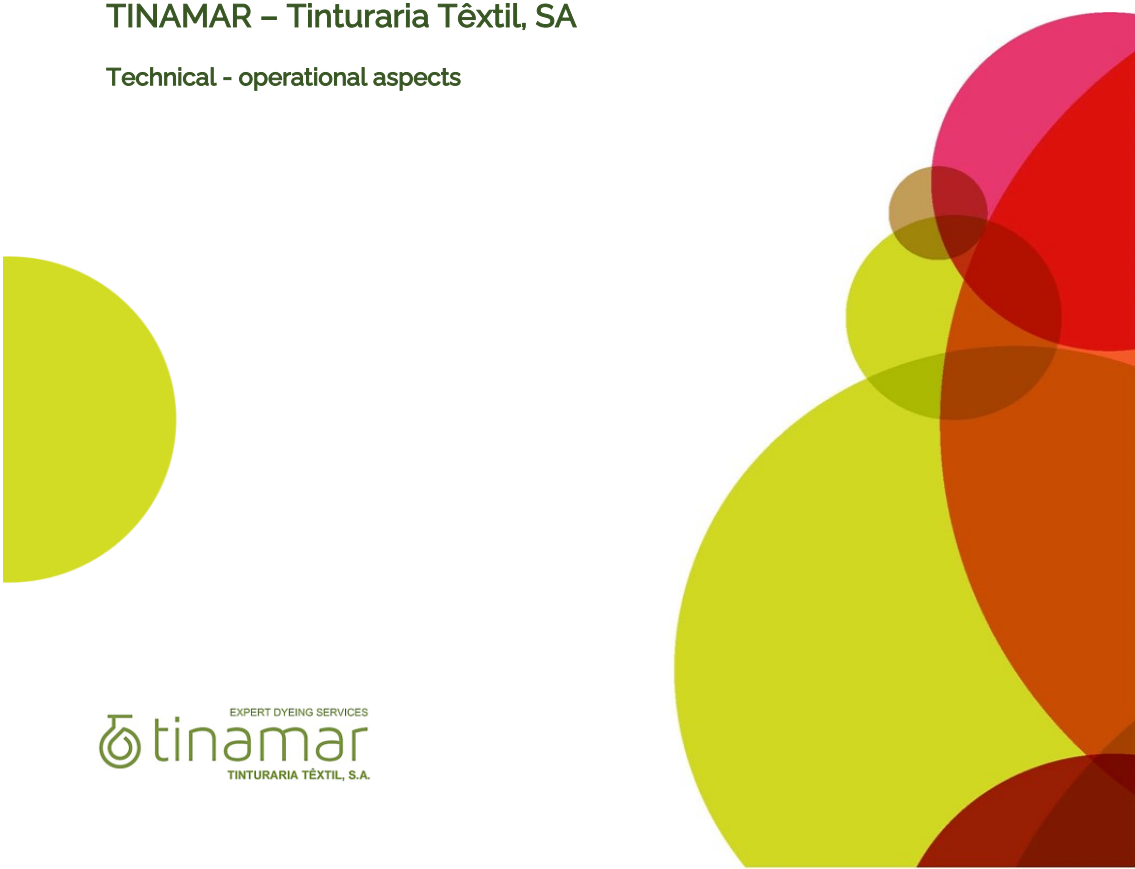
Environmental Sustainability in the Textile Industry

Perspective of TINAMAR – Tinturaria Têxtil, SA

Technical - operational aspects



EXPERT DYEING SERVICES

tinamar

TINTURARIA TÊXTIL, S.A.

1

Introduction

Environmental sustainability plays an increasingly important role in the strategies of textile companies. Growing consumer sensitivity and progressively more restrictive legislation are the main drivers of this strategy.

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Textile articles have a significant environmental impact, from the cultivation or production of fibers, through all stages of manufacture, distribution, washing and treatments carried out by the consumer, to their final destination in landfill or incineration.
The worldwide increase in its consumption, proportionally increases the environmental impacts. These impacts can only be minimized by changing consumption behavior and improving production processes.

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(iii) Consumption of chemicals;
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Due to the visibility of these impacts these companies are at the center of the environmental concerns of the other actors in the production chain.

