A RESEACH ON IMPROVING SEAM PUCKER ON MOCK-SILK FABRICS

NGHIÊN CỨU KHẮC PHỤC ĐỘ NHĂN ĐƯỜNG MAY TRÊN VẢI PHI LỤA

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ABSTRACT

Mock-silk fabric has a big potential and is being used more and more widely in fashion industry; this fabric is manufactured in Viet Nam with high output by many companies like: Thai Tuan Textile, Phuoc Thinh Textile, The Hoa Textile, etc... Mock-silk fabric is used to make traditional "Ao dai", soirée, casual clothes, home garment … This kind of fabric has many outstanding features such as: soft handle, light, elegant appearance, air permeability , etc... however it also has some drawbacks like: fine yarn, high yarn density in fabric, low frictional coefficient thus it caused seam pucker on fabric during sewing processes.

This article focuses on simultaneous influence of processing parameters and sewing equipment on seam pucker on 100% mock-silk fabric and spandex-inserted mock-silk fabric, determines optimal solution in order to reduce seam pucker so that it can recommend the most effective methods of recovery for seam pucker in production of this kind of fabric.

Authors applied second level orthogonal experimental arrangement, optimization method and Design Expert software to design experimental alternates, process and analyse experimental results. The outcomes gave us optimal processing parameters and sewing equipment that remove seam pucker phenomena in the two mentioned above kinds of fabric.

TÓM TẮT

Vải phi lụa là một loại vải tiềm năng được sử dụng ngày càng rộng rãi trong ngành công nghiệp Thời trang; một mặt hàng sản xuất trong nước với sản lượng lớn tại nhiều công ty như: Dệt Thái Tuấn, Dệt Phước Thịnh, Dệt Thế Hoà v.v... Vải Phi lụa được sử dụng may trang phục áo dài truyền thống, trang phục dạ hội, trang phục công sở, đồ gia đình … Đây là loại vải có nhiều ưu điểm nổi bật: mềm mại, nhẹ, vẻ ngoài sang trọng, thoáng khí v.v... tuy nhiên cũng có những đặc điểm: sợi mảnh, mật độ dệt cao, vải trơn nhẵn, hệ số ma sát thấp nên trong quá trình may thường xảy ra hiện tượng nhăn đường may.

Bài báo trình bày kết quả nghiên cứu ảnh hưởng đồng thời của các thông số công nghệ và thiết bị may đến độ nhăn đường may trên vải phi lụa 100% polyester và vải phi lụa có pha chun spandex, xác định phương án tối ưu giảm nhăn đường may và từ đó đề xuất biện pháp khắc phục nhăn đường may một cách hiệu quả nhất trong thực tiễn sản xuất loại vật liệu này.

Các tác giả đã sử dụng phương pháp Qui hoạch thực nghiệm trực giao cấp 2, phương pháp tối ưu hóa và phần mềm Design Expert để thiết kế các phương án thí nghiệm, xử lý và phân tích kết quả thực nghiệm. Kết quả đã xác định được các thông số công nghệ và thiết bị may tối ưu khắc phục hoàn toàn hiện tượng nhăn đường may đối với hai mẫu vải nêu trên.

I. INTRODUCTION

In garment industry, producers are often under pressure of maintaining competition in global market. Competitive abilities mostly focus on productivity and quality. One of elemets which reduce aesthetic value and affect products'quality is seam pucker. This problem was cared about a long time ago and attracted a lot of researchers not only in Viet Nam but also throughout the world. Recently this topic has become hotter and hotter since the high requirements of garment product's quality. Though there have been a lot of recommendations to reduce this phenomenon, in real production there are no optimal solutions to completely resolve this problem.

Mock-silk fabric is made of modified polyester fiber, this fabric has many prominent features, it combines advantages of both traditional polyester and silk like : luster and soft handle from silk; high humidity, air permeability, good absorbency of sweat, comfort; physico-mechenical durability (washing durability, light durability, tensile

strength…); easy to keep, easy to use (no mildew, stain like silk fabric); no electrical charge and the price is reduced a lot as compared with silk fabric, henc this kind of fabric is widely used in making women haute couture.

Structural outstanding features of mock-silk fabric are: made of fine yarn, high yarn density, high luster and smoothness hence friction coefficient and bending stiffness are low which lead to this fabric is easily distorted and cause seam puckers during processing procedure.

