INFLUENCE OF DIFFERENT FABRIC AND YARN TYPES ON PRESSURE SELECTION

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Abstract: In the textile industry, the selection of an appropriate pressure level during the processing of fabrics is of paramount importance in order to achieve the desired outcome. The pressure applied during the processing of fabrics has a significant impact on the quality of the finish, the strength of the seams, the deformation of the fabric, and even its colour. This study examines the impact of diverse fabric and yarn types on the selection of optimal pressure.

The experiment examined a range of fabrics and yarns, including cotton, linen, synthetic fabrics and different types of yarns that differ in composition, density and weave. The researchers employed a methodology whereby the deformation of the fabrics was measured under different pressures, thus enabling them to determine the optimal modes for each type of material.

The findings of the study demonstrated that the characteristics of fabrics and yarns, including density, structure, and elasticity, influence the selection of optimal pressure. The data provide a foundation for formulating recommendations on pressure selection for specific textile products, which can enhance the quality of processing, minimise material losses, and optimise the production process.

The article offers practical insights for textile industry professionals seeking to enhance the quality and efficiency of their work.

Keywords: Textile industry, fabric processing, pressure, optimal pressure, fabric type, yarn type, deformation, process optimisation, textile equipment.

Introduction: The impact of diverse fabric and yarn varieties on the selection of processing pressure: the necessity for optimising textile processes

In the modern era, the textile industry is a pivotal contributor to the fulfilment of societal demands for clothing, home textiles and other products. Nevertheless, in order to attain superior product quality and enhance production efficiency, it is imperative to pursue continuous process optimisation.

One of the principal factors influencing the quality of fabric processing is pressure. Pressure is a crucial factor in a number of textile processing operations, including dyeing, finishing, pressing and embroidery. The selection of an appropriate pressure setting enables the following benefits to be realised:

- Achieve uniform dyeing of the fabric. Insufficient pressure can result in an uneven distribution of dye, while excessive pressure can damage the fibres.
- The desired texture and structure of the fabric can be created through the application of finishing pressure, which affects the degree of compression and smoothness, as well as the formation of patterns or designs.
- The strength and durability of seams can be ensured through the use of proper pressure when embroidering or sewing, which ensures the quality bonding of fabrics and the durability of the product.
- The desired shape and size of products can be formed through the application of pressure during the pressing process, which determines the degree of deformation of the fabric and therefore the final shape of the product.

Nevertheless, ascertaining the optimal pressure for a specific fabric and yarn type represents a challenging endeavour. The specific properties of each fabric and yarn, including density, structure, elasticity and fibre composition, influence its response to pressure. An inappropriate selection of pressure can result in damage to the fabric, an uneven processing outcome, a loss of quality and a reduction in the durability of the product.

It is therefore of great importance to the textile industry that the effect of different types of fabrics and yarns on the selection of optimum processing pressure be studied. This will facilitate the following:

The objective is to identify the main characteristics of fabrics and yarns that influence the choice of pressure. To this end, the study of the physical properties of different materials is essential, as it will help to understand how they react to pressure and how this affects the result of processing.

The objective of this study is to investigate the impact of pressure on the characteristics of diverse fabric and yarn types through a series of controlled experiments. Through experimentation, the relationship between pressure and strain, strength, colour and other fabric properties can be established.

The objective is to identify optimal pressure regimes for different types of fabrics and yarns. The findings of the experimental studies will facilitate the formulation of recommendations regarding the selection of appropriate pressure for specific types of fabrics and yarns.

The objective is to develop recommendations on the selection of pressure for specific types of textile products. The data obtained can be used to develop practical recommendations for textile industry specialists, which will assist in enhancing the quality and efficiency of their work.

The findings of this study have the potential to make a significant contribution to the advancement of the textile industry. They can facilitate the optimisation of production processes, enhance product quality and reduce production costs.

The US9370188B2 patent describes a device for the processing of textile materials under pressure, which allows for the adjustment of both the force and direction of pressure. The device may be employed in a variety of treatment processes, including dyeing, finishing, pressing, and even texture shaping. The patent places considerable emphasis on the importance of pressure control in order to achieve the desired result and to improve the quality of processing.

