Development of Airbag Fabrics by Polyester Filament

Guifen Yao[1, 2, a]

[1]College of Textile and Clothing Engineering, HeBei University of Science and Technology, in 70 Yuhua East Road, Shijiazhuang 050018, China

[2]HeBei Textile & Clothing Engineering Research Center, in 70 Yuhua East Road, Shijiazhuang, 050018, China

[a] yaogf@hebust.edu.cn

Keywords: airbag fabrics polyester filament permeability tensile properties

Abstract: The use of airbags can improve the safety of the car. Since the airbag appears to now, fabric for airbags has gone from the coated fabric to the uncoated fabric. The raw materials for airbag fabric has been nylon, especially nylon 66, which also prompts researchers from all of the countries continue to develop new airbag fabrics. In China, the airbag is gradually becoming the standard part of the car, but the airbag fabric's standard has been always in the absence, so the quality evaluation of airbag fabric has become a major problem. The experimental part designs six varieties of woven fabric by two polyester filaments and three weaves, then test its permeability and tensile properties. The test parameter for permeability is optimized by changing the test area and the test pressure. The relationship between permeability with pressure difference and the test area is analyzed. Based on the analysis of the test results, the optimal solution is fabric weaved by 400d polyester filament with basket weave.

Introduction

Today, the airbag has become one of the important parts of modern automobile. It hold up the umbrella for the passenger in the traffic accident. As the main body of airbag, the airbag fabrics should choose the most suitable raw material and process.

Researchers generally believe that the study of airbag fabrics were experienced three stages.

First stage: the airbag fabrics weaved with nylon 66 , coated by neoprene. The advantage of this fabric has good sealing and flame resistance, cheap. The disadvantage is that service life is short, softness can not meet the requirements. Its shortcomings mainly caused by paint, therefore, at this stage to develop a new type of coating is particularly urgent.

Second stage: the airbag fabrics still weaved by nylon 66 , but coated with organic silicon instead of neoprene. Compared to the first stage fabric, the advantage of this coated airbag fabric is that the fabric has stable performance, long service life, high wear resistance, soft, thin and light. Defect is high raw material prices, not suitable for mass industrial production.

Third stage: people began to research the uncoated fabric for coated airbag fabrics development encountered bottleneck. Uncoated fabric in order to achieve the same performance must has high-density. The uncoated airbag fabric is environmentally friendly products, reduces the car room environment pollution. But the processing is difficult, requirements for equipment is high.

In order to make the uncoated airbag fabric production meet the performance requirements, researchers used a molding technology. The molding technology has greatly reduced the production cost. This is the main reason for uncoated, molding airbags to occupy the market [1]. From a long-term point of view, diversified, intelligent, miniaturization, environmental protection is a new technology development direction of the airbag[2].

Airbag fabric should have small packaging volume, high strength, low elongation, good flexibility low permeability rate, good heat resistance and aging resistance. The permeability is the key performance to meet the use requirements[3].

Experimental details

Raw materials

Polyamide 66, also called nylon 66, industrial PA66 for short. Nylon 66 has good elasticity and fatigue resistance, high tensile strength and wear resistance, small friction coefficient and relative density. But the disadvantage of nylon 66 is high hygroscopicity and poor dimensional stability. As raw materials for the airbag fabric nylon 66 cost is too high[4].

Aramid fiber is also the raw materials for airbag fabrics. Aramid fiber is expensive and difficult to be processed, its industrialization application process has been slow [5].

The high strength polyester filament has almost the same mechanical thermal performance with nylon 66, its melting point is 258˚C are nearly the same with nylon 66 (260˚C). So high strength polyester filament is entirely possible that instead of polyamide 66 yarn as raw materials for the automobile airbag fabric [6].

Using 1000D and 400D polyester filament weave the fabric for airbag. The properties of the polyester filament is shown in table 1.

Table 1 The tensile properties of the polyester filament

Yarn Fineness[D]	Tensile strength[cN/D]	Tensile strength irregularity[%]	Tensile elongation[%]	Tensile elongation irregularity [%]
400	7.88	1.89	20.6	3.11
1000	9.03	2.40	14.0	2.72

Fabric characteristics

The woven airbag fabrics are plain weave, twill weave, and basket weave polyester filament fabrics. The yarns are 400D and 1000D polyester filament yarns. The fabric is woven on the Y200S little loom. The fabric specifications is shown in table 2. Can be seen from the table 2, fabric with twill weave has the largest mass per square meter. Mass per square meter is positively related to yarn fineness and yarn density.

Table 2 The fabric specifications

Fabric number	Yarn fineness[D]	Warp density[/10cm]	Weft density[/10cm]	Fabric weave	Mass per square meter[g/m^2]
1	1000	162	116	Plain weave	314.0
2	1000	172	184	Twill weave	404.4
3	1000	164	166	Basket weave	371.7
4	400	220	216	Plain weave	204.6
5	400	278	286	Twill weave	269.4
6	400	234	243	Basket weave	226.3

Fabric air permeability rate test

There is no specific standards about airbag fabric air permeability in national standard system. According to GB/T 5453 Textiles-Determination of the permeability of fabrics to air[7], use the YG(B)461D/Ⅱ type digital fabric air permeability instrument for the permeability test of airbag fabrics, and by varying the test area and the pressure difference on both sides to discuss the fabric permeability change law. The experimental steps are as follows:

1. Cut the fabric into specified size, each varieties cut 5 pieces, test and calculate the average.
2. Choose the test area of 20 cm^2 circle of fixed value installed on the instrument, choose the specification for the 4 mm nozzle.
3. Switch the instrument on, carries on the parameter setting, nozzle number is 4, the initial ventilation rate 20 mm/s, differential pressure of sample is set to 100 Pa.

