

Study on the Optimization of the Blending Ratio of the Magnetic Fiber Blended Yarns by Using MATLAB Genetic Algorithm Toolbox

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Abstract. Use the magnetic fiber, bamboo fiber and cotton fiber to spun into yarn. Analysis the properties of the blended yarn under different conditions of blended ratio. Use MATLAB genetic algorithm toolbox to ensure that the yarn blending ratio is optimal. It shows that the optimal blending ratio of three kinds of fiber of magnetic, bamboo and cotton is 67%, 13%, 10%.

1 Introduction

Magnetic fiber is a new type of functional fiber materials. It can promote blood circulation, enhance human immunity, keep warm and have health care function, when it is used in fabric and yarn.

At present the literatures of research and development on magnetic fiber are more and more, which is mainly for fiber health care propertie of new fiber development, but the research and introductions of product development on magnetic fibre blended yarn, the method of fiber fabric formation and the analysis of fabric performance are less. On the study of yarn blending ratio, the current research on blending ratio of two kinds of fibre has been widely studied, however, the three more kinds of fibre blended is vacant. The use of MATLAB genetic algorithm toolbox can be a good solution to this problem. This method can reflect the performance of different materials, but also can determine a more reasonable blending ratio.

2 The Process of Spinning Magnetic Fiber , Cotton Fiber and Bamboo Fiber.

Magnetic fiber surface is smooth with subtle vertical stripes. The cross section is relatively rules circular. With the increase of the content of magnetic, fiber surface is

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slightly rough^[1]. It is found that the breaking strength and elongation of the fiber decrease with the increase of magnetic content. When magnetic content is 50%, the tensile property is similar to that of polyester. It seems that magnetic fiber and cotton fiber are suitable for mixed spinning. The performance comparisons of common physical properties are shown in table 1.

Table 1 Performance Comparison Of Several Fibers

	Bamboo	Cotton	Magnetic	Polyester
Length (mm)	35	23-33	40	32-39
Fineness (dtex)	1.5	1.7	2.5	1.73
Regain (%)	13	11.1	2.0	0.4
Breaking strength (cN/dtex)	2.32	2.8-3.2	3.33	3.5-5.0
Breaking elongation (%)	17.5	7.0-8.3	32-41	30-40

Different magnetic content of the magnetic fibers have different mechanical properties. So the magnetic content of magnetic polypropylene fiber 50% is used in this paper. The cutting length of the magnetic fibers is 40mm, and the fineness of fiber is 2.5dtex. Bamboo fiber cutting length is 35mm, and the fineness of fiber is 2.5dtex. In order to study the properties of the blended yarn of magnetic fiber, Magnetic fiber content must be more than 50% to ensure the function of magnetic fibers in fabrics. Eleven kinds of blended yarns with different blending ratio are designed, and the same spinning process is adopted to get more accurate data. The blended ratio of yarns is shown in Table 2.

Table 2 The Blended Ratio Of Yarns

Number Component										0	1
Magnetic fibre	0	0	0	0	0	0	0	0	0	0	0
Cotton fiber		0	0	0	0	0	0	0	0	0	0
Bamboo fiber	0	0	0	0	0		0	0	0	0	0

3 Performance Analysis of Magnetic Fiber Blended Yarn

3.1 The Tensile Property Test

Test the tensile properties of the yarn. Use the YG061F electronic single yarn strength tester which is made by electronic equipment manufacturing company in Shandong. Clip

distance is 50cm. Tension is 5cN. Rotational speed is 500mm/min. Temperature is 20°C. Relative humidity is 65% + 5%. Do 10 experiments of tensile property for each yarn. The results are shown in Table 3.

Table 3 Test Results Of Yarns' Tensile Properties

Number	Breaking strength (cN)		Breaking elongation (%)	
	average value	crest value	average value	average value
1	215.5	241	10.88	12.98
2	178	191	8.71	10.83
3	201	216	8.14	9.73
4	181	194	8.57	9.31
5	170	195	8.14	9.42
6	197.5	221	6.59	8.03
7	188.8	197	8.07	9.52
8	183.3	205	9.6	10.4
9	189.7	207	6.75	9.35
10	187.4	206	9.74	10.95
11	187.6	206	8.39	10.91

3.2 Breaking Strength

From table 3, magnetic fiber strength is higher. But magnetic fiber surface is smooth and rigid, and the magnetic fiber's holding force is relatively poor. So when the magnetic fiber content increases, the slippage between the fiber increases. And blended yarn strength reduces.

