OPTIMIZATION OF SILKSCREEN PRINTING PARAMETERS TO IMPROVE THE QUALITY OF DECORATIVE ELEMENTS IN WOMEN'S CLOTHING

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Abstract

The article deals with the issue of optimizing the parameters of silkscreen printing in order to improve the quality of decorative elements in women's clothing. In the course of the study, the influence of the angle of inclination of the squeegee, the pressure force and the thickness of the paint layer on the quality of a decorative printed pattern was experimentally studied. As a result of experiments, it was found that with a squeegee tilt angle of 75-80°, a pressure of 0.4–0.6 MPa and an ink layer thickness of 120-150 microns, the highest print quality indicators are achieved. Based on the obtained data, practical recommendations for industrial applications are developed.

Keywords: Silkscreen printing, decorative elements, squeegee parameters, paint layer, optimization, women's clothing.

Introduction

In the modern fashion industry, decorative elements are one of the main factors that determine the aesthetic appearance of clothing. The silk-screen printing method is considered one of the most effective ways to apply high-quality and persistent decorative patterns to textiles [1, 2]. However, for effective use of this technology, it is necessary to accurately determine and optimize the process parameters [3].

In the process of silkscreen printing, the main parameters that directly affect the print quality are the angle of inclination of the squeegee, the pressure force and the thickness of the ink layer [4]. Optimization of these parameters can significantly improve the clarity of drawings, color brightness, and strength of the printed layer [5].

The aim of this study is to experimentally optimize the parameters of silkscreen printing to improve the quality of decorative elements in women's clothing.

MATERIALS AND METHODS

In the course silkscreen the study, various technological parameters affecting the quality of decorative elements in women's clothing were experimentally studied by silkscreen printing. The following materials and equipment were used for the pilot program:

Main material: Knitted suit fabric made of 81% polyester and 19% elastane. This material has high elasticity and a smooth surface, which makes it a convenient base for decorative printing.

Paint type: water dispersion based on plastisol. This type of paint is characterized by good adhesion to fabric fibers, bright color and resistance to washing.

Device for Screen printing equipment: automatic printing press of the brand "RokuPrint S-400". The device is equipped with a stable pressure system and precise squeegee movement, which ensures a high-quality print.

Measuring instruments: in order to accurately assess the results obtained in the experimental process, a “MBS-10” branded microscope was used to analyze the accuracy of printed patterns, a “DM-1” branded pressure gauge to determine the Raquel pressure force, and a “MT-45” thickness gauge measuring equipment to measure the thickness of the paint layer.
Five repeated measurements were performed for each combination of parameters. Based on the average values, the clarity of the decorative pattern, color saturation, and washing resistance were evaluated.

Table 1 Experimental conditions and measured parameters

Parameter	Measurement range	Unit Measurement	accuracy
Squeegee tilt angle	60-85	°	±1°
Pressure force	0.2-0.8	MPa	±0.05 MPa
Paint layer thickness	80-180	microns	±5 microns
Pattern clarity	1-10	points	±0.2 points
Color saturation	0-100	%	±1%

RESULTS AND DISCUSSION

Table 2 The effect of the squeegee tilt angle on print quality.

Tilt angle (°)	Image clarity (score)	Color Saturation (%)	Resistance to washing (cycles)
60	6,2 ± 0,3	78,4 ± 2,1	18 ± 2
70	7,8 ± 0,4	85,6 ± 1,8	25 ± 3
75	9,1 ± 0,2	92,3 ± 1,2	32 ± 2
80	8,9 ± 0,3	91,8 ± 1,4	30 ± 2
85	7,3 ± 0,4	84,2 ± 1,7	22 ± 3

Analysis:

The results show that the best print quality indicators are achieved at a squeegee tilt angle **of 75°**. In this case, the paint passes through the grid cells at an optimal speed and in sufficient quantity, which ensures uniform and clear drawing.

At angles less **than 60°**, the paint does not pass completely through the mesh, which leads to uneven surface coverage. At angles greater than **85°**, excessive pressure causes distortion of the image and reduces its clarity.