Seam puckers appear in mock-silk fabric due to 2 reasons :

- The relative replacement between 2 layers of fabric at the seam or accumulation of upper layer beside the under one or slide of upper layer against the under one (F.1).

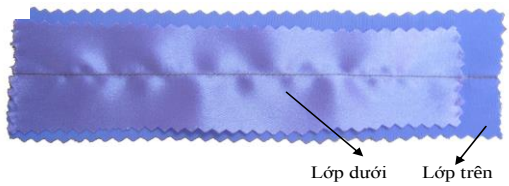

Fig. 1 Displacement of the under fabric layer against the upper one during production.

- The interaction between the thread and the fabric during sewing and using procedures, the thread which is stretched will affect the fabric at stitches and this makes the fabric to be bent and compressed.

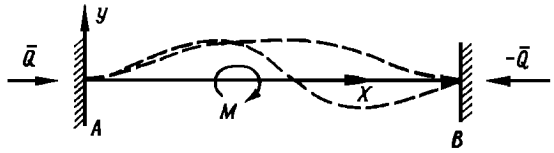

Fig. 2 Scheme of force impacting on the fabric between two stich-holes A and B.The fabric is controled by the thread which leads to seam pucker after sewing procedures.

Seam pucker is a problem which affects on products'quality in general and in mock-silk fabric in particular. There are many factors influencing on seam pucker in mock-silk fabric such as: the composition and structure of threads, production conditions, processing parameters and sewing equipment etc…In this study, the authors focus on researching simultaneous effects of the most important 4 processing parameters and equipment (thread tension, stitch density, needle count and sewing speed) on seam pucker in mock-silk fabric produced in Viet Nam in Thai Tuan Textile Company, HCM City. This research also compare the level of influence and the optimal values of the 4 processing parameters and sewing equipment in order to repair completely seam pucker in studied fabrics.

II. STUDY OBJECT AND METHODOLOGY

2.1 Study object

- Materials:

+ Fabric: Select 2 kinds of mock-silk fabrics popularly used for making Viet Nam traditional 'Ao dai' produced by Thai Tuan Textile Company – HCM City. These kinds of mock-silk fabrics have the same sateen pattern and the same weight of 140,5 g/m^2. Fabric 1 (F1) is 100% polyester mock-silk fabric and fabric 2 (F2) is of 93.7% polyester and 6.3% spandex mock-silk fabric.

+ Thread: Use Astra thread made by Coats Total Phong Phu company, 100% polyester staple yarn, 22 tex, Nm 80/3 and Tiket Number - 140.

- Experimental equipment and tools

+ One needle electronic sewing machine specifically used for fine silk fabric of JUKI, Japan, DDL-8700-7.

+ A set of tools used to measure the smoothness of seams under AATCC 88B-2001 standard.

+ Utilized a standard fabric-feeding mechanism (under-feed mechanism) due to its popularity and low price. Used NS needle which is anti-sticky and effectively decreases heat.

2.2 Methodology

+ Utilized multi-elemental experimental method based on second level orthogonal experimental arrangement. Experimental matrix $N = 2^{K-p}+n_0+2K$ (k=4, p=1) with 20 experimental alternatives, in which there are 8 alternatives around the core, with the confidence $\alpha = \pm 1.68$. With each alternative,

there will be 3 experiments conducted at the same time.

+ Used one-goal optimization method which is executed according to expected function method (belonging to analytical method) researched by Harrington (1965), Gatza-Millan (1972) and Derringer & Suich (1980).

+ Employed Design Expert software which is modern and able to process experimental data of different algorithms, in which there is orthogonal experimental arrangement and one or multi-objective optimization method.

Table 1. Variable range of studied objective

Elements	Values			Variable range ($\triangle X_j$)
	-1	0	1	
Bobbin thread tension X_1(gf)	10	20	30	10
Stitch density X_2 (stitch/cm)	4	5	6	1
Needle count X_3(Nm)	9	10	11	1
Sewing speed X_4 (rpm)	2500	3500	4500	1000

III. RESEARCH RESULTS

Table 2. Experimental arrangement Matrix and results which determine the smoothness of seams in fabrics 1 and 2.

