

## OPTIMAL DESIGN FOR THE DUAL SLOT DIE IN MELT BLOWING PROCESS

by

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*The parameters of the dual slot die in an industrial melt blowing equipment are designed optimally using the orthogonal experimental design method. The air flow fields of different die parameters are simulated. Effects of the die parameters are analyzed using variance analysis. The results show that the inset distance and slot width have significant effects on the air flow field while effect of the slot angle is unremarkable.*

Key words: melt blowing, computer simulation, optimal design

### Introduction

Melt blowing can manufacture non-woven fabrics of superfine fibers [1]. The die parameters influence the fiber diameter greatly. In this paper, the parameters of the dual slot die in an HDF-6D melt blowing equipment are designed optimally using the orthogonal experimental design method.

### Orthogonal experiment

To achieve the best combination of the die parameters, orthogonal experimental design is employed to arrange the simulation experiments. Each parameter has three levels as shown in tab. 1.

The computation area is 200 mm high and 15 mm wide. The computational fluid dynamics software FLUENT is utilized to simulate the air flow field. The inlet air velocity is 200 m/s. The outlet air pressure is 1 atm. The inlet and outlet air temperature are 583 K and 300 K, respectively.

An index named stagnation temperature ( $T^*$ ) is introduced on symmetry axis with a position of  $x = 10$  mm. In the stagnation point, the air kinetic energy will transform into the internal energy that combines with the enthalpy to become the total internal energy.

### Range analysis and variance analysis

As can be seen in tab. 2, the optimum die is Die 8 that has the highest stagnation temperature (437 K). The inset distance is the most important factor, followed by the slot width, and finally the slot angle. In variance analysis,  $F$  values of the slot width, slot angle, and inset distance are 14.645, 0.995, and 41.146, respectively. Values of Sig. are 0.064, 0.501, and 0.024, respectively, which means that the inset distance has the most significant effect,

**Table 1. Factors and levels**

Factor	Level 1	Level 2	Level 3
Slot width [mm]	1	1.5	2
Slot angle [°]	30	45	60
Inset distance [mm]	0	1	2

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**Table 2. Results of orthogonal experiments**

Die	Slot width	Slot angle	Inset distance	Stagnation temperature [K]
1	1	1	1	404
2	1	2	2	368
3	1	3	3	346
4	2	1	2	395
5	2	2	3	352
6	2	3	1	417
7	3	1	3	374
8	3	2	1	437
9	3	3	2	408

using variance analysis. Results show that the inset distance and slot width have significant effects on the air flow field while effect of the slot angle is unremarkable, which helps optimal design of the die.

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### Reference

- [1] Chen, T., Huang, X., Modeling Polymer Air Drawing in the Melt Blowing Nonwoven Process, *Textile Research Journal*, 73 (2003), 7, pp. 651-654

secondly slot width, and finally slot angle. The optimum parameters are level 3 of slot width, level 1 of slot angle and level 1 of inset distance.

### Conclusions

The parameters of the dual slot die in an industrial melt blowing equipment are designed optimally using the orthogonal experimental design method. Effects of the die parameters are analyzed