UTTARA UNIVERSITY

THESIS PAPER
ON

Innovative Techniques for Enhancing Dye Uptake in Synthetic Fabric Blends a Focus on Spandex

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Date: 12 November 2026

STUDENT'S DECLARATION

I hereby declare that the project entitled Innovative Techniques for Enhancing Dye Uptake in Synthetic Fabric Blends a Focus on Spandex' has been done by the following student and it was not submitted elsewhere for the award of Fashion Design and Technology BSc or any other discipline.

Sincerely yours,

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LETTER OF TRANSMITTAL

12 November 2026

Engr. Md. Sadiqur Rahman
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Subject: Request for submission of the dissertation report.

Dear Sir,
With due respect, I have prepared my Dissertation report on Innovative Techniques for Enhancing Dye Uptake in Synthetic Fabric Blends a Focus on Spandex' to fulfill the partial requirements for the award of the degree of B.Sc in Fashion Design and Technology.
I am honestly thankful for your guidance during the preparation of the report. I have tried my level best to conduct this in a professional manner. It is true that, it could be done in a better way. However, despite of my best effort there may remain some flaws in the report. I hope you will assess my report considering the limitations study and time frame.
I hope and pray that the mistakes will be kindly excused. It would be a profound pleasure for me if the report could serve its purpose.

Sincerely yours,

Md Habibur Rahman
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BONAFIDE CERTIFICATE

This is to certify that Md Habibur Rahman, Program: BSc in Fashion Design & Technology, Batch: 31st, ID: 2223401065 has completed his dissertation report on "Innovative Techniques for Enhancing Dye Uptake in Synthetic Fabric Blends a Focus on Spandex." Under my supervision as a part of partial fulfillment of the requirements for the Degree of Bachelor of Science (BSc) in Department of Fashion Design & Technology at Uttara University (UU). This report can be accepted for evaluation.

_____

Engr. Md. Sadiqur Rahman
Lecturer
Department of Fashion Design & Technology
Uttara University

DECLERATION

I declare that the thesis draft presented here in has been developed for academic critique and review in accordance with the guidelines and using the presentation, pertinent literature and standards documents provided. Where required, evidence of process conditions has been included using advice from the literature. No experimental measurements have been made for this document.

All references have been verified by the student, who is responsible for ensuring that all the instructions to the reader and other comments from the original presentation and other sources are properly cited and/or acknowledged. Where a supervisor has directed the student to perform primary experimental work, the related methods and data, results, and analysis have been performed by the student. This draft should not be represented as an experimentally validated study unless primary experimental work has been performed.

ACKNOWLEDGMENTS

I am indebted to my academic adviser for reviewing the thesis and giving valuable comments. Thanks, are also due to the technical presentation that provided the initial structural elements of this review especially for its discussion of spandex handling, heat-setting, polyester/spandex dyeing and nylon/spandex dyeing.

Thanks are due to the authors of published technical papers for their explanation of mechanisms of dyeing synthetic fibers, aspects of color fastness, and other operational problems of wet processing. These papers placed the process of recommendations for the presentation in a context of general interest. The final version should provide acknowledgement of the adviser, department, institution, laboratory, and company, and/or individuals who made a direct contribution to the student's actual work

ABSTRACT 3
LIST OF ABBREVIATIONS 4
CHAPTER 1: INTRODUCTION 5
1.1 BACKGROUND AND PROBLEM STATEMENT 6
1.2 SIGNIFICANCE OF THE STUDY 6
CHAPTER 2: Aim, Objectives and Scope 7
2.1 RESEARCH QUESTIONS AND LIMITATIONS 8
CHAPTER 3: SOURCES EVALUATION 8
CHAPTER 4: SYNTHETIC TEXTILE FIBRES AND BLENDED FABRICS 9
CHAPTER 5: SPANDEX: ITS STRUCTURE, PROPERTIES AND APPLICATIONS 10
5.1 STORAGE AND HANDLING OF SPANDEX 10
5.2 DAMAGE TO THE PACKAGE AND MIDDLE BUNCH 13
CHAPTER 6: CONE IDENTIFICATION, LOT CONTROL AND FEEDING 14
CHAPTER 7: HEAT SET AND DIMENSIONAL STABILIZATION 15
7.1 INTERPRETATION OF SETTING DATA PRESENTED 16
CHAPTER 8: POLYESTER/SPANDEX FABRIC FEATURES 17
CHAPTER:9 DISPERSE DYES AND PET DYEING MECHANISM 18
CHAPTER 10: PET/SPANDEX DYEING PROCESS OVERVIEW 21
CHAPTER 11: SCOURING AND PRE-TREATMENT FOR PET/SPANDEX 22
CHAPTER 12: PRE-SETTING PET/SPANDEX 24
CHAPTER 13: DYEING WITH DISPERSE DYES AT HIGH TEMPERATURES 25
CHAPTER 14: REDUCTION CLEANING AND WASHING 26
CHAPTER 15: FINAL HEAT-SETTING OF PET/SPANDEX 27
CHAPTER 16: CHOOSING DISPERSE DYES AND THEIR FASTNESS FEATURES 28
CHAPTER 17: CHARACTERISTICS OF FABRICS MADE OF NYLON/SPANDEX 29
CHAPTER 18: MECHANISM OF DYEING NYLON WITH ACID DYES 30
CHAPTER 19: NYLON/SPANDEX SCOURING 31
CHAPTER 20: NYLON/SPANDEX DYEING PROCESS 32
CHAPTER 21: FIXING AND FINAL HEAT-SETTING OF NYLON/SPANDEX 34
CHAPTER 22: NYLON/SPANDEX FIXING AND FINAL HEAT TREATMENT 35
CHAPTER 23: QUALITY CONTROL AND TESTING 36
DISCUSSION 37
CONCLUSIONS 38
REFERENCES 39
Contents
ABSTRACT 3
LIST OF ABBREVIATIONS 4

CHAPTER 1: INTRODUCTION 5
1.1 BACKGROUND AND PROBLEM STATEMENT 6
1.2 SIGNIFICANCE OF THE STUDY 6
CHAPTER 2: Aim, Objectives and Scope 7
2.1 RESEARCH QUESTIONS AND LIMITATIONS 8
CHAPTER 3: SOURCES EVALUATION 8
CHAPTER 4: SYNTHETIC TEXTILE FIBRES AND BLENDED FABRICS 9
CHAPTER 5: SPANDEX: ITS STRUCTURE, PROPERTIES AND APPLICATIONS 10
5.1 STORAGE AND HANDLING OF SPANDEX 10
5.2 DAMAGE TO THE PACKAGE AND MIDDLE BUNCH 13
CHAPTER 6: CONE IDENTIFICATION, LOT CONTROL AND FEEDING 14
CHAPTER 7: HEAT SET AND DIMENSIONAL STABILIZATION 15
7.1 INTERPRETATION OF SETTING DATA PRESENTED 16
CHAPTER 8: POLYESTER/SPANDEX FABRIC FEATURES 17
CHAPTER:9 DISPERSE DYES AND PET DYEING MECHANISM 18
CHAPTER 10: PET/SPANDEX DYEING PROCESS OVERVIEW 21
CHAPTER 11: SCOURING AND PRE-TREATMENT FOR PET/SPANDEX 22
CHAPTER 12: PRE-SETTING PET/SPANDEX 24
CHAPTER 13: DYEING WITH DISPERSE DYES AT HIGH TEMPERATURES 25
CHAPTER 14: REDUCTION CLEANING AND WASHING 26
CHAPTER 15: FINAL HEAT-SETTING OF PET/SPANDEX 27
CHAPTER 16: CHOOSING DISPERSE DYES AND THEIR FASTNESS FEATURES 28
CHAPTER 17: CHARACTERISTICS OF FABRICS MADE OF NYLON/SPANDEX 29
CHAPTER 18: MECHANISM OF DYEING NYLON WITH ACID DYES 30
CHAPTER 19: NYLON/SPANDEX SCOURING 31
CHAPTER 20: NYLON/SPANDEX DYEING PROCESS 32
CHAPTER 21: FIXING AND FINAL HEAT-SETTING OF NYLON/SPANDEX 34
CHAPTER 22: NYLON/SPANDEX FIXING AND FINAL HEAT TREATMENT 35
CHAPTER 23: QUALITY CONTROL AND TESTING 36
DISCUSSION 37
CONCLUSIONS 38
REFERENCES 39

ABSTRACT

This thesis reviews the handling of spandex (elastane) and dyeing of Polyester (PET)/spandex and nylon/spandex fabrics. Elastane has properties of recoverable stretch, and its performance can be affected by various factors, including storage, mechanical handling, and exposure to heat and moisture. Also, dyeing blended fabrics should achieve the desired shade and fastness while retaining fabric appearance and elasticity and dimensional stability.