STT	X_1	X_2	X_3	X_4	Y'_1	Y'_2
1	-1	-1	-1	-1	3.33	3
2	1	-1	-1	1	2.66	3.33
3	-1	1	-1	1	3	3
4	1	1	-1	-1	2	2.66
5	-1	-1	1	1	2.33	3.33
6	1	-1	1	-1	3	3.66
7	-1	1	1	-1	3.33	3.66
8	1	1	1	1	2.66	1.33
9	-1.68	0	0	0	2.66	3.33
10	1.68	0	0	0	2.33	3.33
11	0	-1.68	0	0	3.33	4
12	0	1.68	0	0	3	3.33
13	0	0	-1.68	0	3.33	3.66
14	0	0	1.68	0	3.33	3.33
15	0	0	0	-1.68	3.33	3.33
16	0	0	0	1.68	3	3.33
17	0	0	0	0	3	3.66
18	0	0	0	0	2.66	3.33
19	0	0	0	0	2.33	3
20	0	0	0	0	3	3.66

(With Y'_1, Y'_2 are the smoothness of fabric 1 and 2, respectively and Y_1 , Y_2 are pucker level of fabric 1 and 2, respectively).

By basing on the experimental results, using Design Expret software, we can form regression equations for smoothness and if we invert them we have equations for seam puckers of the 2 studied fabrics as following:

Fabric1: $Y_1 = 2.56 + 0.16X_1 - 0.06X_2 + 0.03X_3 + 0.11X_4 + 0.09X_1^2 - 0.15X_2^2 - 0.21X_3^2 - 0.15X_4^2 + 0.25X_1X_2 - 0.21X_1X_3 - 0.18X_1X_4$.

$R^2 = 0.88$.

Fabric2: $Y_2= 3.17 + 0.15X_1 + 0.28X_2 + 0.04X_3 + 0.15X_4 + 0.03X_1^2 - 0.09X_2^2 - 0.03X_3^2 + 0.03X_4^2 + 0.42X_1X_2 - 0.25X_1X_3 - 0.17X_1X_4$.

$R^2 =0.83$.

Deductions from above equations

3.1 Fabric 1

1. Analysis of elements related to each other, effects of each factor and mutual effects of each pair of factors on seam puckers

- Mutual relation of bobbin thread tension X_1 and stitch density X_2 has the greatest affect on seam puckers.

- As we reduce bobbin thread tension by 10 gf, the seam pucker on fabric 1 will decrease by 6.25%.

- As we increase stitch density by 1 stitch /cm, the seam pucker on fabric 1 will decrease by 2.54%.

- As we reduce needle count by 1 unit, the seam pucker on fabric 1 will decrease by 1.06%.

- As we reduce sewing speed by 1000 rpm, the seam pucker on fabric 1 will decrease by 4%.

- Relations between stitch density and needle count, stitch density and sewing speed, needle count and sewing speed don't have significant affects on seam puckers on fabric 1.

- As we simultaneous reduce bobbin thread tension and increase stitch density, the seam pucker on fabric 1 will decrease (figure 3).

- As we simultaneous reduce bobbin thread tension and reduce needle count, the seam pucker on fabric 1 will decrease (figure 4).

- As we simultaneous reduce bobbin thread tension and reduce sewing speed, the seam pucker on fabric 1 will decrease (figure 5).

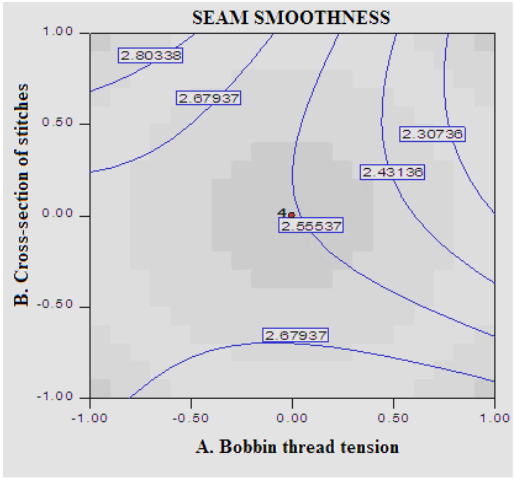

Fig. 3 2D diagram which expresses the relation of bobbin thread tension and stitch density on fabric 1.