Faced with this pressure, this subsector has been adopting strategies to reduce it, aiming the natural environmental benefits, but also to reduce the associated costs.

The dyeing and finishing subsector has been adopting strategies to reduce its environmental impacts.

However, these companies, normally service providers, do not usually have any intervention in the design of the articles and are limited to producing the products according to the specifications presented to them.

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This work is intended to alert those responsible for defining these specifications, to the environmental impacts that some requirements represent.

2

Color Evaluation

One of the characteristics of today's textile market is the large number of collections. This results in the production of a variety of colors and a large number of small batches/dyeing lots.

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The dyeing process is complex and highly sensitive. It depends on numerous process parameters (physicochemical, kinetic and thermodynamic), which are difficult to control and predict. Despite technological advances, it is exposed to some imponderables, and it is impossible to eliminate minimal color differences between a reference standard and a batch or lot.

The human eye, due to its ability to detect color differences, remains the most used means of color evaluation. The problem is the natural subjectivity of the evaluator in perception of color.
In In addition, the following aspects modify the perception of color:

Visual evaluation of color leads to divergent evaluations.

(i) Illuminant;
(ii) Relative size of the compared samples;
(iii) Field of view;
(iv) Distance and the angle of comparison;

(v) Degradation of the color of physical standards, due to bad packaging (exposure to light, humidity, etc.), handling (texture alteration, grease deposition, etc.) or contamination.

These factors lead to divergent color evaluations by different people. Frequently, colorimetrically very similar colors are rejected by the client, incurring what is commonly called "excessive rigor".

Very similar colors are rejected by the client, incurring what is commonly called "excessive rigor".

Such circumstances force color correction operations that, besides increasing the total processing costs by about 24-36% in the case of simple color correction and 170-200% in cases where reprocessing of the dyeing is required, produce, in the same order of magnitude, an increase in environmental impacts, as illustrated in Figure 1.

Color correction operations increase processing costs and environmental impacts.

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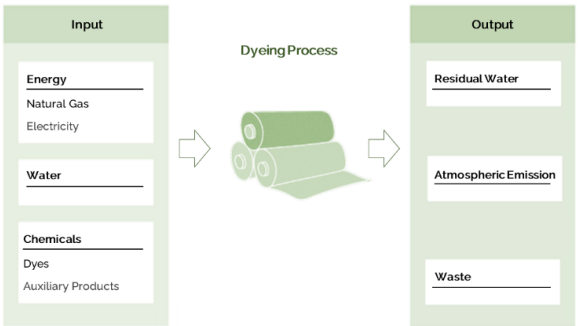

Figure 1: Main environmental impacts associated to the dyeing process

To dye one kilogram of knitted around 110 liters of water are needed and around 2.7 kg of CO_2 are emitted due to energy consumption.

The average daily consumption of water by a person is 110 liters and in their daily activity emit around 5 kg of CO2/day. The color correction of 1000 kg of knitted implies an additional consumption of 110,000 liters of water which is equivalent to the consumption of 1,000 people for one day. It also represents an additional emission of 2,700 kg of CO2 which is equivalent to the activity of 540 people for one day.

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The repetition of the dyeing process determines an increase in processing time (which can represent an additional 16 h). These redyeings act by chemical, thermal and mechanical action that strongly decreases the fiber/knitted resistance, with a subsequent decrease in quality and reduction of the product's useful life.

Increasing the dyeing process time decreases the fiber/knitted strength.

Visual color approval also implies that physical samples are transported, between dye houses and the client. This process leads to delays and environmental impacts associated with transportation.

Better environmental and operational efficiency implies communicating accurately and unequivocally the color difference using a spectrophotometer.

The CIE[1], has established ΔE (Delta E, dE) as the standard color difference metric. In this way, the acceptability of a color reproduction can be numerically evaluated.

ΔE (Delta E, dE) is the standard color difference metric.

[1] Commission internationale de l'éclairage (International Commission on Illumination) is the international authority on light, illumination, color, and color spaces.

Several models for determining the ΔE were developed over the years, either by the CIE or by SDC[2], of which stand out: (1) ΔEab in 1976; (2) ΔECMC in 1984; (3) ΔE94 in 1994 (4) ΔE00 in 2000, having been standardized in 2013

The ΔE94 and the ΔECMC are still widely adopted in the textile industry, however, ΔECMC, due to its specificities, is more suitable for textile samples.