The review examines the storage and cone handling of spandex; pre-setting and final heat-setting; disperse dyeing of PET/spandex; acid dyeing of nylon/spandex; scouring; reduction-mordanting; fixing; defects; and quality control. Examples of process conditions cited in the presentation include PET dyeing at about 130°C for 40 minutes, nylon dyeing at about 95-98°C for approximately 40 minutes, and heat-setting at 170-195°C, depending on the stage and substrate. These are process windows for the examples cited, and similar conditions could be used in other cases. However, actual conditions should be established through trials, based on capability of the equipment, the construction of the fabric, customer requirements, and requirements of the fabric dyeing industry.

This literature-based, technical review offers summary findings of various experiments, identifies key elements essential for controlling quality, and describes general process windows. Further process control experiments are suggested to determine the impact of processing conditions on spandex power, colour difference, shrinkage, and fastness.

LIST OF ABBREVIATIONS

PET: Polyethylene terephthalate

PA: Polyamide,

commonly called nylon

PES: Polyester

EL: Elastane

Spandex: Generic term commonly used for elastane in

some markets HT: High temperature

pH: Measure of acidity or alkalinity

°C: Degrees Celsius min: Minutes

m/min: Meters per minute g/L: Grams per liter

SET%: A setting-related measurement as defined by the source or

test protocol Dtex: Grams per 10,000 meters of yarn

Denier: Grams per 9,000 meters of yarn

Trenter/Stenter: A machine used to control fabric width and heat-

set fabric Scouring: Removal of oils, lubricants and other

impurities

Reduction cleaning: Reductive after-treatment used to remove surface disperse dye and residues

Colour fastness: Resistance of colour to a specified exposure or

treatment Shade: The visual colour appearance of a dyed material

Lot number: Production batch identifier used for traceability

Note: Terms and abbreviations should be aligned with the terminology used by the department and the original technical source.

CHAPTER 1: INTRODUCTION

Polyester fiber is a viscous fiber that has good tenacity, elasticity, high strength, good dimensional stability, and drainage performance. Sportswear, tight pants, and swimsuits are widely used.

Nylon, because of its strength and abrasion resistance and smooth hand, is used in a wide range of apparel. Spandex is blended with nylon or polyester for fabric stretching. The challenge in using spandex in blends is that the base fiber, which makes up the bulk of the blend, must be colored while the spandex performance has to be preserved.

The presentation, "Handling spandex & dyeing of synthetic fabrics," highlights the practical controls in knitting and wet processing. It mentions that there are several safe methods of storing spandex cones, that direct exposure to sunlight and high humidity should be avoided, that the yarn package should be handled with care, that lots should be uniform, and that the heat-setting conditions should be strictly controlled. It then discusses the dyeing of PET/spandex blends, as well as of nylon/spandex blends.

Fabric quality is a combination of many factors. A fabric may be the proper color but has poor fabric washing fastness or exhibit yellowing or shrinkage. These should be considered together in a single, continuous process in order to achieve the desired fabric quality.

The aim of this thesis is to integrate and explain, in a more complete manner, the information provided by the presentation, and indicate where practical quality-control measures can be instituted. The parameters discussed are examples from the presentation and literature; they should be adjusted to each production facility.

1.1 BACKGROUND AND PROBLEM STATEMENT

The manufacture of spandex is done with fibers that are elastic. The yarn properties depend on its polymer and on the method of preparing the yarn. When stored and handled incorrectly, yarn defects, poor package orientation, friction, contamination, and incorrect feeding can cause improper fabric formation. In addition, for the wet processing, if the fabric is subjected to excessive heat or if improper procedure is used, it may damage the elasticity of the fabric and create defects. The chemical nature of both PET and nylon is different, which also affects its manufacturing process. Because PET is a hydrophobic polymer, it is normally dyed using disperse dyes at high temperatures. At the same time, nylon had an amide group that can be dyed by acid dye at low ph. As a result, there is a need for a procedure that would take into account the properties of both materials. A significant challenge in the production process is ensuring the quality of the final product. More specifically, a problem arises when pre-setting is done incorrectly, resulting in poor fabric width control during further processing. On the other hand, exposure to high temperatures for a prolonged period can ruin the spandex's power and cause dye sublimation. For nylon/spandex, knitting oil can cause poor level dyeing; thus, the dyeing and fixing process must be performed correctly to avoid defects related to wet fastness. As a result, the key research question for this study is how the handling, processing, dyeing, and finishing of PET/spandex and nylon/spandex fabrics can be organized to ensure quality.

1.2 SIGNIFICANCE OF THE STUDY

This topic is relevant for students and practitioners in the textile industry, especially dye-house technicians, quality personnel, and fabric manufacturers. Understanding the effect of process conditions can assist operators to arrive at conclusion based on causes rather than relying on repeated trials. This study can improve interaction among knitting, dyeing and finishing, and quality departments. Controlling process conditions can result in reliable processing, less rework, less rejected lots, and less variation in shades. Less rework, reduced variability in shades, and saving in water, energy and chemicals consumption are benefits of better process control. This review is a valuable training document, as it links hands on process guidance from the available presentation with fundamental teachings of textile coloration. It does not claim or imply that a given temperature or recipe can be applied to all fabrics. It however posits that, to understand the effect on the desired end, process conditions (whether physical or chemical), should be verified against the type of fibers and yarns, the machine, the dye supplier, and the instructions of the buyer.

CHAPTER 2: Aim, Objectives and Scope

This report reviews the key aspects of handling spandex and the associated dyeing processes for polyester/spandex and nylon/spandex fabrics and explores the effect of key process parameters on color and elastic properties of the fabrics.

The objectives are to:

1. Explain the special care needed for spandex, especially its storage and handling.

2. Describe package identification and lost control systems and feeding practices that facilitate consistency of knitting.

3. Describe heat-setting and the consequences of under- and over-setting.

4. Describe the mechanism of disperse dyeing and the typical process steps for the disperse dyeing of PET/spandex.

5. Describe the mechanism of acid dyeing and the typical process steps for the acid dyeing of nylon/spandex.

6. List the scouring, bleaching, washing and fixing effects.

7. Identify common flaws and outline ways of avoiding them

8. Propose process conditions to investigate the effect of process parameters on fabric quality.

The review is restricted to the technical aspects of handling and dyeing spandex blends with PET and nylon. It is not an exhaustive review of synthetic fibers, commercial dye classes, or types of machinery. The work is based on the presentation provided and other published works. Original research works are not part of this report.

2.1 RESEARCH QUESTIONS AND LIMITATIONS

The review covers five questions. The first questions cover recommended spandex storage and handling. The second questions cover the effect of time and temperature during heat-setting and how they affect the stability of the fabric and the performance of elastane. The third questions cover the use of disperse dyes on PET and the role of reduction cleaning and final setting. The fourth questions cover acid dyes on nylon and the importance of scouring before dyeing. The fifth questions cover quality tests to verify the color and physical performance. The presentation gives examples of processes, recommendations, and conclusions, but a complete set of laboratory methods, raw data, and statistics is lacking. Therefore, many values (ex. dyeing temperature, pH, chemical dosage) are presented as case examples requiring local evaluation. The recommendation of a process as "best" does not indicate that this is an industry practice. The final thesis should be reviewed by the adviser for corrections based on departmental requirements. These include peer-reviewed reviews on disperse dyeing of PET, academic textile coloration material, the description of ISO 105-C06 by the International Organization for Standardization, and the listing of relevant test methods by the American Association of Textile Chemists and Colorists. While these sources support some of the mechanisms and principles of testing, they do not provide evidence for every aspect of the process and setting described in the presentation. The review identifies and explains the major steps in the process for each of the two fabric types. It describes potential causes of major defects. The recommendations are, however, presented as process control principles, and no guarantees are made. It is noted that process control principles may also depend on a series of external variables and factors, and that no claims are made that an industrial trial or laboratory experiment was conducted for this research.

CHAPTER 3: SOURCES EVALUATION

Sources have been taken into account in relation to their relevance, technical content, and authority. Scholarly articles are helpful in explaining the interaction between dyes and fibers and in understanding the complexity of the dyeing process. Organizations of standards are suitable sources for the purpose and scope of colour-fastness testing. Technical presentation materials may provide useful information on practical process recommendations, but will refer to a certain supplier, product range, or factory experience. A drawback of the presentation provided is that some slides include short sentences, pictures, or diagrams without full bibliographic citation. Therefore, the exact wording and numbers should be cross-checked against the full text of the supplier's presentation before using it in any research claim. The diagram with values of SET% and “1st loading” is included in this review only as reported data from the provided presentation, and not as an experimentally proven data set.