3.3 Breaking Elongation

As is shown in table 3, when the magnetic fiber content is kept constant, the breaking elongation of bamboo fiber is more than cotton. The trend of the breaking elongation of the blended yarn is decreased with the decrease of the bamboo fiber. But when the content of the magnetic fiber is increased, the breaking elongation of the blended yarn is increased.

3.4 The Content of Yarn Hairiness Test

Test the content of yarn hairiness. The test instrument is YG172 type yarn hairiness tester made in China. Sample length is 5cm, each tube is test 5 times, test speed is 30m/min, temperature is 20°C and the relative humidity is 60% + 5%. Test results are shown in table 4.

Table 4 Test Results Of Yarns' Hairiness Number

Number	The average of the number of hairiness					
	1mm	2mm	3mm	4mm	5mm	≥6mm
1	432.6	73	22.4	11.2	8.2	9
2	639	132.6	48.6	26.2	16.8	26.8
3	769	172.4	58	31.6	16.2	19.6
4	764.4	212.8	82.2	44.2	26.8	30.8
5	622	152.6	54.8	10.6	15.4	21.2
6	632.2	139.8	43.4	16.8	6.4	6.4
7	460.8	56.6	8.6	2.4	1.4	2
8	579.8	77	13.8	3.6	1.4	1.2
9	535.4	85.4	21	7.2	2.6	5.4
10	425.4	52.6	9.8	4.4	1.8	2.2
11	455.4	76.8	13.8	2.8	0.6	0

Table 4 shows that hairiness content decreases with the increase of the magnetic fibers. In the process of increasing the twist, the change of hairiness and twist is proportional^[2].

3.5 Yarn Evenness Test

Test the yarn evenness. Test instrument is ME100 USTER evenness tester, the test speed is 200 m/min, the test time is 1 min, the temperature is 20 °C and the relative humidity is 60%. Test results as shown in table 5.

Table 5 Test Results Of Yarns' Evenness

Number	2	3	4	5	7	8	9	10	11
CV -%	24	21.12	22.43	23.38	24.3	21.88	22.29	22.87	25.93
Thin place/km	1385	1020	855	1355	1330	1100	1260	1150	1385
Thick place/km	790	770	785	1195	640	950	1055	545	930

Neps/k	365	4	4	6	2	3	5	1	5
m	00	60	95	50	95	80	75	35	

It can be seen from table 5, when the content of bamboo fiber and cotton fiber is similar, the thin places in the yarn are obviously reduced. And the thick places in the yarn increase with the increase of cotton fiber content. So when the fiber content is closer, the yarn irregularity is smaller^[3].

4 Using MATLAB Genetic Algorithm Toolbox to Determine the Optimal Blending Ratio[4]

The emphasis of this paper is to obtain an optimal proportion of blended yarn. Using MATLAB genetic algorithm toolbox can be more convenient to optimize the calculation. Genetic algorithm is a kind of optimization search method based on natural selection and genetic theory. At present, it has been infiltrated into many fields, and has become an effective tool to solve complex problems in various fields. Using the MATLAB genetic algorithm toolbox to optimize the process (simplified code) is as follows.

4.1 Write Objective Function

```
function Z=my fun(solutions)
x=solutions(1);
y=solutions(2);
u=solutions(3);
Coe=[0.25,0.2,0.3,0.25];
F=[f1,f2,-f3, -f4];
Z=Coe*F'; Z=Z;
```

4.2 Constraint Condition

```
function [c,ceq]=mycon(solutions)
c=x+y+u-1;
ceq=[];
```

4.3 Call the Main Program

```
opts=gaoptimset('PlotFcns',{@gaplotbestf,@gaplotstopping});
FitnessFunction=@myfun;
numberOfVariables=3;
[solutions,fval,exitFlag,Output]=ga(FitnessFunction,numberOfVariables,[],[],[],[],[0;0;0],[],[1;1;1],@mycon,opts)
fprintf('The number of generations computed is %d \n',Output.generations)
```

5 Results Output

The number of generations computed is solutions = 0.6704 0.2255 0.1041.

The result shows that The blending ratio of three kinds of fiber of magnetic, bamboo and cotton is 67%, 13%, 10%, when the weight coefficient is [0.25,0.2,0.3,0.25]

6 Conclusion

Magnetic fiber blended yarn has good performance in all aspects. When the content of the magnetic fiber is increased, the breaking elongation of the blended yarn is increased. The hairiness content decreases with the increase of the magnetic fibers. When the fiber content is closer, the yarn irregularity is smaller.

Through the analysis of the data and use the MATLAB genetic algorithm toolbox, it shows that the optimal blending ratio of three kinds of fiber of magnetic, bamboo and cotton is 67%, 13%, 10%.

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