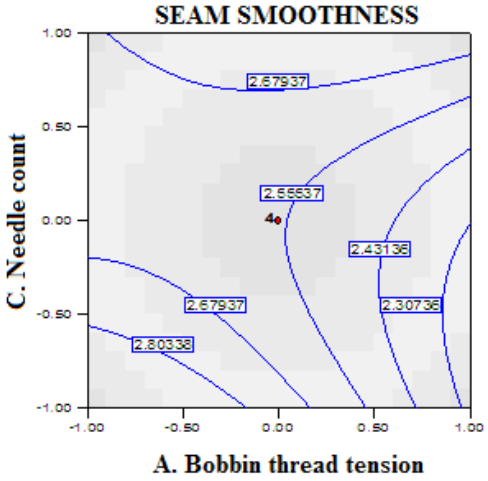

Fig. 4 2D diagram which expresses the relation of bobbin thread tension and needle count on fabric 1.

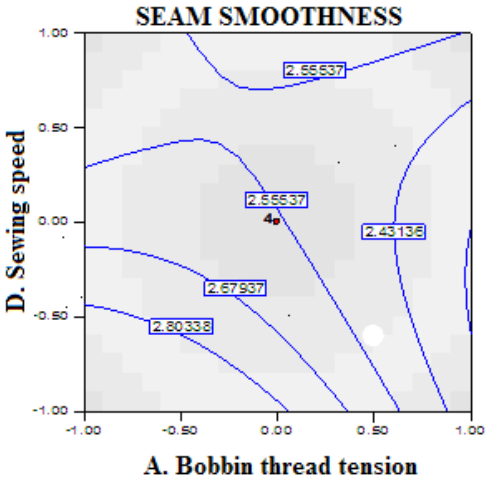

Fig. 5 2D diagram which expresses the relation of bobbin thread tension and sewing speed on fabric 1

2. Optimal solution to reduce seam pucker for fabric 100 % polyester mock-silk V1

When we use Design Expret software, we determined an optimal solution in order to reduce minimally seam pucker on fabric 1 which is:

Coded variable: x_1 = - 0.94; x_2 = 0.54; x_3 = - 0.89; x_4 = -0.75. Real variable: Bobbin thread tension: 10.6 gf; Stitch density: 5.5 stitch/cm (stitch length: 1.8mm); Needle count: 9; Sewing speed: 2700 rpm**.**

3.2 Fabric 2

1. Analysis of elements related to each other, effects of each factor and mutual effects of each pair of factors on seam puckers

- Mutual relation of bobbin thread tension X_1 and stitch density X_2 has the greatest affect on seam puckers of fabric 2.

- As we reduce bobbin thread tension by 10 gf, the seam pucker on fabric 2 will decrease by 4.8%

- As we increase stitch density by 1 stitch /cm, the seam pucker on fabric 2 will decrease by 8.84%.

- As we reduce needle count by 1 unit, the seam pucker on fabric 2 will decrease by 1.3%.

- As we reduce sewing speed by 1000 rpm, the seam pucker on fabric 2 will decrease by 4%.

- As we simultaneous reduce bobbin thread tension and increase stitch density, the seam pucker on fabric 1 will decrease (figure 6).

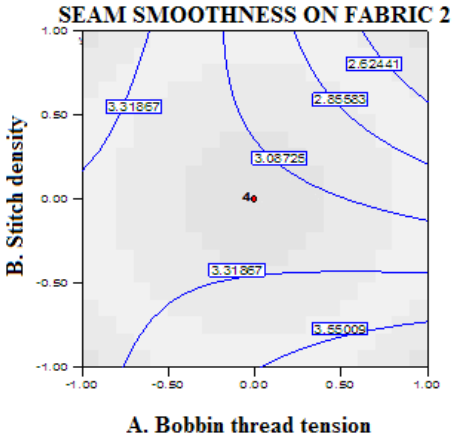

Fig. 6 2D diagram which expresses the relation of bobbin thread tension and stitch density on fabric 2.

- As we simultaneous reduce bobbin thread tension and reduce needle count, the seam pucker on fabric 2 will decrease.

- As we simultaneous reduce bobbin thread tension and reduce sewing speed, the seam pucker on fabric 2 will decrease.