CHAPTER 4: SYNTHETIC TEXTILE FIBRES AND BLENDED FABRICS

Textile blends are made by combining different fibers to get the correct combination of properties. Polyesters are responsible for stability and strength, and for allowing for high dyeing temperatures. Nylon is strong, resistant to abrasion, and has different dyeing behaviors due to its polyamide composition. The addition of spandex gives a blend of stretch properties.

A blend's performance also depends on the proportion of materials, the way the yarn is constructed, the knitting system applied, and the finishing processes. In the case of a knitted stretch fabric, the tension of the yarns and how the stitches are set will affect the width, weight, stretch, and recovery.

Even a small variation in elastane during processing will affect the final product.

Blended fabrics are more complex to dye than those made from only one fiber due to the differing reactions of each component to heat, chemicals, and dyes. PET is dyed in the process of disperse dyeing, while nylon is normally dyed using acid dyes. In both cases, spandex must withstand the process without losing its strength and becoming contaminated.

CHAPTER 5: SPANDEX: ITS STRUCTURE, PROPERTIES AND APPLICATIONS

Spandex, which is also known as elastane, can be defined as an elastomeric fiber that has been produced to be stretched in a significant amount when subjected to load conditions and also to return to its original state when the load has been removed. Its elastic property is sometime referred to as the structure of its polymer chain that has a flexible area and a stiffer area that allows the material to revert. Several processes are available commercially and thus the exact effectiveness regarding heat and chemical resistance should be verified according to the information from the yarn supplier.

Generally, spandex is used only in small amounts; however, it can greatly influence the garments and their general comfort and fitness. It can be used in leggings, activewear clothing, swimwear, underwear, socks, and also stretch denim. In knitted fabrics, the elastane can be fed in a bare form or in a way that is still covered by another textile material.

The nature of fabric containing spandex could be affected by the length of exposure to such factors as heat, ultraviolet rays, chemicals, and mechanical influence. So, proper usage of yarn is important.

5.1 STORAGE AND HANDLING OF SPANDEX

The information available suggests that spandex should be stored in such a way so that direct sunlight impact is avoided, and humidity is kept to a minimum, ensuring that the room temperature is maintained. Therefore, spandex should not be exposed to less than 0°C. This information should be treated as part of the presentation handling recommendations and compared with the corresponding requirements of the supplier on the type of the given yarn.

All the packs should not be damaged and should remain in their closed boxes until used for manufacturing. The boxes have to be properly stacked and moved, making sure that package clarity is ensured. If the boxes are stacked incorrectly, damaged or not properly handled, it can lead to packing circuit failures or even yarn breaking.

During the handling process, operators should hold the tube or pack without pulling the yarn. No cone should be getting stuck during the process of yarn unwinding. If some segment of the yarn is damaged, it should be tested according to the supplier's recommendations but should not be fed automatically to the knitting machine.

As a minimum, the storage checklist has to include detailed information about

Figure No:1.1

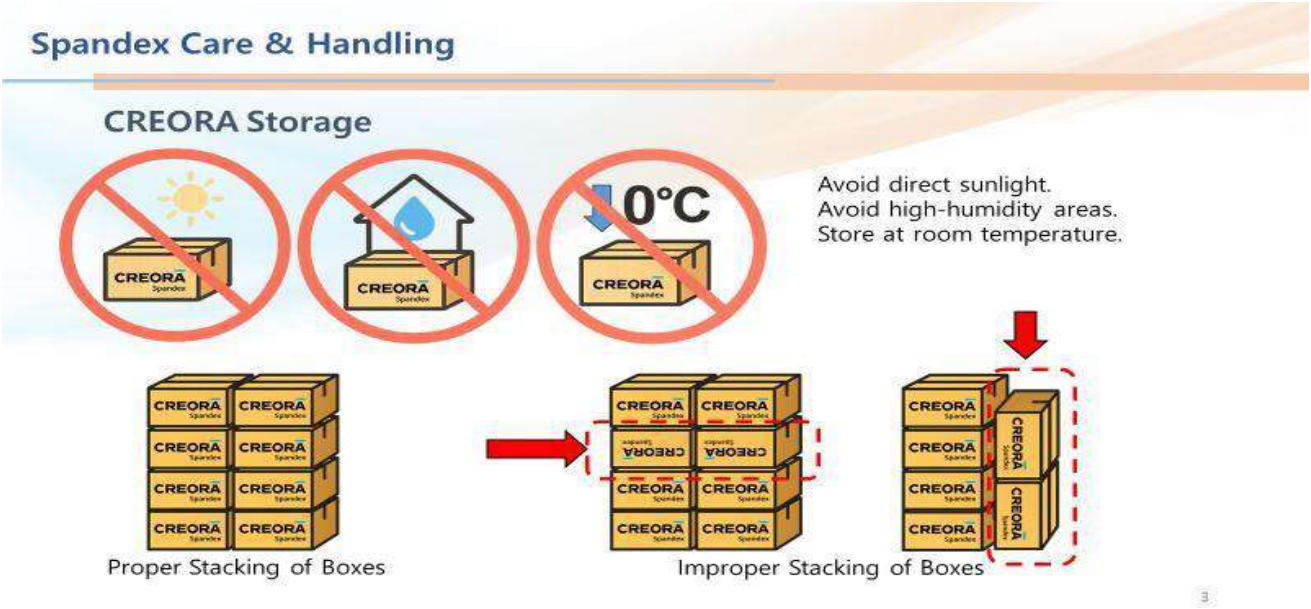

Spandex Care & Handling
CREORA Storage
0°C
Avoid direct sunlight.
Avoid high-humidity areas.
Store at room temperature.
Proper Stacking of Boxes
Improper Stacking of Boxes

Figure No:1.2

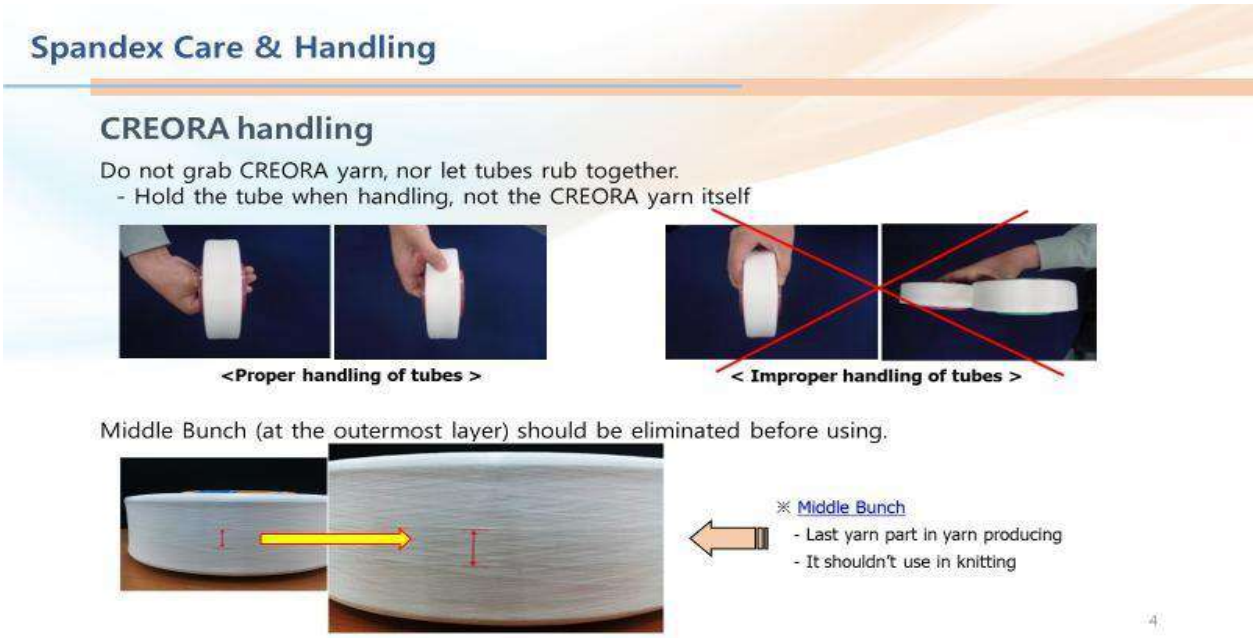

Spandex Care & Handling
CREORA handling
Do not grab CREORA yarn, nor let tubes rub together.
- Hold the tube when handling, not the CREORA yarn itself
<Proper handling of tubes >
< Improper handling of tubes >
Middle Bunch (at the outermost layer) should be eliminated before using.
※ Middle Bunch
- Last yarn part in yarn producing
- It shouldn't use in knitting
4

Figure No:1.3



5.2 DAMAGE TO THE PACKAGE AND MIDDLE BUNCH

The report talks about the presence of the "middle bunch" at the outer part of the new spandex cone and advises removal before knitting. The middle bunch is defined as the last piece of yarn during yarn production and should not be used in knitting. The term middle bunch may be specific to the supplier, so operators need to understand the yarn supplier's correct term and procedure. Before using the package, it must be checked for crushed tubes, loose winding, contamination, broken seals, and any visible abnormalities. If there are any doubts, the package must be taken to the quality department. As said in the presentation, the faulty piece of spandex must be rubbed gently with the palm, and while changing the thread of spandex, the roller and guide should be cleaned. These instructions must be confirmed with the supplier. In general, although any repairing should not be added to oil, dust or friction, it is not recommended if the yarn has lost the properties.

