Journal of the Technical University of Gabrovo, Vol. 46’2013 (48-51)

ИЗВЕСТИЯ
на Технически университет
Габрово

ЗАКОН НА ДВИЖЕНИЕ НА МЕХАНИЗЪМ РЕАЛИЗИРАЩ НАВИВАНЕ НА КОНУСНИ НАМОТКИ

MOTION`S LAW OF MECHANISM REALIZED WINDING OF CONE COILS

Борислав Стоянов[*]
Технически университет – Габрово

Статията е постъпила на 23 септември 2013 г.; приета за отпечатване на 11 октомври 2013 г.

Abstract

This article discussed the law of motion of the ring rail of ring spinning machines. The mathematical law of motion for rising and lowering of ring rail is worked out. The problem of regular winding of spools with conical shape is discussed. An even distribution of yarn upon conical surface of spool is determinated with correction of the law of motion of ring rail.

Keywords: ключова дума; ключова дума; ключова дума; ключова дума; ключова дума.

INTRODUCTION

Winding of yarns in ring spinning machines is one of the most important processes. The proper running out is significant for high quality producing of yarns, its stable structure on the spool, abilities for transporting without any disturbance in the shape, prepackaging in bobbin-winding frame and finishing. Building of proper body shape of spinning spool in respect of taper surface of winding and preserving of conical shape layers of wounded yarn coils is the main goal of this research. To achieve this object the strong mathematical dependences have to be founded for exact movement of winding mechanism in ring spinning machine

APPROACH

I. Basic law of motion of ring rail.

The law of motion of ring rail which is obtained from previous kinematic mechanisms made the forming process of main and cross layers. Knowing the rule of moving of ring rail and the type of transmissions driving it, could be received easily the form of cam.

With higher possibility could be assumed that the helical line of winding over different surfaces will be tangential to the generant plane of helical line.

In winding process onto conical surface with equal pitch inclination of tangential plane is changed slightly therefore it will be assumed as constant and take out the ring rail`s movement.

Supposed that equation of formed conical surface which is plane for winding is described with Eq.(1), shape of if showed in Fig.(1).

$$y=\frac{H\left(R-x\right)}{R-R_o}. \tag{1}$$

Eq. (1) is formulated in coordinate system which axis Oy is direction of spindle axis Fig.(2); R is radius of full spinning spool; Ro – radius of spinning spool; H – height elevation of ring rail.

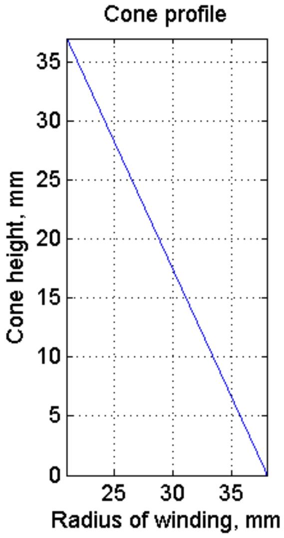

Fig. 1. Form of conical surface of yarn layers on spinning spool

When the yarn is wounded onto conical surface in way of helical coils with equal distance between them is definited the next equation:

$$xn_t = C_1, \tag{2}$$

where n_t – revolution of spindels; x – variable radius of winding.

---

[*] *Tel: +359 66 827 246; e-mail: stoyanov_b@mail.bg*

ISSN 1310-6686© 2013 Известия на Технически университет Габрово

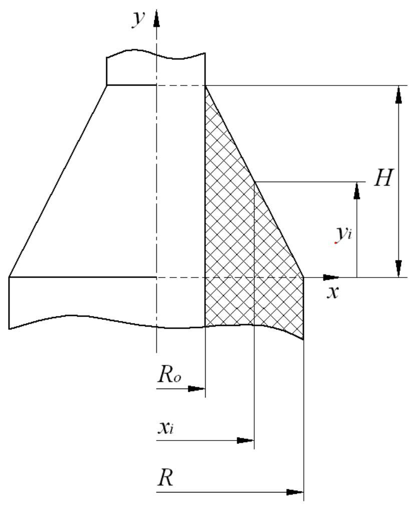

Fig. 2. Dimensions in spool building

The codition for positioning with equal distance between neighbour coils is described with:

$$\frac{dy}{dt}=C_2n_t \qquad (3)$$

Replace Eq. (2) in Eq. (3) the next diferential equation is obtained:

$$\frac{dy}{dt}=\frac{C_2C_1}{x} \qquad (4)$$

Derived x from Eq. (1) and replaced in Eq. (4) is obtained:

$$\frac{dy}{dt}=\frac{C_2C_1}{R-\frac{R-R_o}{H}y}$$

$$\frac{dy}{dt}=\frac{C_3}{R-\frac{R-R_o}{H}y};$$

$$\left(R-\frac{R-R_o}{H}y\right)dy=C_3dt \qquad (5)$$

Integrated Eq. (5):

$$-\frac{H}{2(R-R_o)}\left(R-\frac{R-R_o}{H}y\right)^2=C_3t+C_4 \qquad (6)$$

At $y=0$ and $t=0$ the value C_4 is received:

$$-\frac{H}{2(R-R_o)}R^2=C_4 \qquad (7)$$

Replaced Eq. (7) in Eq. (6):

$$\frac{H}{(R-R_o)}\left\{R^2-\left(R-\frac{R-R_o}{H}y\right)^2\right\}=2C_3t \qquad (8)$$

$$R^2-\left(R-\frac{R-R_o}{H}y\right)^2=\frac{2C_3(R-R_o)t}{H}$$

$$R-\frac{R-R_o}{H}y=\sqrt{R^2-\frac{2C_3(R-R_o)t}{H}}$$

$$y=\frac{HR}{(R-R_o)}\left\{1-\sqrt{1-\frac{2C_3(R-R_o)t}{HR^2}}\right\} \qquad (9)$$

From Eq. (8) is founded, that for assumption made before the ring rail would be moved by parabolic law of motion.

At $y=H$ and $t=t_{up}$ the constant for rising of ring rail is obtained:

$$C_{3,up}=\frac{HR^2}{2(R-R_o)t_{up}}\left\{1-\left(1-\frac{R-Ro}{R}\right)^2\right\}, \qquad (10)$$

where t_{up} is the relative time for rising of ring rail versus time for winding of one layer.

At $y=H$ and $t=t_{down}$ the constant for lowering of ring rail is obtained::

$$C_{3,down}=\frac{HR^2}{2(R-R_o)t_{down}}\left\{1-\left(1-\frac{R-Ro}{R}\right)^2\right\} \qquad (11)$$

where t_{down} is the relative time for lowering of ring rail versus time for winding of one layer.

Transforming Eq. (10) and Eq. (11) are received:

$$C_{3,up}=\frac{H(R+R_o)}{2t_{up}} \quad \text{and}$$

$$C_{3,down}=\frac{H(R+R_o)}{2t_{down}}. \qquad (12)$$

Replace Eq. (12) in Eq. (9) the law of motion of ring rail of spinning machine is obtained – Fig.(3).

The mathematical equations are realized as algorithm in Matlab^{TM}. The initial conditions are as follows:

$H=37mm;$
$R=38mm;$
$R_o=21mm;$
$t_{up}=64;$
$t_{down}=36.$

Replaced upper parameters are obtained:

$$C_{3,up}=17{,}0547$$

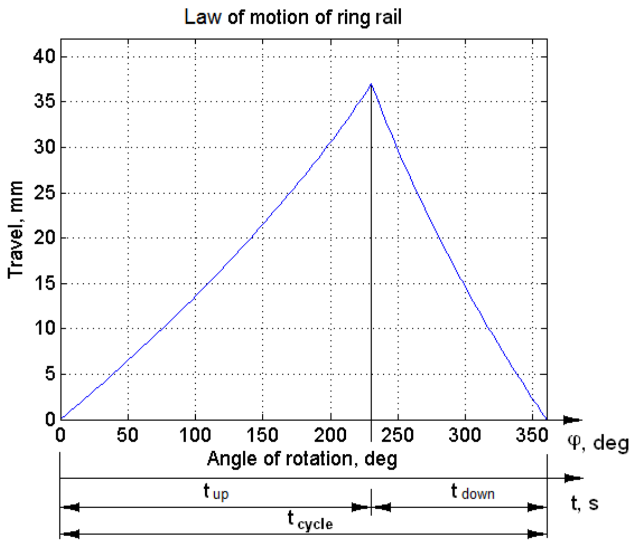

Fig. 3. Law of motion of ring rail

$$y_{up} = 82{,}7\left(1-\sqrt{1-\frac{1}{92}t_{up}}\right)$$

$$C_{3,down} = 30{,}3194$$

$$y_{down} = 82{,}7\left(1-\sqrt{1-\frac{1}{52}t_{down}}\right)$$

II. Correcting the basic law of motion of the ring rail taking into account the taper of the spool.

Appropriate solution to a problem arises from the fact that spinning spool having a conical shape which is the surface for yarn coils situation. When the machine is operated with a permanent law of motion of the ring rail, change in the radius of the winding is occurred, respectively structure and shape of the spool is changed from the beginning of the process of winding up its end. This change can lead to difficulties in unwinding of the yarn in subsequent processes, and to incorrected work of winding mechanism - Fig. (4).