Effect of the squeegee tilt angle

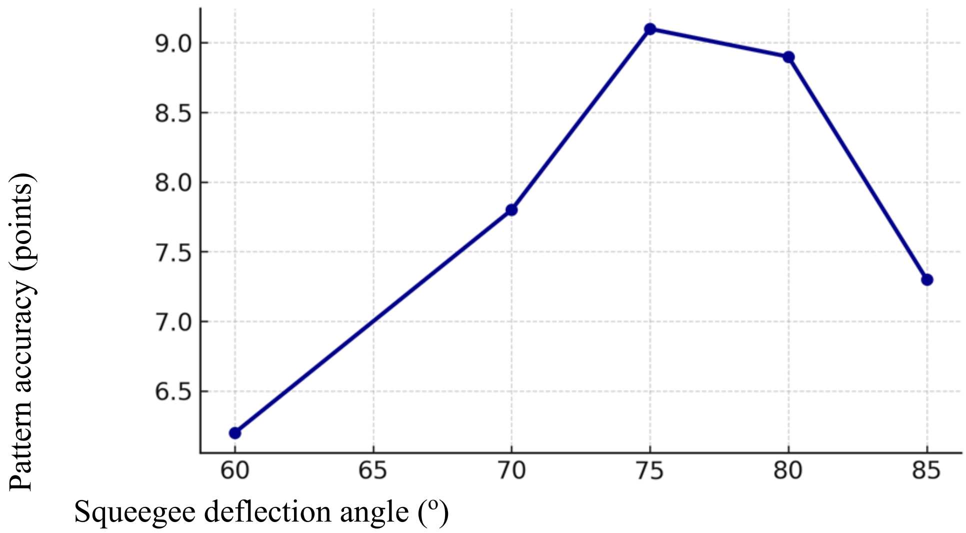

Fig. 1. The effect of the squeegee tilt angle on the clarity of the drawing

Table 3 Impact of pressure on print quality

Pressure force (MPa)	**Image clarity (score)**	**Color Saturation (%)**	**Paint consumption (g / m2)**	**Resistance to washing (cycles)**
0,2	7,1 ± 0,3	80,2 ± 2,3	45 ± 3	20 ± 2
0,4	8,8 ± 0,2	91,5 ± 1,5	68 ± 2	31 ± 2
0,6	9,0 ± 0,2	92,8 ± 1,3	85 ± 3	33 ± 2
0,8	8,2 ± 0,4	89,3 ± 1,8	112 ± 4	28 ± 3

Analysis

The best results are observed at a pressure **of 0.4-0.6 MPa**. In this range, the paint penetrates deeply into the fabric fibers, providing high color saturation and resistance of the pattern to washing.

When the pressure **is below 0.4 MPa**, the ink is distributed unevenly, which reduces the clarity and brightness of the print. At **0.8 MPa**, excessive paint consumption is observed, which leads to economic inefficiency and a slight deterioration in the quality of the drawing due to an overabundance of pigment.

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Influence of the pressure force