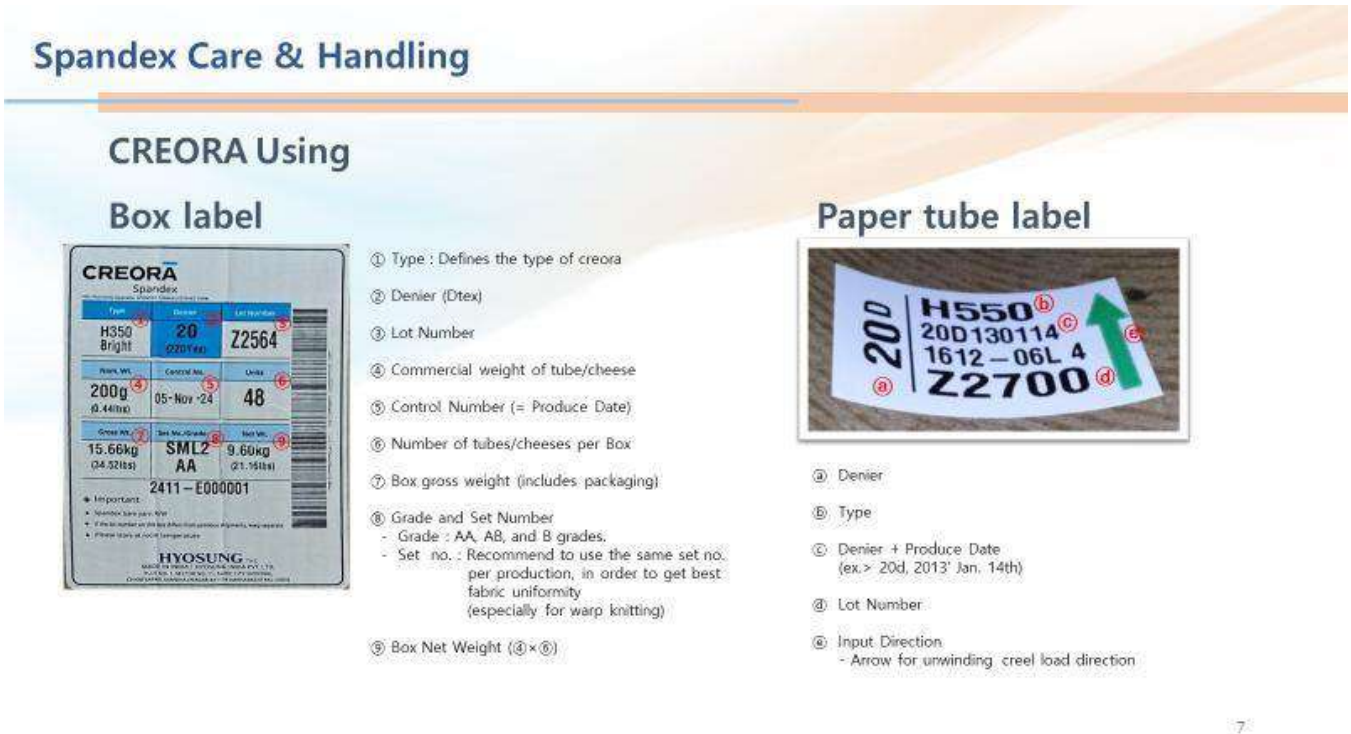
The best preventive measure is to avoid damages during handling, keep a record of the package condition, and create criteria for the cones that

CHAPTER 6: CONE IDENTIFICATION, LOT CONTROL AND FEEDING

In order to help operators facilitate compatibility of yarn and traceability, package labels provide necessary information. The presentation of the package includes the type of spandex used, denier or dtex, lot number, commercial weight of the package, date of production or controlling number, number of cones and weight (both gross and net), grade of yarn, set number, and direction of unwinding.

The box label may provide information on a particular product, whereas the tube label may contain other information of relevance. It is essential that the yarn type and the linear density are stated on the specifications and checked by the operator For circular knitting, it is necessary to alternate cones from different boxes in the ratio of 1:1. It should be undertaken to understand that this approach is a certain type of handling recommendation, and the use of yarn should not replace any approved creneling plan of the machine.

Figure No:1.4

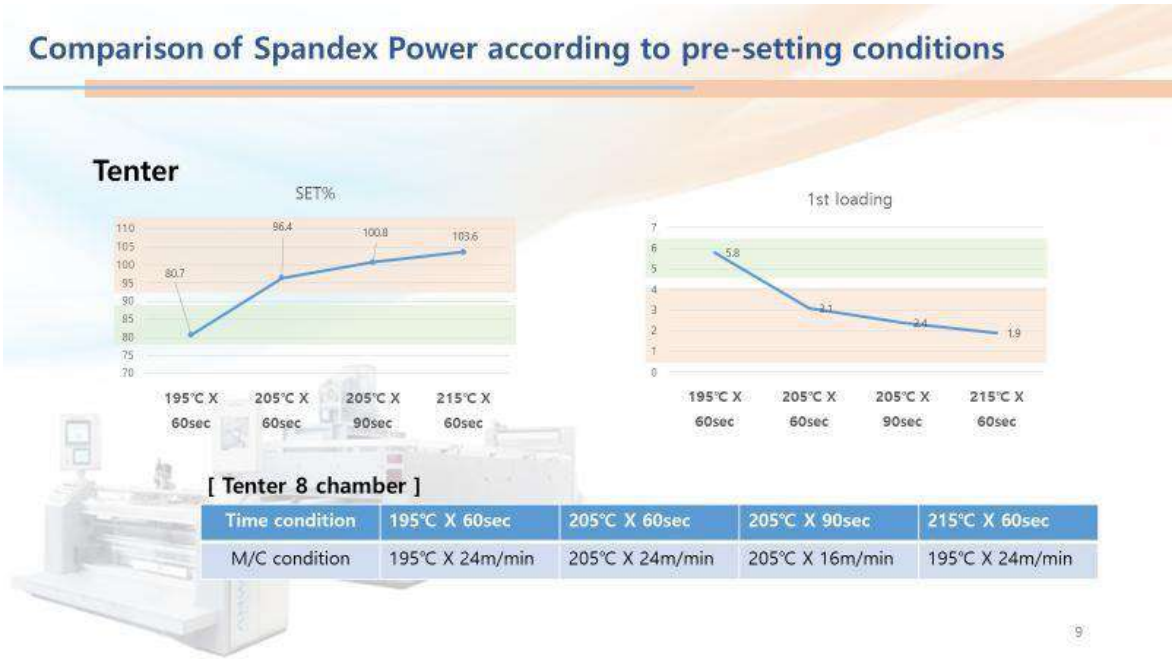


CHAPTER 7: HEAT SET AND DIMENSIONAL STABILIZATION

Heat setting refers to the method of treating synthetic textiles with temperature as well as time control, leading to the achievement of the required dimensions of stability in the fabric. The heat-set method proves to be important for the stretchy fabrics influenced by the process of making fabrics from spandex and also leads to the successful movement of the fabrics through the stages of wet processing. The tenters and stenter devices are machines which can control the width of the treated fabrics and provide them with hot air.

Finding suitable settings for the process is an important moment. Not enough pre-settings can lead to shrinkage and width modification during dyeing. Improper use of temperature and time may lead to a decrease of spandex efficiency, change the hand of the fabric, alter the ability of the fabric to take dye, and lead to changes in colour during heating. Suitable heat-setting depends on the type of fiber, elastane content in the fabric, its construction, speed of operation of the device, structure of a drying chamber, degree of overfeed, and the final use of the fabric.