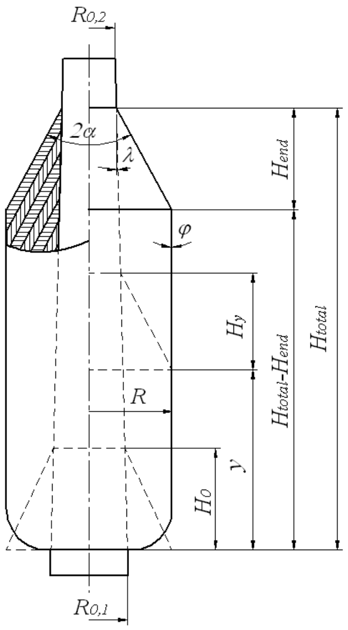

Fig.4. Geometrical parameters of spinning spool during winding process

In this coil significant deviations from the cylindrical shape may occured. Besides disturbances of form and structure to decrease the mass of the yarn in the coil compared to the estimated 8 ÷ 10%.

Particularly significant loss of mass of the coil increase was observed in the travel of ring rail that modern ring spinning machines up to 300mm.

There are analytical methods for the design of lever-chain mechanisms, taking into account the compensation of conical spools [1, 2].

The disadvantage is the time cost and low accuracy in mind that the task as a rule, be decided to choose only one parameter. Properties of mathematical models of winding mechanisms allow to extend the parameters taking into account the requirement to compensate the taper of the spool as a task of nonlinear programming.

The decision is to determined the number of variables $x_1, x_2, x_3 \ldots x_n$ in which some criteria of optimality $K = K(x_1, x_2, x_3 \ldots x_n)$ had extreme values, expressed as a series of inequalities. This approach to finding the parameters of the kinematic scheme of winding mechanism is necessary to make a preliminary study of mathematical relationships and the necessary conditions and also to develop an algorithm that allows the use of optimization methods in the computing environment. In the conical coil at the ring spinning machine, point of the wounded filament must be moved along the axis of the spool by the parabolic law of motion – Eq. (9). Studies of several authors [2, 3] showed that for assure of the cylindrical body shape of the coil (constant diameter along the axis of the coil) is necessary for its winding after few steps the height elevation H_y to be changed. Given requirements can be realized, providing a value formed by winding cycle for reducing of yarn guide. To determine the law of change of dependence H_y is introduced:

$$H_y = \frac{H_0\left(R^2 - R_{0,1}^2\right)}{\left(R^2 - \left(R_{0,1} - ytg\lambda\right)^2\right)}, \qquad (13)$$

where H_y - height of cone in the ring rail cycle at distance y from the base of winding; H_o - theoretical height of cone at $y = 0$ without the impact of flexible link in the formation of the winding nest; R - radius of winding; $R_{0,1}$ - radius of spool in the beginning of winding; y - distance along spool axis from the beginning of winding to recent coil; λ - angle between axis and its generant.

The height of the peak cone regarded to uniform coil:

$$H_{end} \geq \frac{R - R_{0,2}}{tg\alpha} = \frac{R - R_{0,2}}{\mu}, \qquad (14)$$

where $R_{0,2}$ - radius of spool at the top position o ring rail; α - angle between generant of the top cone and axis; μ - friction coefficient between filament and spool. Eq.(13) assumed:

$$H_o = \frac{H_{end}\left\{R^2 - \left[R_{0,1} - \left(H_{total} - H_{end}\right)tg\alpha\right]^2\right\}}{R^2 - R_{0,1}^2} \qquad (15)$$

where H_{total} is windings high.

CONCLUSIONS

The law of motion of the classical spinning machines is displayed. The influence of the tapered surface of the spinning spool on the form of spinning package during the winding of the yarn was obtained. The correction coefficient is determined by means of which the influence of the taper of the spinning spool to be eliminated.

REFERENCES

[1] Макаров А.И., Э.А. Попов, М.М.Раков и др., „Расчет и конструирование машин прядильного производства”, Москва, Машиностроение, 1981, 463стр.

[2] Попов Э.А., „К вопросу о наработке шпуль одиноковой плотности и цилиндрической формы на прядильных и крутильных машинах”, Изв. Вузов. Технология текстильной промышленности, 1971, №2, стр.133-136.

[3] Прошков А. Ф., „Исследование и проектирование мотальных механизмов”, М.: Машгиз, 1963, 315стр.

[4] Светик Ф.Ф., „Проектирование механизмов раскладки нити”, Машиностроение, Москва, 1984г., стр.70-71.