- Other relations between stitch density and needle count, stitch density and sewing speed, needle count and sewing speed don't have significant affects on seam puckers on fabric 2.

2. Optimal solution to reduce seam pucker for 93.7 % polyester blended with 6.3% spandex mock-silk fabric V2

When we use Design Expret software, we determined an optimal solution in order to reduce minimally seam pucker on fabric 2 which is: Coded variable: x_1= 0.52; x_2= -0.57; x_3= -0.93; x_4= -0.96. Real variable: Bobbin thread tension: 25.2 gf; Stitch density: 4.5 stitch/cm (stitch length: 2.26mm); Needle count: 9; Sewing speed: 2540 rpm.

3.3 Comparison of sewing engineering between 100% polyester mock-silk fabric and 93.7 % polyester + 6.3% spandex mock-silk fabric. Recommendations for repair

- By basing on experimental results, with the same thichness of fabrcs, the same processing parameters and equipment when we make 100% polyester mock-silk fabric there will be more seam puckers than those ofo polyester blended with spandex mock-silk fabric.

- For 100% polyester mock-silk fabric, bobbin thread tension has the greatest influence on seam puckers. For spandex inserted mock-silk fabric, stitch density has the greatest influence on seam puckers.

- On 100% polyester mock-silk fabric, as we increase stitch density the seam pucker will decrease, but on spandex inserted mock-silk fabric, the lower the stitch density is, the lower the seam pucker (big stitch length).

- Other processing parameters and equipment are: needle count and sewing speed have the same effects on seam puckers on both fabrics, this means small needle count and low sewing speedn will decline seam pucker.

Solutions recommended for reparing seam puckers on fabric 1 and 2:

Fine and thin mock-silk fabrics are difficult to process because it is easy to crease during sewing procedures. While be sewn or a short time used, fabrics will be shrunk vertically which causes crimps. Removing crimps by ironing or fix press methods are comtemporary solutions. After the first wash, crimps will be back. In order to give out the most effective alternative, the most important thing si to analyze reasons causing seam puckera. Bascically, there are 3 main causes: Tension pucker; Feed pucker and Displacement pucker.

According to above experimental results, this group recommend several repairing ways in order to decrease seam puckers on mock-silk fabrics:

- Adjust bobbin thread tension as low as possible, about 10,6 gf for 100% polyester mock-silk fabric and 25.2 gf for spandex inserted mock-silk fabric, then adjust needle thread tension to be balanced with bobbin thread tension in order to ensure thread knot between 2 fabric layers.

- Adjust to have suitable stitch length, for 100% polyester mock-silk fabric, stitch length should be 1.8mm and for spandex inserted mock-silk fabric should be 2.26mm**.**

- Adjust the lift of the feed dog that the teeth protrude only slightly above the stitch plate.

- Use Teflon presser feet.

- During sewing, keep the fabric stretched in front of and behind the needle.

- Reduce the sewing speed at 2700 rpm for 100% polyester mock-silk fabric and at 2540 rpm for spandex inserted mock-silk fabric.

- For each type of thread use the finest needle count. For mock-silk fabric we should use needle number 9. Use the finest thread count but still ensure the strength of seams (100% polyester thread 80/3).

- For synthetic polyester mock-silk fabric, we have to use NS needle which is facial processed with AUS Ceramic layer, this layer is anti-crimped and decreases needle's heat, maximum

reduces (about 45%) resistance when the needle goes through the fabric.

IV. CONCLUSIONS

- Processing parameters and sewing equipment have significant influences on seam pucker on 100% polyester mock-silk fabric (V1) and Spandex inserted mock-silk fabric (V2), they are: Bobbin thread tension (X_1), Stitch density (X_2), Needle count (X_3), Sewing speed (X_4). Simultaneous effects of processing parameters and sewing equipment on seam pucker on 100% polyester mock-silk fabric and Spandex inserted mock-silk fabric follow 4-variable quadratic rule.

- Experimental reseached results are the scientific basis by which we can recommend thoroughly repairing solutions seam puckers in real production of 100% polyester mock-silk fabric and Spandex inserted mock-silk fabric which have a weight of 140,2 g/m^2 manufactured by Thai Tuan Textile Company-Ho Chi Minh City.

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