Figure No:1.5



7.1 INTERPRETATION OF SETTING DATA PRESENTED

The presentation provided indicates SET% values as 80.7, 96.4, 100.8, and 103.6 for the four conditions. There is a second row called "1st loading" with corresponding values of 5.8, 3.1, 2.4, and 1.9, respectively. The slide, however, does not give sufficient methodological information for a complete determination of measured values in terms of its measurement procedure, size of sample, testing method, variation, and statistical significance. In its example, the presentation explains that SET% equal to 100% means that the setting condition is too high. For illustration, it emphasizes the example of pulling 10 centimeters of spandex and heat-setting it to 20 centimeters. While this explanation serves good as a training analog, it cannot be referred to as a scientific definition of SET%. The exact meaning of SET% will depend on the testing method and calculations used. The practice described in the presentation leaves no doubt that setting conditions lead to changes in the achieved setting response and first loading values. However, without a precise method of testing, it is impossible to reach a conclusion that the described experience will occur with all the fabrics or machines. For a formal thesis, the table should provide referencing to the original source of data, measurement units, definitions

CHAPTER 8: POLYESTER/SPANDEX FABRIC FEATURES

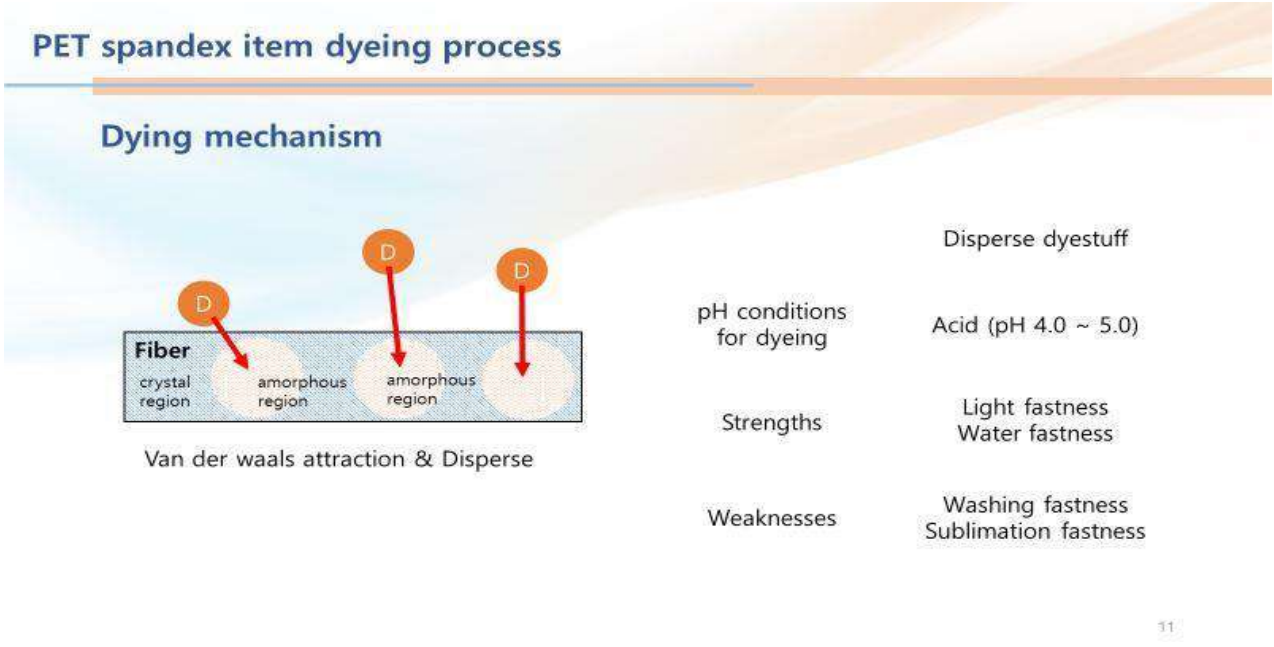
Polyester is a synthetic fiber that is usually referred to as PET and has a low affinity for water-soluble dyes. The dyeing of the polyester is usually performed with the help of a disperse dyeing process that requires high temperatures for dye transfer. The dyeing process of PET/spandex fabrics also must ensure that the elastic component is preserved.

The components of the fiber do not behave the same way. The dyeing of PET usually involves high temperature processing with the dyeing temperature being usually around 130°C. Spandex can be put in the same dyeing bath, but excessive heat can lead to degradation of spandex performance. The pre-setting step of the production process stabilizes the fabric, whereas the final setting influences the dimensions and properties of the fabric.

The presence of disperse dye on the surface may reduce stability of color or cause staining. That is why reduction-cleaning is an essential step in the dyeing process - it removes surface colorant from the fabric. If the colorant is not washed away during the reduction step, subsequent finishing may lead to color migration and sublimation staining.

The main goals during the production process are making the fabric.

Figure No:1.6



CHAPTER:9 DISPERSE DYES AND PET DYEING MECHANISM

Disperse dyes are slightly soluble, non-ionic dyes used on hydrophobic fibers like PET. They are applied to the material as a dispersion in a water bath using special dispersing agents. When dyeing, dye molecules are released from the dispersed dye particles, travel through the dye bath to the fibers, and absorb in the accessible polymer regions. The process of dye absorption is complex, and many articles explain the theory of dye transfer and absorption.

PET consists of crystalline and amorphous parts. The crystalline part of the polymer complicates the dye uptake. The amorphous part of the polymer facilitates the diffusion of the dye. **An increase in temperature improves dye diffusion, which is possible because the** fibers get more thawed at higher temperatures. Absorption occurs due to physical interactions between the dye and the polymer rather than ionic interaction as in the case of acid dyes in nylon.

Today people can influence such features of dyeing as the pH level of the dye bath, the rate of heating, temperature, time of exposure to heat and cooling. Dispersing agents are used in the dye process to keep the dye DM stable. The dye should be chosen considering the shade, build

Figure No:1.7

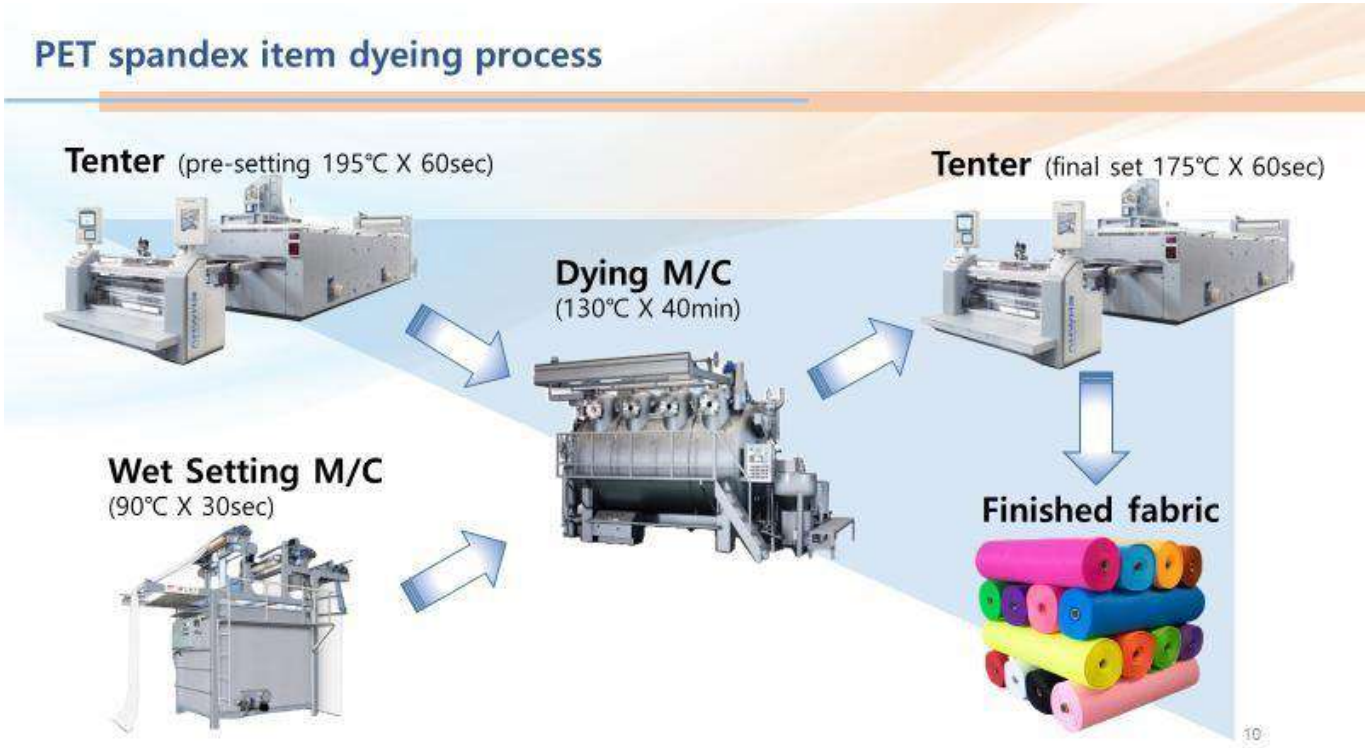
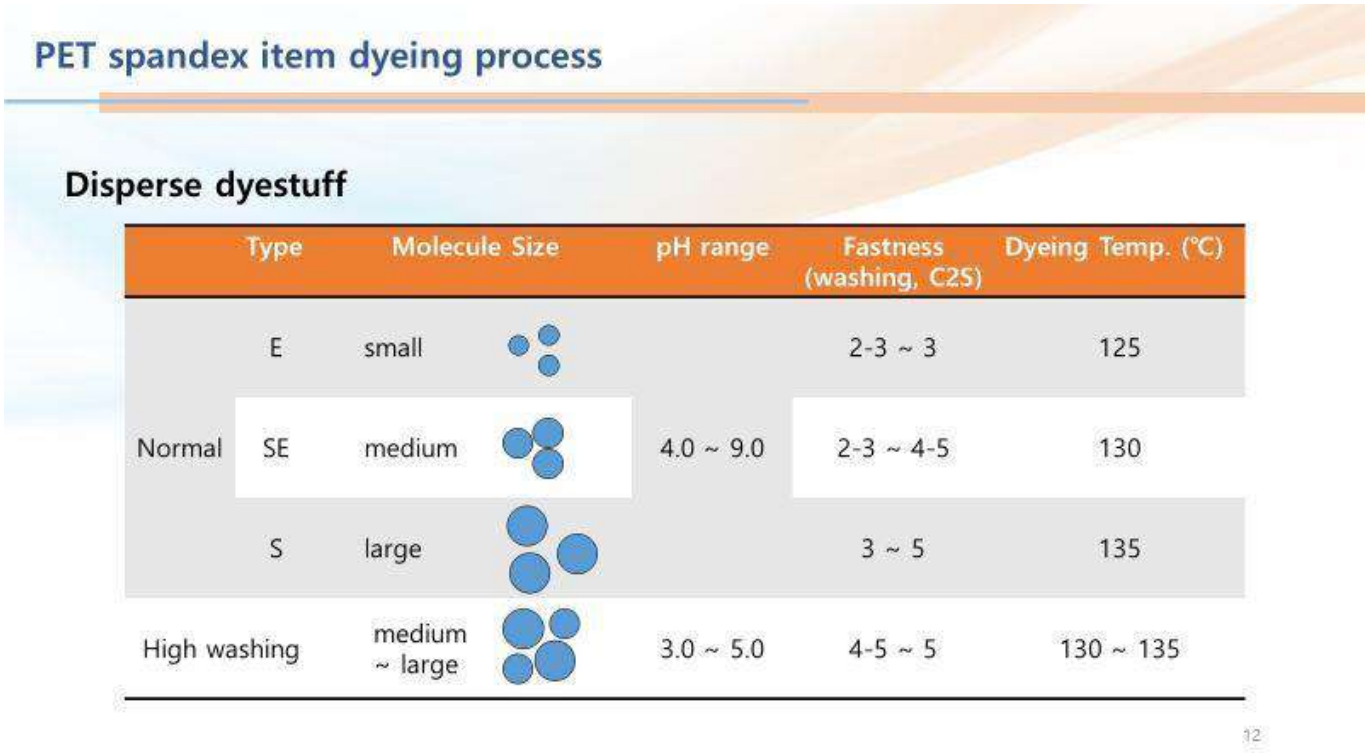

