\frac{q}{v}\left(e^{-\frac{vt}{l_3}} - e^{-\frac{vt}{l_4}}\right) \qquad (8)$$

Here are the coefficients:

$$\omega_{21} = \frac{l_2}{l_1 - l_2} \quad \omega_{43} = \frac{l_1}{l_1 - l_4} \quad \omega_{42} = \frac{l_2}{l_2 - l_4} \quad \omega_{44} = \frac{l_3}{l_3 - l_4} \quad \omega_{45} = \frac{l_3}{l_2 - l_4}$$

Conclusion. Thus, based on the constructed models, we can determine the maximum values of twists in all sections and the moments at which they will take place. In addition, we can determine the length of the yarn produced with a twist that differs from the nominal by more than a predetermined small value at a stop. Curves 1, 2, 3, 4 correspond to a change in the twists $K_{п1}$, $K_{п2}$, $K_{п3}$, and $K_{п4}$, respectively (Fig. 2).

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