ΔE94 and ΔECMC, are the models, for determining ΔE, widely adopted in the textile industry.

More information, about the design and use, of the ΔECMC model, is available in ISO 105-J03: *Calculation of colour differences.*

The appearance of the color depends on the incident light. The CIE has standardized an enormous variety of illuminants of which stand out the D65 (daylight to midday including ultraviolet light), the A (incandescent lamp), the F2 (fluorescent lamp) and the UV (ultraviolet) and the 840/P15[3], called "store light", is also frequently used.

D65, A, F2 and 840/P15 are the most commonly used illuminants in the textile industry.

Thus, for the establishment of color tolerances, it is imperative to have an adequate technical criterion, acceptable to all parties involved, that includes at least:

(i) The value of ΔE maximum allowable;
(ii) The mathematical model for calculating ΔE;
(iii) The illuminant(s) to use.

The establishment of color tolerances should include: (i) Maximum allowable ΔE value; (ii) Model for calculating ΔE; (iii) Illuminant(s) to be used and be accepted by all parties involved.

[2] Society of Dyers and Colourists is an international professional society specializing in color in all its manifestations.
[3] 840/P15 replaces the old TL84 Philips illuminant.

There are no official regulations on color tolerances, for the textile industry, it is, however, internationally accepted, as convenient, the tolerance of ΔE_{CMC} (2:1) ≤ 1.0, for the illuminant D65.

ΔE_{CMC} (2:1) ≤ 1.0, for the D65 illuminant, is internationally accepted as a convenient color tolerance, in the textile industry.

3

Color Fastness

Color fastness to washing, water, light, rubbing, perspiration, etc., is one of the main indicators of product quality and durability. It is also a consumer health protection factor. It depends on the chemical nature of the fiber(s), the molecular structure of the dye and its concentration in the fiber(s), the presence of certain chemicals in the substrate, and the conditions under which the tests that quantify fastness are performed.

The improvement of the color fastness, to a certain agent, often has the opposite repercussion in another. Color fastness specifications of an additive nature "the more, the merrier" are, therefore, highly counterproductive. This type of requirement has a significant impact on the processing of the product, its costs, and its sustainability.

Color fastness specifications of an additive nature "the more, the merrier" are highly counterproductive.

Color fastness, particularly to wet treatments, is improved mainly by increasing the number of washes. This implies prolonging process time, increased consumption of water, chemicals and energy.

To operationalize a sustainable production, it is important to define appropriate color fastness requirements, that take into consideration:

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(i) The type of fiber;
(ii) The color and their intensity;
(iii) The end use of the textile product;
(iv) The finishing.

It is very important that each of these aspects be considered in the eco-design[4] of textile articles.

A neglected aspect in *ecodesign* is the influence of color and its contrasts on the resulting environmental impacts.

The design option of highly contrasting color combinations, defined in textile jargon as "contrast with white," is an option incompatible with the desire for greater environmental sustainability.

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In fact, the "effort" required to achieve a grade of color fastness[5] (GCF) 4-5 or 5, (to washing and water) compatible with the "contrasts with white" condition, can represent, depending on the color(s)/fiber(s), significant environmental and operational costs.

Grades of color fastness compatible with the "contrasts with white" condition can represent significant environmental and operational costs.

As an example, a difference of ½ point in grade of color fastness to washing (staining), in a cellulosic fiber, as illustrated in Figure 2, can mean an increase in specific consumption of 15% - 20% of water and 10% - 15% of energy in the dyeing process.

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[4] Ecodesign is a methodology that systematically integrates environmental aspects into product design process.

[5] The grade of color fastness represents the color difference or staining between a tested and untested specimen. For more information see ISO 105: Textiles - Tests for colour fastness - Part A02 e A03, concerning the *Grey scale for assessing change in colour* and *Grey scale for assessing staining*, respectively.