PET spandex item dyeing process
Tenter (pre-setting 195℃ X 60sec)
Dying M/C
(130℃ X 40min)
Tenter (final set 175℃ X 60sec)
Wet Setting M/C
(90℃ X 30sec)
Finished fabric
10

Figure No:1.8


PET spandex item dyeing process
Disperse dyestuff
Type
Molecule Size
pH range
Fastness (washing, C2S)
Dyeing Temp. (℃)
Normal
E
small
2-3 ~ 3
125
SE
medium
4.0 ~ 9.0
2-3 ~ 4-5
130
S
large
3 ~ 5
135
High washing
medium ~ large
3.0 ~ 5.0
4-5 ~ 5
130 ~ 135
12

CHAPTER 10: PET/SPANDEX DYEING PROCESS OVERVIEW

The given PowerPoint slide presents a general process description of the PET/spandex dyeing process including pre-setting, high temperature dyeing, reduction of cleaning or washing, and final heat-setting. The sequence may be presented as pre-setting on a tender at 195°C for 60 seconds, dyeing at 130°C for 40 minutes and after that the final setting for about 175C for 60 seconds. There is also a slide illustrating the process of scouring at 80°C for 20 minutes and reduction cleaning at 80°C for 20 minutes with examples of chemicals added. The presented numbers are related to the example in the presentation but should not be perceived as a universal recipe for production.

Dyeing conditions depend on the type of disperse dye used, the depth of shade, the weight of the fabric, the liquor ratio of the machine, the additives used as well as the requirements of the buyer. The complete process involves different variations of settings; thus, in one place of the presentation the final setting is expressed as at 170°C and in another place as at 175°C. One should verify the final mode with the original technical owner of the fabric.

The goal of the dyeing process

CHAPTER 11: SCOURING AND PRE-TREATMENT FOR PET/SPANDEX

Scouring is a cleaning process that eliminates oils, knitting oils, dirt, and other contaminants that may prevent dyeing. In the case of PET/spandex, the degree of scouring depends on the history of fabric preparation and contamination levels. The following presentation gives an example of scouring conducted at 80 degrees Celsius for 20 minutes with scouring chemical displayed in the process diagram.

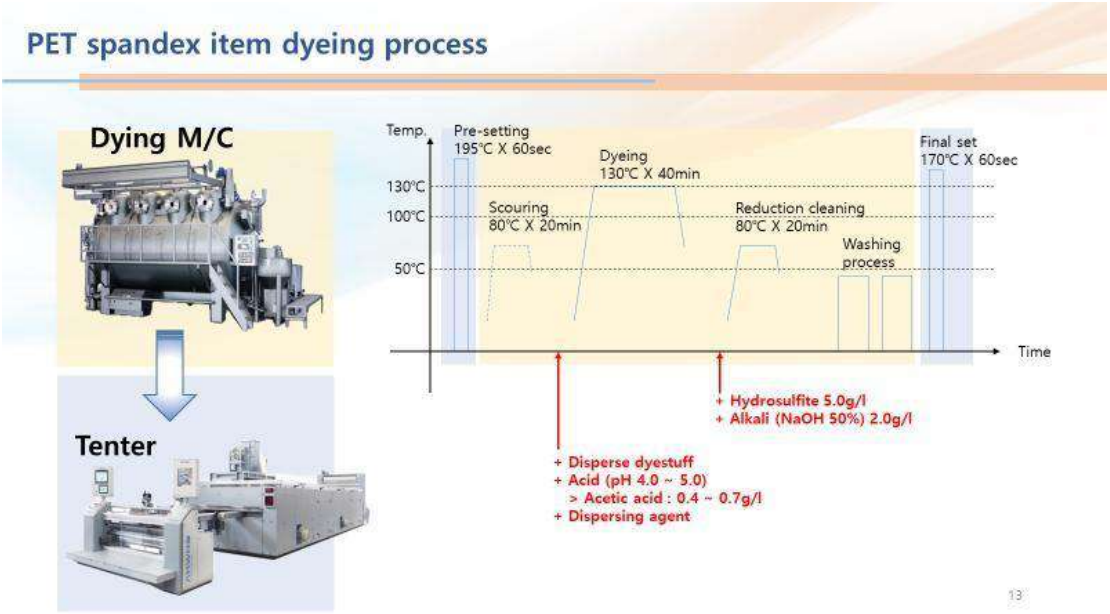
Effective pre-treatment is a prerequisite to achieving even wetting and dye uptake. Residual oil in the fabric may cause non-uniform shade, spots or delay dyeing due to different interactions of dyes and chemicals with the fabric. Excessively harsh chemical processing can also cause damage to the elastic component of the fabric and result in excess waste water.

Pre-treatment (recipe) – should include chemical name and concentration, liquor ratio, temperature, time, pH and method of rinsing.

The operators should never rely on temperature and time solely. Water hardness, loading of the machine with fabric, fabric motion, and type of lubricant should all be taken into consideration.

After scouring all auxiliaries should be rinsed. During rinsing quality control team may compare the wetting behavior, look for oil marks and check

Figure No:1.9


PET spandex item dyeing process
Dying M/C
Tenter
Temp.
Pre-setting
195℃ X 60sec
Dyeing
130℃ X 40min
Final set
170℃ X 60sec
130℃
100℃
50℃
Scouring
80℃ X 20min
Reduction cleaning
80℃ X 20min
Washing
process
Time
+ Hydrosulfite 5.0g/l
+ Alkali (NaOH 50%) 2.0g/l
+ Disperse dyestuff
+ Acid (pH 4.0 ~ 5.0)
> Acetic acid : 0.4 ~ 0.7g/l
+ Dispersing agent
13

CHAPTER 12: PRE-SETTING PET/SPANDEX

Pre-setting is done to make the fabric stable before going through the high-temperature dyeing process. The given presentation advises setting a temperature of 195 degrees Celsius for 60 seconds. A warning is provided in terms of incorrect setting temperature which could negatively affect the width and the shrinkage of the finished fabric. At the same time, excessively low temperature or time may lead to loss of spandex power and fabric weight of the treated fabric.