4. Place the sample smoothly on the circle of fixed value, tread down the pedal with the foot, compact the sample.

5. Press the start button and instrument start testing automatically, when to set pressure difference on both ends of the specimen, the instrument automatically stop.

Fabric tensile properties test

According to the national standard GB/T 3923.1 textile-tensile properties of fabric-Part 1: determination of maximum force and elongation at maximum force using the strip method[8]. Choose UTM5150 electronic universal testing machine to test the fabric maximum force and elongation at maximum force.

Results

The influence factors of air permeability

The influence factors of air permeability include test parameters and fabric structure parameters. The fabric permeability result is shown in table3.

Table 3 the permeability of fabric at certain test area and differential pressure

Test area[cm^2]	20	20	50	50	100	100
Differential pressure[Pa]	100	200	100	200	100	200
Permeability of Fabric 1 [mm/s]	65	161.7	105.3	255.0	141.0	501.3
Permeability of Fabric 2 [mm/s]	138.7	678	365.3	806.0	664.0	1935.2
Permeability of Fabric 3 [mm/s]	45.5	157.7	64.0	188.3	78.3	244.7
Permeability of Fabric 4 [mm/s]	13.3	44.7	21.3	66.3	29.3	88.0
Permeability of Fabric 5 [mm/s]	76.3	233.3	153.7	342	302.0	1041.0
Permeability of Fabric 6 [mm/s]	9.7	26.0	15.5	45.3	22.7	83.0

From table 3, fabric 2 and fabric 5 with twill weave has the highest air permeability, fabric 1 and fabric 4 with plain weave has the higher air permeability than fabric 3 and fabric 6 with basket weave. The fabric with twill weave do not accord with the requirement of airbag fabrics in air permeability, therefore, shall not be taken into account in the process of development of airbag fabrics. Air permeability is positively related to test area and differential pressure.

The influence factors of the tensile strength

Table 4 tensile properties of the fabric for airbag

Fabric number		Maximum force[N]	Elongation at maximum force[%]
1	warp direction	1766.4	32.0
	Weft direction	1679.4	30.0
2	warp direction	1306.5	26.4
	Weft direction	1219.1	28.9
3	warp direction	1395.6	25.6
	Weft direction	1430.8	23.3
4	warp direction	1399.2	22.4
	Weft direction	1349.0	21.5
5	warp direction	973.7	16.4
	Weft direction	893.5	14.6
6	warp direction	1012.9	14.2
	Weft direction	998.4	13.8

The influence factors of tensile properties include yarn fineness, yarn strength, fabric weave and yarn density. The fabric tensile properties is shown in table4. Gauge length is15mm.

From table4, fabric 1 with plain weave has the highest tensile properties among fabric 1-3, fabric 4 with plain weave has the highest tensile properties among fabric 4-6. Fabric 2 with twill weave has the lowest tensile properties among fabric 1-3, fabric5 with twill weave has the lowest tensile properties among fabric 4-6. The fabric weave has significant affection on fabric tensile properties. The yarn strength and the yarn fineness have significant affection on fabric tensile properties. Compared with fabric 4-6, fabric1-3 has higher tensile properties. Fabric tensile properties is positively related to yarn fineness and yarn strength. Within the scope of the experimental data, warp yarn density and weft yarn density have no significant effect on fabric tensile properties.

Conclusion

From what has been discussed above, in the process of airbag fabric design, material selection and fabric structure design have a decisive influence on the performance of the result fabric. In the process of airbag fabrics air permeability test, the differential pressure and test area have a significant influence on the test result of air permeability.

1. The influence factors of air permeability: (1) the test parameters: when the differential pressure is the same, the larger the test area, the greater the air permeability; when the test area is the same, the larger the differential pressure, the greater the air permeability. Compared with test area, the differential pressure has significant affection on fabric air permeability. (2) design parameters: when the test parameter is the same, such as test area and differential pressure, the fabric weave has significant affection on fabric air permeability. The rules are as follows: twill weave > plain weave > basket weave. The thinner of the yarn fineness, the smaller the air permeability of woven fabric.

2. The factors affecting the tensile strength: (1) the fabric weave: plain weave fabric has the highest maximum force and elongation at maximum force. Basket weave fabric has the higher maximum force and elongation at maximum force than that of twill weave fabric. (2) the yarn count: The coarser the yarn fineness, the higher the maximum force and elongation at maximum force of the fabric.

In conclusion, the optimal scheme for airbag fabric design is the woven fabric with basket weave and 400D yarn .

References

[1] Li Jie, Chu Caiyuan. Automobile airbags and its fabric (1) - development course, present situation and prospect [J]. Journal of textile research, 1998 (12) : 33-34

[2] Liu Yan. The development and application of automobile airbag [J]. Science and technology entrepreneurs, 2013 (1) : 222

[3] Chen Shaojuan, Ma Jianwei. Technical textiles [M]. Beijing: China textile press, 2008:176

[4] High-performance polymer materials company (Germany), airbags on the world market trend [J], the international textile guides, 2004 (4) : 70.

[5] Qian Bozhang. Aramid development present situation and the market [J] new materials industry, 2008 (12) : 41

[6] Zhu Junwei, Fang Hongtian. The optimal selection of polyester filament of airbag and weaving discuss [A]. "Tianli cup" the 11th functional textiles, nanotechnology applications and low carbon textile international symposium [C]; 2001

[7] GB/T 5453-1997 Textiles-Determination of the permeability of fabrics to air

[8] GB/T 3923.1-2013 Textile-tensile properties of fabric-Part 1: determination of maximum force and elongation at maximum force using the strip method