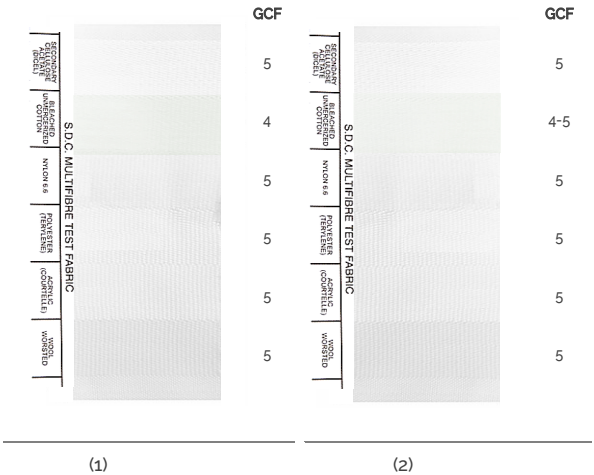

Figure 2: Multifiber test fabric of a one color fastness to washing test before (1) and after (2) treatment for your improvement

Thus, the reprocessing of 1000 kg of Knitted implies an additional water consumption of 20,000 liters of water, which is equivalent to the consumption of 200 people in one day.

The reprocessing of 1000 kg of knitted implies an additional water consumption of 20,000 liters.

A color adjustment of 1000 kg of knitted implies the emission of another 400 kg of CO_2 into the atmosphere, which is equivalent to the emission of CO_2 by 80 people.

It should be noted that dyes with high grade of color fastness, indispensable in the context of contrasting colors, are difficult to degrade by conventional wastewater treatment methods, persisting in

Dyes with high grade of color fastness are difficult to degrade, threatening water quality and aquatic life.

the treated effluent, and more significantly threatening water quality and aquatic life.

When establishing color fastness requirements for an article must, therefore, consider the intended end use of the article and the associated environmental impacts.

Color fastness requirements must consider the intended end use of the article and the associated environmental impacts.

Euratex[6], in its document "*Recommendations concerning characteristics and faults in fabrics to be used for clothing*" available at https://www.dialog-dtb.de/en/dtb-brochures/ presents, in detail, among many others, the recommended specifications for color fastness.

Euratex presents, in detail, recommended specifications for color fastness.

Tinamar has a definition of Minimum Quality Specifications that we believe are adequate for the articles we dye, for most possible uses of textile articles.

[6] European Apparel and Textile Confederation, representing the interests of the European textile and clothing industry at the level of the EU institutions.

4

Products and/or Processes, by Request

The dyeing and finishing sub-sector, has faced the challenges to health and the environment posed by its processes and products, prioritizing solutions that favor them, namely by promoting eco-efficiency[7] and the adoption of safer chemicals products.

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[7] Eco-efficiency, as defined by the World Business Council for Sustainable Development (WBCSD), "is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle to a level at least in line with the Earth's estimated carrying capacity."

5

Environmental Sustainability Labels and Certifications

Environmental sustainability labels and certifications can be an important tool to support companies in adopting principles leading to more environmentally sustainable procedures and practices.

The different approaches, of the different sustainability labels and certifications, make it impossible to standardize and optimize processes and resources, with a consequent increase in costs and considerable decrease in environmental performance.

However, the different labels and certifications, although with a common core, regarding the concern with environmental sustainability, present approaches and, therefore, often divergent criteria and methods.

This circumstance forces, to ensure compliance with client requirements, linked to a type of label or certification, to a multiplicity of restrictions, methods, and procedures, which make it impossible to standardize and optimize processes and resources, decreasing operational agility and efficiency, with a consequent increase in costs and considerable decrease in environmental performance.

Currently, dye houses have to stock several chemicals with the same functions, but which have different approvals for the various labels.

6

Final Considerations

Dye house clients can make a huge contribution to improving environmental sustainability

Textile articles have a significant environmental impact at all stages of their life cycle, as already mentioned.

Dye house has a fundamental role in reducing this environmental impact. Much has been done, continues to be done, and certainly much can still be achieved in the future.

Dye house clients can make a huge contribution to these improvements, namely through:

(i) Use of objective criteria for color evaluation, through instrumental techniques (spectrophotometer);

(ii) Request for universal "ecolabels" and recognized by reputable entities;

And taking into consideration that:

(iii) Very intense colors have higher environmental impacts than less intense colors;

(iv) The greater the color fastness requirements, the greater the environmental impact;

(v) "Contrasts with white," have a greater environmental impact;

(vi) Requirements of certain processes and products can be harmful to the overall environmental impact of the dyehouse.

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