The stated line speed of 24 m/min is associated with the example of the eight-chamber tenter given in the presentation. Machine speed is related to the dwell time, but the specifics of such relationship depend on the design of the equipment and of the heated path. One should remember that the nominal air temperature does not always equal the temperature gained by the fabric itself. Therefore, one should stress the importance of calibration and validation of the equipment being used.

Another issue to take into consideration is the tension applied to the fabric as well as the over feed value. Excess tension may stretch the fabric during pre-setting, while lack of width control will result in

CHAPTER 13: DYEING WITH DISPERSE DYES AT HIGH TEMPERATURES

The information talks about dyeing with spandex and PET at a temperature of about 130 degrees Celsius for 40 minutes, in a bath with a pH value of about 4.0-5.0 acid bath. It consists of type of dye, acids like ethanoic acid, dispersants etc. Exact formula will be based on the colours manufacturer suggestions & also the colour required.

The heating profile itself is important as we want to ensure that the dye molecules are diffusing into the PET at an appropriate rate.

If the heating rate is too high, the dye will diffuse too fast, which will lead to uneven results, especially when there are different exhaustion rates of different dye combinations used. Adequate rise of temperature, sufficient circulation and adequate shelf time are needed to ensure even color formation. The equipment must be designed to ensure safety at the working temperature and pressure level.

The presentation defines disperse dyes into E, SE, and S types according to their molecular sizes and the dyeing behavior. E type is defined as a type with relatively small molecules that require less energy, but which give low washing fastness in many cases. SE is the type of disperse dyes of a medium.

CHAPTER 14: REDUCTION CLEANING AND WASHING

Reduction cleaning is one of the methods employed after dyeing PET fibers with dispersive dyes. The purpose of the treatment is to remove some dyes and impurities located on the surface of the fabric, reducing the amount of dye that penetrated into the fibers. The presentation describes the reduction cleaning procedure with the example carried out at 80 °C for 20 minutes with the dosages of 5 g/L of hydrosulfite and 2 g/L of sodium hydroxide. These dosages should be considered as examples since specific information must be obtained from dye and agent suppliers.

The significance of cleaning consists in the fact that leftover dye on the surface of the fabric can lead to poor wash fastness and could cause damage to the product during subsequent heat processing. The literature describes reduction cleaning as the process where reducing chemicals are used in alkaline conditions. As for other chemicals, the recipe and their utilization is a matter of the particular process in question.

Once the reduction cleaning is finished, the fabric is subject to washing for getting rid of residues of the chemicals. If the quality of the cleaned fabric cannot satisfy the manufacturer.

CHAPTER 15: FINAL HEAT-SETTING OF PET/SPANDEX

The last heat-setting step determines the fabric's finished dimensions and stretches it out and assists the recovery process after any liquid treatment. One of the presentation examples is to conduct final heat-setting, for example, at 175℃ for 60 seconds, while another process diagram shows the same process at 170°C for 60 seconds. That showcases the significance of particular techniques being studied for given fabric and finishing line.

Too high final heat can lead to the dye being migrated or sublimed, color change or bleaching, or loss of spandex functional properties. Risk factors include dye chemistry, colors used, as well as other processes of dyeing and finishing and interval between them.

The final specification of a fabric during final heat-setting must include some target sizes, overfeed, and speed of production. at the end of setting, fabric must be evaluated in terms of its appearance and width, shrinkage, color variation, and stretch recovery.

In the end, the final process should ensure the fabric's stability.

CHAPTER 16: CHOOSING DISPERSE DYES AND THEIR FASTNESS FEATURES

Dye choice influences things such as the reproducibility of colour, fastness properties, cost, and possible surface contamination. In the present presentation, regular disperse dyes are distinguished from high washing disperse dyes. It can also be observed that despite cleaning the spandex with regular dyes, some residues may remain on its surface, but they may still be avoided with high-washing ones. The speaker also mentions that in terms of setting the dyed fabric, if the dye flows, the discoloration or fastness will be worse.

This is an important consideration for the production process. However, it is always necessary to test the dye used for the actual shade and blend. Although the dye is said to be a high-washing one, it does not mean it would achieve good test results.

The effectiveness of such tests will depend on shade, dye combination, cleaning method, rinsing, and temperature for final setting.

Testing for colour fastness should be based on the following parameters of the product. Washing fastness is specific for assessing colour changes and staining after washing.

Rubbing fastness indicates the colour transfer after exposure to

dry or wet friction. Water and perspiration tests

CHAPTER 17: CHARACTERISTICS OF FABRICS MADE OF NYLON/SPANDEX

Nylon belongs to polyamide fibers and has amide groups in its polymer structure. Such presence of the functional groups is responsible for the fiber's dyeing properties. The application of nylon/spandex blends covers sportswear, swimwear, underwear, and many other items where properties such as good stretching, strength, and flexibility are important.

Taking into consideration the fact that nylon is not like PET, it is dyed using acid dyes. The dye uptake is related to the ionic sites present in the fibers, the structure of the dye, pH of the bath, temperature, time, and the features of the substrate. Nylon may be heat sensitive, and its color or the shade can be changed under inappropriate finishing conditions. Besides, the elastane part has some restrictions as its conformity to the elastane's functional purposes should not be lost.

In the presentation, special attention is devoted to scouring stage as a critical point of the nylon/spandex dyeing process. It states that the scouring process should take between 80 and 90° C and last for 7-15 minutes. The dyeing process should be performed at 95-98° C with a duration of approximately 40 minutes. It should be stated that these temperatures

CHAPTER 18: MECHANISM OF DYEING NYLON WITH ACID DYES

Also known as anionic dyes, acid dyes operate in a medium of acid-based water. As a result of the environment created, nylon fibers can be influenced by protonated amino groups that react with anionic dyeing agents. Thus, ionic bonding is the main stage in the dyeing process. How effective the dyeing process will be is affected by parameters such as pH level, temperature, molecular structure of the dye, its affinity, and heating intensity.

The information from the presentation indicates that the right pH range for the dye bath is around 4.0-
5.0. The process diagram indicates that the right pH is about pH 4.5-4.8. Any change depends on the dye class used as well as the recipe selected. If the pH level is changed both quickly and beyond the required level, the dyeing process can become less efficient.

According to the presentation, acid dyes can be classified into leveling acid dyes, half milling acid dyes, milling acid dyes, and metal-complex dyes. Different groups of dyes vary in size, usage, and fastness, etc. In general, dye ingredients have to meet all the requirements, e.g., levelness of dyes, brightness and depth of color, and fastness

CHAPTER 19: NYLON/SPANDEX SCOURING

Scouring is one of the essential steps for nylon/spandex because of the fact that oil and lubricants used in knitting interfere with wetting and the interaction between dye and fiber. According to the presentation, if the oils are not properly removed, it may result in the failure to achieve consistent color. Scouring may be continuous pre-treatment or performed in the dye machine.

The presentation provides an example condition of 80-90°C for 7-15 minutes, but this condition may change depending on the type and the amount of oil, weight of fabric, machine loading, scouring agent, and the supplier's recommendations. Excessive scouring may lead to the waste of energy and create unease for elastane while insufficient scouring will allow some oils to remain which may bring to the problems with spots and uneven color.

After scouring, a thorough rinsing which is necessary to remove dirt, oil and remaining detergent and auxiliaries. If the bath follows into the dyeing stage, it may alter the chemistry and bring problems with leveling. A dye house should find a practical method for checking cleaning: inspection, wetting or validated lab method.