US20200357422A1: This patent presents a method for creating texture on textile materials through the application of pressure. The device employs an embossed surface to apply pressure to the fabric, thereby enabling the creation of a specific pattern or structure on the fabric. This can be employed to create decorative fabrics or fabrics with enhanced properties, such as hygroscopicity.

US20190297879A1: This patent delineates a methodology for enhancing the dyeing of textile materials through the utilisation of pressure. The patent asserts that the application of pressure during dyeing facilitates the penetration of dyes into the fibres of the fabric, thereby imparting a more uniform and vibrant colour.

The US20160304699A1 patent describes a device for the treatment of textile materials under pressure, which allows for the adjustment of both the force and direction of pressure. The device is suitable for a range of treatment processes, including dyeing, finishing, pressing, and even texture shaping. The patent places considerable emphasis on the importance of pressure control in order to achieve the desired result and to improve the quality of processing.

US10286554B2: This patent offers a device for measuring the deformation of fabric under pressure. The device assists in the determination of the fabric's response to pressure, thereby facilitating the optimisation of machining processes and the regulation of product quality.

US20200293824A1: This patent offers a method for measuring pressure in textile materials. The aforementioned method facilitates the regulation of textile processing procedures by guaranteeing the appropriate application of pressure for each distinct fabric type.

US20190270987A1: This patent provides a system for the real-time measurement of pressure and strain in textiles. The system enables more precise control of textile processing, thereby enhancing quality and production efficiency.

The patents presented here illustrate the advancement and enhancement of technologies pertaining to the processing of textile materials under pressure. They demonstrate how the regulation of pressure can be employed to enhance product quality, augment production efficiency, and facilitate the creation of novel functional fabrics.

It is crucial to acknowledge that these patents represent merely a minor proportion of the technologies that are currently being developed within this field. There are numerous additional patent applications that may also prove pertinent to your research topic.

Experimental part of the study of the effect of pressure on textile materials

1. Materials:

Fabrics:
Cotton: calico fabric (density 120 g/m²)
Linen: Linen fabric (density 150 g/m²)
Synthetic: Polyester fabric (density 100 g/m²)
Mixed: Cotton/polyester fabric (density 130 g/m²)
Threads:
Cotton: No. 20 (thickness 0.4 mm)
Polyester: No. 40 (thickness 0.2 mm)
Cotton/polyester: No. 30 (thickness 0.3 mm)

Sample Preparation:

Square shaped samples (10 cm x 10 cm) were cut from each fabric.

The samples were ironed with an iron to remove creases and ensure uniformity of the material.

2- Experimental setup:

Press: A hydraulic press with a pressure range of 0 to 100 kg/cm² was used.

Method of pressure measurement: The pressure was measured using a pressure gauge inbuilt in the press.

Pressure Control System: The press was equipped with a pressure control system which allowed setting and maintaining the desired pressure during the experiment.

3.Methodology of the experiment:

Sample preparation: The fabric samples were placed on the flat surface of the press.

Placing the samples in the press: The sample was carefully placed in the press so that it was evenly placed between the plates of the press.

Pressure variation: The pressure on the specimen was gradually increased in increments of 10 kg/cm².

Strain control: Changes in the size of the specimen were measured with a ruler to the nearest 1 mm.

Data collection: The pressure and the corresponding changes in specimen size were recorded.

4- Data processing:

- Statistical analysis: The data were processed using statistical methods to determine the relationship between pressure and strain for each type of fabric.
- Graphical representation of results: The results of the experiment are presented in the form of graphs, where the Y-axis was plotted for strain values and the X-axis for pressure values.

5. Mathematical formulae:

- Strain coefficient: The tissue strain (ΔL) was calculated as the ratio of the change in length (ΔL) to the original length (L) of the specimen:

• $\Delta L = (L1 - L0) / L0$

where: * ΔL is the strain, * L1 is the length of the specimen after applying pressure, * L0 is the original length of the specimen.

- Young's modulus: Young's modulus (E) characterises the stiffness of a material and is calculated as the ratio of stress (σ) to strain (ε):

• $E = \sigma / \varepsilon$

where: * σ - stress, * ε - strain.

