DYNAMIC ANALYSIS OF THE RING SPINNING PROCESS

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In this paper, the theory of the ballooning yarn has been adapted to the ring spinning process. The effect of the balloon control ring was incorporated into the mathematical model. The control ring is modeled as a frictionless circle constraint on the yarn path in the balloon. The balloon shape is determined by taking into account all the significant phenomena. The method of solution is applicable to more than one control ring in the threadline. The results from dynamic analysis are presented and show a marked effect of balloon control ring in reduce the yarn tension. The developed numerical solution procedures can be used to explore the regions of instability of the balloon.

Key words: *ring spinning, yarn balloon, balloon control ring*

1. Introduction

The ring spinning belongs to textile processes that are connected with rapidly rotating yarn about a fixed axis. The moving yarn creates three-dimensional curve and the imaginary surface generated by a loop of this yarn is called a balloon. The role played by yarn ballooning as a cause of tension variations in winding and unwinding processes has long been recognised in the textile industry. Indeed, in processes such as ring spinning, ring twisting and two-for-one twisting a yarn balloon is used as a tension regulation device. Up to now presented results [1], [2], [3] demonstrate the non-linear nature of this yarn ballooning phenomenon. Significant role plays for example air drag [4], yarn balloon-limiter [5] and contact friction. Except free balloon is often used controlled one. The first case occurs when the yarn is allowed to expand in space until it reaches a state of dynamic equilibrium, the second case when an appropriate limiter limits the yarn expansion. The effect of the balloon-limiter stands in stabilising the balloon, restricting its diameter and in reducing the yarn tension.

In ring spinning, the movement of the yarn from delivery rolls of drafting mechanism to bobbin represents a complex motion. As shown in Fig. 1, it can be divided into four or five regions. It depends on using free or controlled balloon. Next we consider the balloon constrained with one limiter. Region I includes motion from roll delivery point to the yarn guide (pigtail), region IIa from pigtail to the balloon limiter, region IIb from the limiter to traveller. In region III the yarn is moving on the surface of limiter. In region IV there is yarn passage through the traveller and region V includes yarn motion from the traveller to wind-point on the bobbin. Ballooning yarn in this region creates a secondary balloon. The yarn rotation in regions IIa and IIb gives a rise to dynamic forces, which determine the level of tension produced in the yarn and its distribution along the yarn path.

In recent papers [1], [6], [7], [8], the authors have described a computational model for ballooning yarn in ring spinning and gave some numerical results. Some of them used the equa-

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