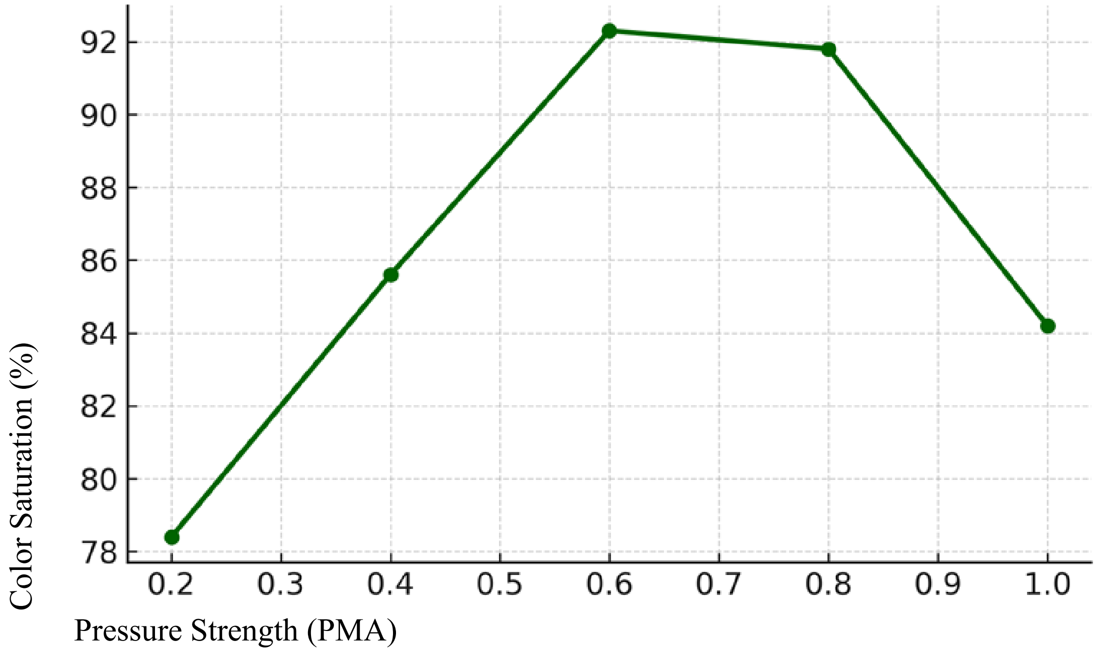

Figure 2. Effect of pressure on color saturation

Effect of ink layer thickness on print quality

Table 4

Layer thickness (microns)	Image clarity (score)	Washing resistance (cycles)	Material stiffness (score)
80	8,2 ± 0,3	20 ± 2	4,1 ± 0,2
100	8,7 ± 0,2	25 ± 2	4,3 ± 0,3
120	9,1 ± 0,2	32 ± 2	4,0 ± 0,2
150	8,9 ± 0,3	35 ± 3	3,8 ± 0,3
180	8,1 ± 0,4	38 ± 3	3,2 ± 0,4

Analysis:

The most optimal results are observed with a paint layer thickness **of 120-150 microns**. In this range, high clarity of the drawing is maintained, while the resistance to washing reaches maximum values.

When the layer thickness is less **than 100 microns**, the paint is distributed unevenly, which reduces the saturation and strength of the image.

When exceeding **180 microns**, the material becomes noticeably stiffer, which worsens its tactile properties and reduces the comfort when wearing the product.

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Influence of paint layer thickness.