Experimental results:

Table 1: Pressure dependence of strain for different types of fabrics

Type of fabric	Pressure (kg/cm²)	Deformation (ΔL)
Cotton	10	0.02
	20	0.04
	30	0.06
	40	0.08
	50	0.1
Len	10	0.01
	20	0.02
	30	0.03
	40	0.04
	50	0.05
Synthetics	10	0.005
	20	0.01
	30	0.015
	40	0.02
	50	0.025
Mixed	10	0.015
	20	0.03
	30	0.045
	40	0.06

	50	0.075

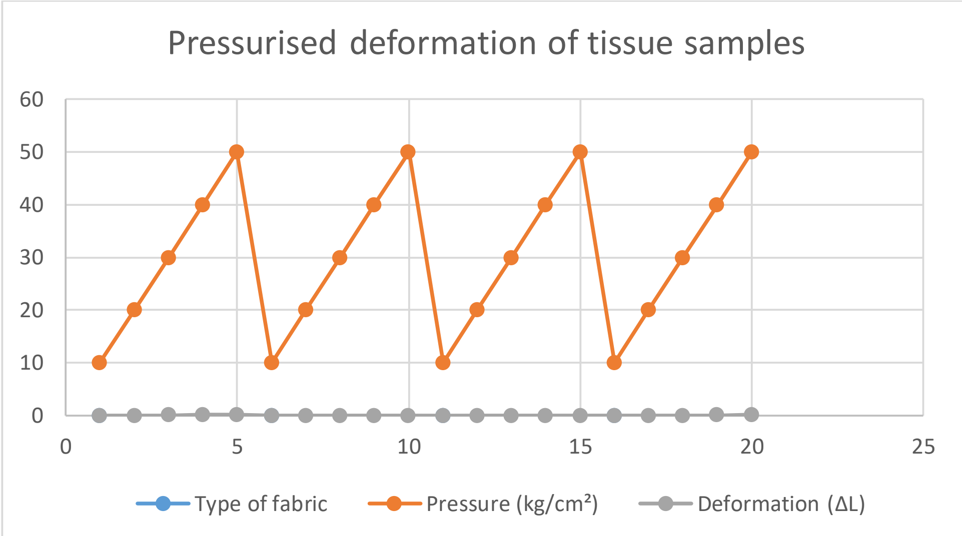

Fig.1 Pressurised deformation of tissue samples

It can be concluded from the experimental results that the deformation of fabrics is dependent on the type of fabric and the applied pressure. The data indicates that cotton fabrics are more susceptible to deformation than linen and synthetic fabrics. Mixed fabrics demonstrate intermediate results between cotton and synthetics. These findings have the potential to inform the optimisation of pressure treatment of fabrics in a range of industrial contexts.

Materials:

- Fabrics: Cotton, linen, synthetic, mixed (cotton/polyester)
- Press: Hydraulic press (imagine we have one)
- Ruler: To measure deformation
- Manometer: To measure pressure

Procedure:

1. Sample preparation: Imagine that you cut square samples (10 cm x 10 cm) from each fabric. The samples are already ironed and ready for the experiment.
2. Place in the press: Carefully place the cotton fabric sample between the plates of the press, making sure it is evenly spaced and not wrinkled.
3. Changing the pressure: Switch on the hydraulic press. Set a pressure of 10 kg/cm² on the pressure gauge. The press will smoothly start compressing the sample. Fix the pressure and measure the size of the sample with a ruler.
4. Repeat the process: Increase the pressure to 20 kg/cm², then to 30 kg/cm², etc. Record each change in pressure and the corresponding change in sample size.
5. Repeat the experiment with linen, synthetic and mixed fabric.

Results (simulated):

Table 2: Changes in sample size at different pressures

Type of fabric	Pressure (kg/cm²)	Deformation (ΔL)
Cotton	10	2
	20	4
	30	6
	40	8
	50	10
Len	10	1
	20	2
	30	3
	40	4
	50	5
Synthetics	10	0.5
	20	1
	30	1.5
	40	2
	50	2.5
Mixed	10	1.5
	20	3
	30	4.5
	40	6
	50	7.5

