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# A Simulation of the Extended States of Fiber Bundle in a Roller-drafting Process

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**Abstract**

Many studies indicate that the irregularity of the bundle of output sliver was caused by the irregular action of the fibers in the drafting zone. In this research, each staple fiber length of the bundle in the back roll nip and the accelerated points of every fiber in this bundle were generated by using Monte Carlo method according to the theories of the density function of the length distribution using nonparametric kernel estimation method and parabolic-type probabilistic density function of accelerated points distribution. The profile changes of the fiber number in cross section of the bundle in drawing process was simulated, and the various states of the bundle and the attenuation curve of bundle in the drafting zone were obtained. The profiles of the state curves of the bundle changes shows a turning area obviously and the profiles of the attenuation curve experienced a jerk near the front roll, which caused irregularities in the linear density of the output sliver.

*Keywords*: Simulation; Draft; Bundle; Acceleration Point; Distribution

## 1 Introduction

The staple fiber bundle is drawn thinner by the roll-drafting system which is a main operation unit for manufacturing staple yarn. However, in the process, the evenness of bundle that is worsened to a certain extent leads to the quality of the production and the efficiency of the subsequent processes reduced. According to the traditional theory, fiber shifting deviation (the dispersion of the accelerated points) could be the main factor for this unevenness. However, only two fibers with different locations can be described for this explanation, and the value of shifting deviation is both positive and negative, so it is necessary to research the moving state of the bundle composed of many fibers.

Grishin [1] classified the research approaches of the fibers moving in the drafting zone into four principal categories: the descriptive or qualitative approach, the mechanical approach, the statistical approach, and a combination of the mechanical and statistical approach. Balasubramanian [2] et al. used the fiber-end density and the output thickness in the dynamic model,

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concluding that the back roller is an actuating element. Assuming a random sliver and fiber end distribution, a correlogram and spectrogram based on a time series of the number of fibers in the bundle cross section generated through the simulation of computer was obtained by Johnson [3]. Yao [4] established the model of the fibers acceleration and simulated the acceleration point by computer on press-bar draft device. Lin and Yan [5] obtained the length distribution of the cotton fiber by nonparametric kernel estimation method, and found that this distribution had a good fitting effect. Yan and Yu [6] proposed a distribution of the float fibers acceleration based on the parabolic density function group and proved that this distribution was correct according to the fiber length distribution. Su [7] simulated the acceleration point of the float fibers in draft zone using the cotton length distribution proposed by Lin and Yan and the theory of the fibrogram, and proposed the number of the float fibers in the zone. Yan and Su [8] fitted the attenuation curve of the bundle in the draft process using the theory of parabolic density function class.

The former theories established the basis for the following research about draft. To control the fibers moving and optimize the roll drafting operation, a research of how a fiber bundle in back roll nip is extended is required. Based on the results of the cotton fiber length distribution of nonparametric kernel estimation and the float fibers acceleration distribution based on the parabolic density function group as well as theory of the fibrogram, each fiber length, its length outside the back roll nip and its acceleration point can be generated by using the Monte Carlo method. Then, the fiber bundle extended state on different moments is simulated under the different draft parameters on simple roll drafting system. This result shows the change characteristics and the composite effect of the fiber shifting deviation of the fiber assemble in draft process.

# 2 Theoretical Model

## 2.1 Model of the Distribution of Fiber Length

According to Lin and Yan's theory about the distribution of fiber length used by the nonparametric kernel estimation method, the normal kernel function has the best fitting effect, so the cotton fiber length distribution function may be represented as equation (1).

$$f_n(x) = \frac{1}{nh_n\sqrt{2\pi}} \sum_{i=1}^{k} n_i \exp\left(-\frac{(x-li)^2}{2h_n^2}\right) \tag{1}$$

Where $n$ is the total number of fiber tested, $n = \sum_{i=1}^{k} n_i$, $k$ is the set number, $l_i$ is the length of the $i$th set, $h_n$ is bandwidth, $h_n = 1$. $n$ and $l_i$ can be obtained by drawing out cotton samples and test on the Premier Large capacity cotton detector made in India.

## 2.2 Model of the Acceleration Point Distribution in Roll-drafting Process

The model of parabolic density function class describes the acceleration point distribution proposed by Yan and Yu that a parabolic curve can be used to describe the accelerated point