Scouring is not just a simple housekeeping procedure

CHAPTER 20: NYLON/SPANDEX DYEING PROCESS

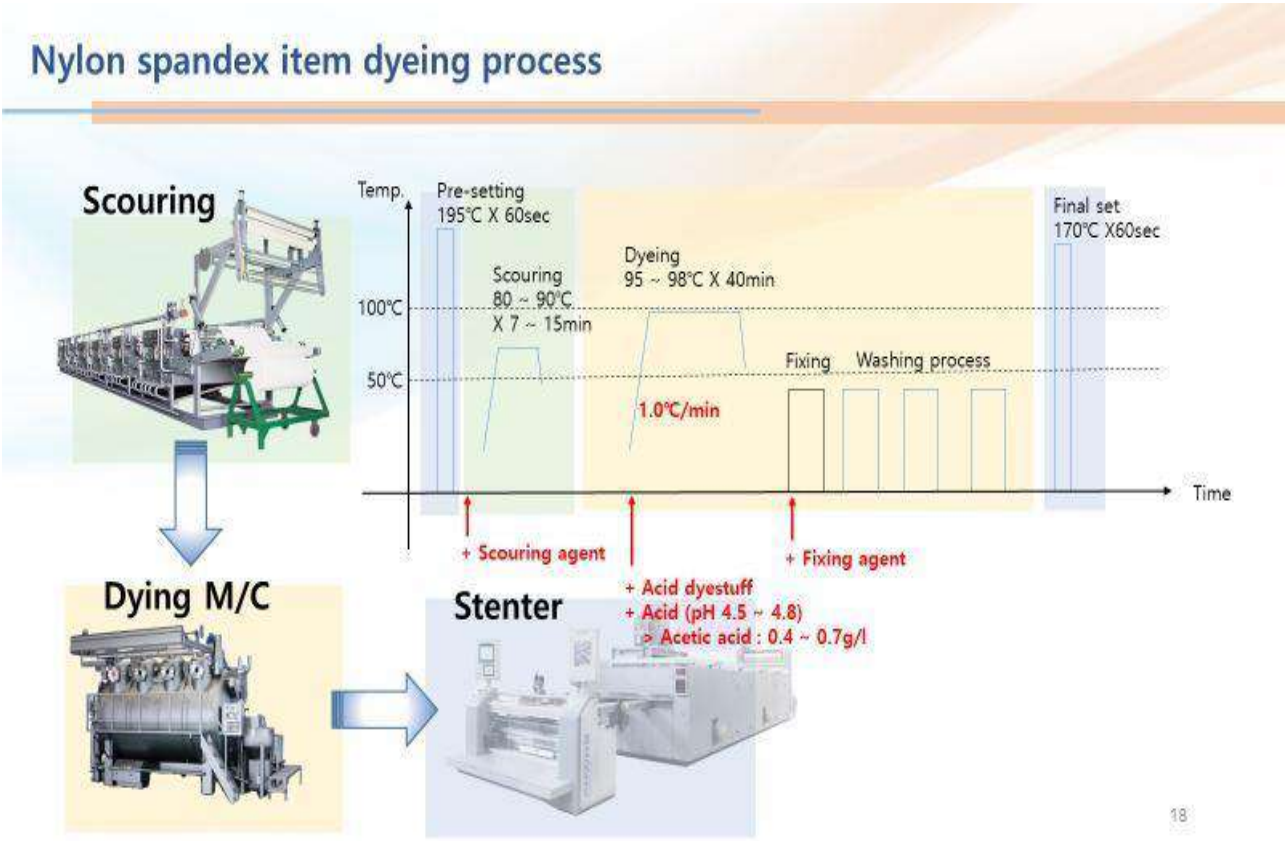
The presentation provided is about a simplified nylon/spandex process. It mentions pre-setting that takes place at 195°C lasting for 60 seconds, followed by scouring at 80–90°C lasting for 7–15 minutes. Acid dyeing is carried out at 95–98°C for about 40 minutes, and final heat-setting occurs at 170–175°C for 60 seconds. The source also provides information on the acid concentration of around 0.4–0.7 g/L and the heating rate that may be around 1°C/min.

These parameters are not universal. The specifics of dyeing may change depending on the type of dye, shade, and composition of fabric and machine design. Thus, one should check the procedures with the dye supplier. It is important to be cautious with the addition of acids and auxiliaries since high concentrations of dyes may result in problems and unevenness of dyeing.

The increase in temperature should be controlled in order to provide dye migration and equalization of dyeing. When the dyeing process is finished, the dyeing bath may be cooled down according to the procedure.

It is important to keep a detailed record of the process during dyeing for future reference in case there is a need to repeat the same procedure.

Figure No:2.0


Nylon spandex item dyeing process
Scouring
Temp.
Pre-setting
195℃ X 60sec
Scouring
80 ~ 90℃
X 7 ~ 15min
Dyeing
95 ~ 98℃ X 40min
Final set
170℃ X60sec
100℃
50℃
Fixing
Washing process
1.0℃/min
Time
+ Scouring agent
+ Acid dyestuff
+ Acid (pH 4.5 ~ 4.8)
> Acetic acid : 0.4 ~ 0.7g/l
+ Fixing agent
Dying M/C
Stenter
18

CHAPTER 21: FIXING AND FINAL HEAT-SETTING OF NYLON/SPANDEX

According to the presentation provided, the acid types of dyes are recognized for their good properties regarding washing possibilities and light resistance. However, it is essential to remember the water-fastness property of these types of dyes, which may be worse than their properties mentioned above. Therefore, there is a fixing of dyes that can be done if needed, depending on the type and color of dyes, expected requirements for the final product, and results of testing. When selecting and applying fixing agents, it is important to follow the instruction of the supplier since the efficiency and effectiveness of the fixing agent are variable.

Usually, after dyeing fixing, rinsing or other after-treatments processes might be appropriate to make sure that there are no unreacted compounds left. If this procedure is not carried out as required, it will negatively affect the quality characteristics of the product. It is also important to perform any washing and water-fastness tests required by the customer.

Final heat-setting is a stage that controls the final width and dimensional stability of the fabric. According to the presentation, the temperature should be 170-175 degrees centigrade for 60 seconds.

CHAPTER 22: NYLON/SPANDEX FIXING AND FINAL HEAT TREATMENT

The presentation states that the acid-dyeing method allows us to take advantage of the attractive features of such dyes, such as ease of washing and excellent light fastness. However, it should be noted that the water-fastness of acid dyes is not on the level of the previous features. Thus, dye fixing is performed depending on the dye type, dye color, requirements for the final product, and test results. When choosing and applying the fixing agents, it is important to follow the recommendations provided by the supplier, since the fixing efficiency can vary depending on the agent used.

In most cases, the dye fixing process is followed by any rinsing or other treatment to ensure that all unreacted substances are removed as well. If this step is missed, it negatively affects the desirable quality parameters.

It is also essential to conduct all required wash-facings tests. The process of final heating is meant to achieve the necessary final width of the polyester fabric. According to the presentation, the temperature needs to be equal to 170-175 degrees Celsius for 60 s.

CHAPTER 23: QUALITY CONTROL AND TESTING

The control of quality needs to check not only the performance but also the appearance. The visual assessment is not enough for establishing whether washing resistance, dimensional stability, and stretch recovery have been achieved. To have good results, it is better to draw up a plan that includes both control during the production processes and tests of the finished products.

The fastness to washings can be defined through the methods given in ISO 105-C06 that contain information about the procedures of washing resistance against domestic and industrial washing. AATCC also gives the methods of testing fastness to washing, light, perspiration, and rubbing. It is important that the method of testing chosen, preparation of the sample, assessment scale and the examination level meet the requirements of the customer or the relevant standards

In the case of blends with spandex, the following tests need to be carried out to determine whether the quality is achieved: fabric width, weight, shrinkage, and stretch ability if they are applicable to the end of use. The testing must be performed on the representative samples, and the information about the lot and dyeing must be noted down.

DISCUSSION

The information on the presentation and the existing literature show that the successful dyeing of spandex mixtures depends on controlling the entire technological process. Yarn quality and yarn handling affect the reliability of the knits. Pre-setting has an effect on the fabric stability and the reaction of the fabric to further treatment. Scouring helps ensure even absorption of dye because it removes oil. The dyeing process and material used control the colour that is produced while any remaining dyes are removed or fixed by post processing. PET/spandex and nylon/spandex need different dyeing approaches as their components are chemically different. PET is dyed using disperse dyes in combination with high-temperature dyeing and sometimes reduction cleaning, whereas the dyeing of nylon utilizes acid dyes in an acidic media, and some fixing may be needed according to the target of fastness. In both processes, care should be taken to protect elastane from unnecessary damage. The figures in the presentation can be used as a starting point for discussion, but it is impossible to say whether these parameters are appropriate without knowing what channel, fabric, dyes etc. were used. For example, there are two instances of setting at both 170°C

CONCLUSIONS

This research discussed how to work with spandex, as well as how to dye PET/spandex and nylon/spandex fabrics. The first conclusion is that the spandex has to be handled with care in order to preserve its properties. Direct sunlight, damaged packages, dragging, improper stacking, and rough handling of the fibre can interfere with the result of the production process. Package labels and lot tracking documents play an important role in maintaining traceability of the products and their streamlining.

The second conclusion is that heat-setting involves controlling the temperature, time duration, speed, and tension of the fabric. According to the presentation, the information provided suggests that the ideal temperature for pre-setting is roughly 195 degrees Celsius for 60 seconds, but this information has to be corroborated depending on the fabric being used. The third conclusion states that PET/spandex fabrics are typically dyed using disperse dyes at high temperatures. Scouring might be necessary when cleaning the fabric, as this process eliminates the dirt from the fabric, and reduction cleaning process eliminates the dye deposits from the surface of the fabric. The type of dye and heating at the end are essential for preventing stains.

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