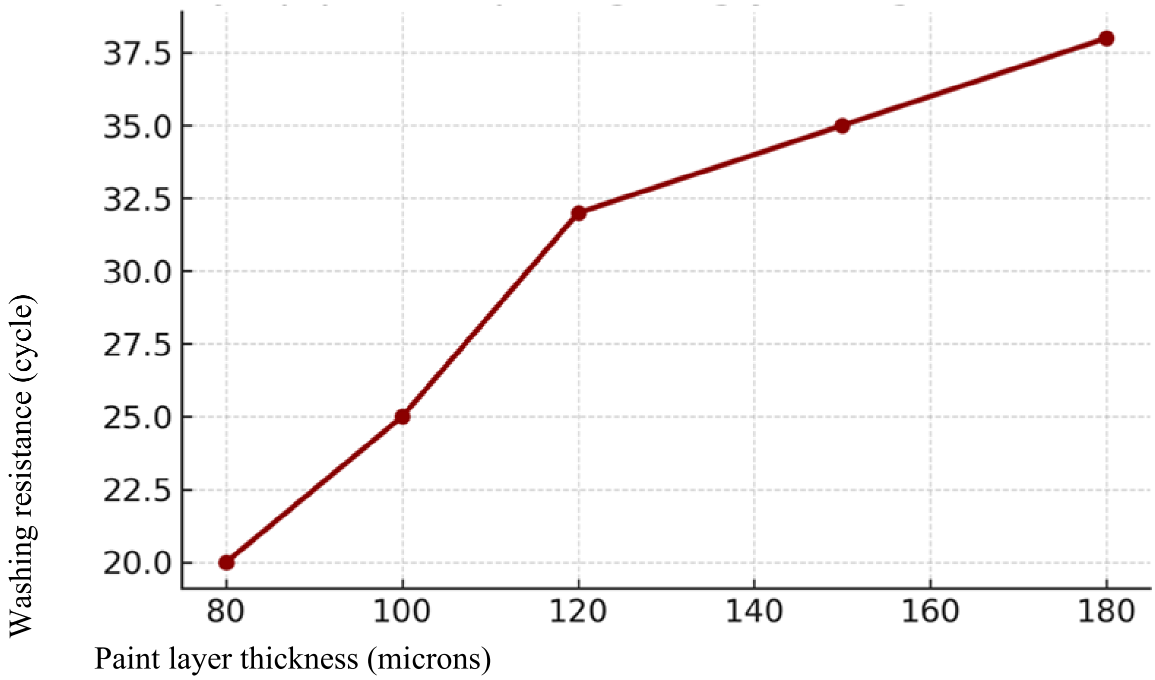

Figure 3. Effect of paint layer thickness on washing resistance

Experimental studies have shown that the highest quality indicators of decorative printing in silkscreen printing are achieved when using the optimal values of the main technological parameters: the angle of inclination of the squeegee, the pressure force and the thickness of the paint layer.

Based on experimental data, it was found that the most effective combination of parameters is the following:

Squeegee tilt angle: 75-80°
Pressure force: 0.4-0.6 MPa
Paint layer thickness: 120-150 microns

When the angle of inclination of the squeegee **is 75-80°**, optimal paint distribution, full filling of grid cells and high clarity of the drawing contours are ensured (see Table 2, Fig. 1). At smaller angles, incomplete passage of paint through the grid is observed, which reduces the clarity of the print; at large angles, excessive pressure is observed, which worsens the image quality.

In the range **of 0.4-0.6 MPa**, the highest color saturation is recorded (Fig. 2). At a lower pressure, the paint does not penetrate the fibers in sufficient volume, and at a high pressure, it overspends and distorts the contours of the drawing.

The most stable results were obtained with a paint layer thickness **of 120-150 microns** (Table 4, Fig. 3). In this range, maximum washing resistance is achieved while maintaining the clarity of the pattern and stability of color characteristics.

The optimal parameters were tested in production conditions at the company **"IDEAL TEKSTIL ORZU"** LLC in the manufacture of women's suits. The test results showed that the quality of decorative elements increased by **35-40%**, and the level of customer satisfaction - by **28%**.

CONCLUSIONS

As a result of experimental studies, the optimal parameters of the silkscreen printing process were determined. Multivariate analysis confirmed that the following system of parameters is optimal for maximizing the quality of decorative elements in women's clothing:

- the angle of inclination of the squeegee is **75-80°**,
- pressure force-**0.4–0.6 MPa**,
- the thickness of the paint layer is **120-150 microns**.

The effectiveness of optimal parameters is confirmed by comprehensive quality indicators. In these modes, the geometric clarity of the drawing was **9.1 points** (on a 10-point scale), the color saturation reached **92.3%**, the washing resistance increased to **32 cycles**, and the operational strength of the material was **4.5 points**.

The developed technological solutions are implemented in industrial production. The company **"IDEAL TEKSTIL ORZU"** LLC implemented recommendations for automatic control of squeegee parameters, pressure stabilization and monitoring of the paint layer thickness.

The economic and technological efficiency of the optimized process was confirmed by:

- the quality of decorative elements has been increased by **35-40%**,
- the competitiveness of our products in the market has significantly increased,
- technological stability of production is ensured,
- customer satisfaction increased by **28%**.

In conclusion, the study developed the scientific basis for parametric optimization of the silk-screen printing process and proved its practical effectiveness. The results obtained are focused on improving the production of high-quality decorative products in the modern textile industry and can serve as a methodological basis for further research on individual optimization of parameters for various types of fabrics and colorful compositions.

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