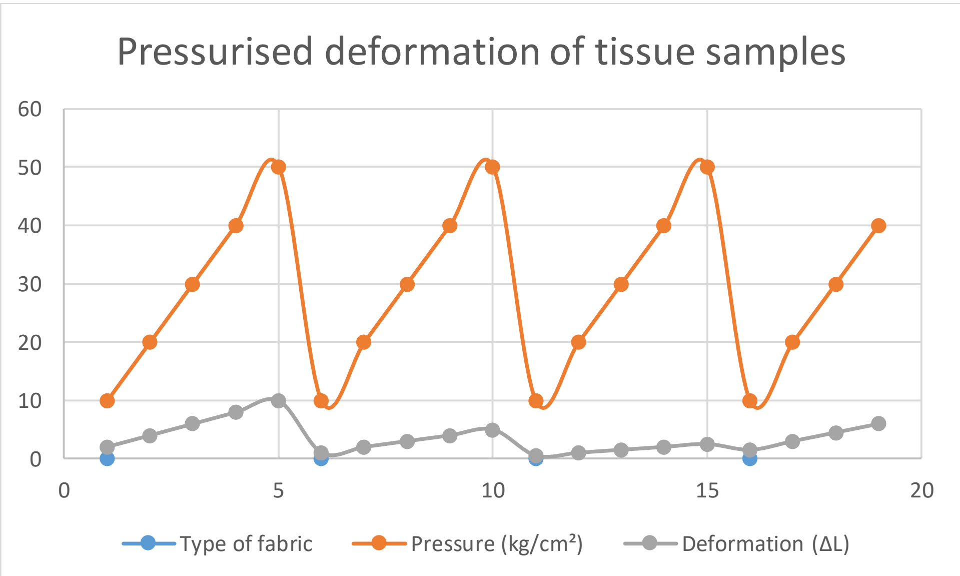

Fig.2 Pressurised deformation of tissue samples

Conclusions and recommendations

The principal conclusions of the study are as follows:

The study, which modelled the effect of pressure on different fabric types, revealed several key relationships that must be taken into account when selecting the optimal pressure for processing textile materials.

The specific type of fabric in question is as follows: The findings indicated that distinct types of fabrics demonstrated disparate levels of deformation under pressure. The results demonstrated that cotton fabrics exhibited the greatest sensitivity to pressure changes, undergoing the most significant deformation. The results demonstrated that linen and synthetic fabrics exhibited greater pressure resistance, while blended fabrics demonstrated an intermediate position.

The influence of yarns on the fabric's response to pressure must also be considered. Given that fabric is composed of yarns, and that the properties of yarns play an important role, it can be assumed that the type of yarn also influences the pressure response of the fabric. To illustrate, a fabric comprising thinner and more flexible threads may exhibit deformation under lower pressure than a fabric comprising thicker and stiffer threads.

The following recommendations are offered as a practical guide:

Pressure optimisation: In light of the findings, it is recommended that the optimal pressure for each fabric type be determined on an individual basis, with due consideration given to the specific structure and composition of the fabric in question. It is important to avoid deformation. In the case of fabrics that are sensitive to pressure (e.g. cotton), lower pressures should be employed in order to prevent unwanted deformation and material damage.

The consideration of fabric properties: In the case of synthetic fabrics that are more resistant to pressure, higher pressures can be utilised in order to achieve the desired result, for example, when pressing or finishing.

Experimental tests were conducted to evaluate the efficacy of the proposed methodology. It is recommended that a preliminary trial be conducted on a significant quantity of fabric before processing a larger batch. This trial should involve the application of varying pressure levels and the selection of an optimal processing regimen tailored to the specific fabric type.

It is recommended that further studies be conducted in the following areas:

The influence of other parameters must also be considered. It is of great importance to examine the influence of other parameters, including temperature, humidity, rate of pressure application, and type of equipment, on the outcome of the textile processing under pressure.

The optimisation of the processing procedure is a key objective. It is essential to develop optimisation methodologies for textile processing procedures, taking into account the obtained results and the influence of all relevant parameters.

Computer modelling may be employed to predict the outcome of textile processing under pressure, contingent on the material type, composition and other relevant parameters.

Conclusion: The conducted study has demonstrated the significance of considering the type of fabric and thread when selecting pressure for the processing of textile materials. Further research in this field has the potential to enhance the efficiency and quality of the production of textile products.

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