NUMERICAL STUDY ON THE POLYMER DRAWING OF THE SPUNBONDING PROCESS

by

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A polymer drawing model is established for the spunbonding process through numerical computation of the air flow field. The results show that the model predicts the filament diameter effectively. The paper contributes to in-depth understanding of the spunbonding technology.

Key words: *spunbonding, polymer drawing, simulation*

Introduction

Spunbonding is a non-woven technology which attenuates polymer melts into fine filaments with high velocity air in a drawing conduit. Our previous paper [1] has revealed the numerical simulation and experimental verification of air flow field of the drawing conduit. In this paper, the polymer drawing model of the spunbonding process will be established and simulated numerically. The filament diameters will be measured to verify the polymer drawing model.

Polymer drawing model

The polymer drawing model consists of the continuity, momentum, energy, constitutive, and crystallization kinetics equations, and boundary conditions. The simulation results of the air flow field are introduced into this model which is solved using a fourth order Runge-Kutta method.

Results and discussions

Experiments are carried out on the spunbonding equipment of a non-woven factory [2]. The image analysis method is employed to measure the filament diameters of seventeen spunbonded samples. Table 1 shows the measured filament diameters, predicted filament diameters and prediction errors. It can be seen that the maximum prediction error is 12.81% and the minimum is 6.74%. The mean prediction error of 9.95% indicates the predicted diameters tally well with measured diameters, which proves the polymer drawing model is effective.

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Table 1. Measured and predicted filament diameters of spunbonded samples

No.	Measured diameter [μm]	Predicted diameter [μm]	Prediction error [%]	No.	Measured diameter [μm]	Predicted diameter [μm]	Prediction error [%]
1	18.40	16.74	9.02	10	26.97	24.54	9.01
2	21.81	20.27	7.06	11	24.78	27.86	12.43
3	17.40	18.92	8.74	12	23.24	25.97	11.75
4	19.23	17.25	10.30	13	21.71	18.96	12.67
5	21.56	23.57	9.32	14	23.04	20.78	9.81
6	19.98	21.63	8.26	15	19.88	21.34	7.34
7	19.31	16.94	12.27	16	20.18	18.26	9.51
8	18.63	20.89	12.13	17	22.01	24.83	12.81
9	23.44	25.02	6.74				

Conclusions

The polymer drawing model of the spunbonding process is established and simulated. The model predictions have good agreements with the experimental data. The results given in tab. 1 show a high accurate prediction, the model is helpful for insight into in-depth understanding of the spunbonding technology.

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