Bundle Flow Dynamics in Roll Drafting

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Abstract

Fiber bundles output from a draft operation have linear density irregularity. This study is dealing with modeling the dynamics of fiber bundle during roll drafting based on continuity, momentum balance, and a constitutive assumption. The simulation results from this model are compared with experimental results and analyzed by applying the concept of the Describing Function(DF). It can be confirmed that the simulation results agree well with experiments in a steady state, if the model parameters are good adjusted.

Introduction

To analyze the characteristic of a roll draft system, we set up a mathematical model for the dynamic behavior of fiber bundle in roll draft zone. The theoretical model was confirmed by measuring the linear density in draft zone and by applying the DF describing the thickness of output bundle for input draft ratios with various amplitudes and frequencies.

Theoretical Model

In a steady state a theoretical model describing the dynamic behavior of fiber bundle during a roll drafting can be described as following equations.
The model equation for mean velocity [1]:

$$\mu \cdot \{\frac{\partial v(t,x)}{\partial x}\} = v(t,x)^2 + a_0 \cdot v(t,x) \cdot (1 - \cos\frac{2\pi}{L}x)$$

or the model equation for linear density:

$$\mu \cdot \frac{\partial\{lb(t,x)\}}{\partial x} + a_0 \cdot (1 - \cos\frac{2\pi}{L}x) \cdot lb(t,x) = -m_0$$

(m_0: the rate of fiber mass flow in, μ, a_0: model parameters)

Experiments

The parameters μ, a_0 are adjusted to static experimental results, and linear density curves are obtained by cutting and weighing method. For the DF of the fiber bundle dynamics, the thickness of output bundle was measured for the input draft ratio with various amplitudes and frequencies.

Results

Fig.1 shows the linear density measured and the velocity profiles simulated, while the dots denote the data form experiments. Fiber bundles are accelerated as the bundle attenuation proceeds and might get a jerk while passing through the nip line of the front roll. The DF for a roll draft system approximated from experiments for various fundamental frequencies is given in Fig.2. The dotted curve stands for the simulation result from the model.

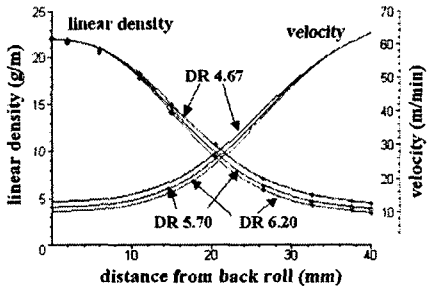

Fig.1 Profiles of the linear density and the mean velocity of fiber bundle for various draft ratios. ($v(L)$:68.1m/min, μ:3700m^2/min, a_0:112.3 for *DR:4.67*, a_0:126.0 for *DR:5.7*, a_0:137.5 for *DR:6.20*)

The amplitude of output thickness increases non-lineally with the increase of the amplitude of draft ratio, depending on the input frequency.

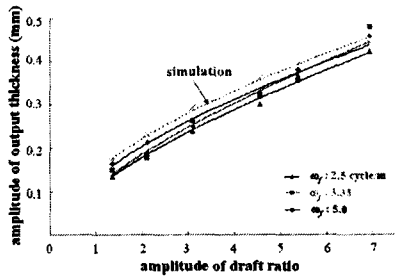

Fig.2 Describing Function of the roll draft system.

Conclusions

This research shows that fiber bundles might get a jerk while passing through the nip line of the front roll, to which the mathematical model offers a good approximation and the DF can be delineated nonlinearly , depending on the frequency.

References

1. Y. Huh,"Modeling of Fiber Dynamics in Roller Draft"the 6th ATC, HonKong, Aug.22-24,2001.