WINTEX

Unit 2 Environmental issues in the T&C Industry
Lecture 2.4 Minimal impact technologies and eco friendly production

D 2.1 Training toolkit and e-book

May 2021 – Marianna Maglara Morneau (CEDECS-TCBL)

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Lecture 2.4 Minimal impact technologies and eco friendly production

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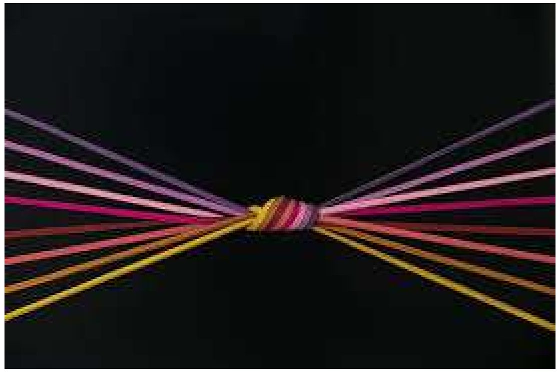
In this course we will learn more about ....

1) The impact of T&C processes and products
2) Minimal impact technologies for eco-friendly processes applicable to dying (dry-dying), printing (digital printing) and finishing (plasma, ozone and micro nanomaterials treatments): what they are, their scope, their advantages versus the traditional ones and how they improve efficiency, innovation & chemical safety in the production & finishing process of textile.
3) Development and use of innovative materials ("preferred" classic ones, bio-based, radically new) to lower the global impact of T&C



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The Negative impact of T&C

The impact of Textile & clothing industry

Major environmental effects of the textile & clothing industry

- discharge of high amounts of chemical loads
- high consumption of water and harmful chemicals used in this **sector**
- water pollution,
- high energy consumption in **production** processes
- air emissions

Some Key figures

The amount of clothes bought in the EU per person has increased by 40 % in just a few decades, driven by a fall in prices and the increased speed with which fashion is delivered to consumers. Clothing accounts for between 2 % and 10 % of the environmental impact of EU consumption.

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Focus on Water impact of T&C

After agriculture, the textile industry is the heaviest industrial consumer of water:

- world demand for fresh water will increase by 40 % in 2030 and by 2050, an estimated billion-plus people will also lack the water they need for daily living.

-Up to 100 liters of water are needed to dye just one kilogram of cotton fabric.

-daily water consumption of an average sized textile mill having is about 1.6 million liters.

-Specific water consumption for dyeing varies from 30 – 50 liters per kg of cloth depending on the type of dye used. Dyeing section contributes to 15% – 20% of the total wastewater flow.

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The European Legislation

REACH

REACH Regulation for Registration, Evaluation, Authorization and Restrictions of Chemicals (EC Regulation n.1907/2006), which defines the degree of safety or danger of the substances used. The regulation has the objectives of ensuring a greater level of protection of human health and of the environment, and of improving knowledge of dangers and risks deriving from the use of chemical products. Around 30,000 chemical substances and products are subject to analysis to determine their dangerousness and are included into a database shared by all member States of the European Union.

ECHA (European Chemicals Agency)

ECHA, with offices in Helsinki, Finland, performs the role of technical-scientific coordination of all activities provided for by the REACH Regulation and organizes the database for collecting and managing the data provided for the registration of substances, also with the objective of guaranteeing the public's access to information about chemical substances.

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Norms & Certifications

Norms (Industry standards)

OEKO-TEX® Standard OEKO-TEX® is the first system to guarantee the safety of textile products in Europe, and Nissenken is the exclusive certification authority in Japan. Certifications concern all the phases of manufacturing the raw material, the products and the environment within the firm. The OEKO-TEX® STANDARD 100 certifications is over 20 years old and has granted over 160,000 certificates for millions of finished textile products to more than 10,000 participating firms, belonging to all sectors of textile production chain.

EcoPassport (by Oeko-Tex) A certification system through which textile chemicals suppliers demonstrate that they can be used for sustainable textile production. The ECOPASSPORT program offers two distinct yet complementary stages: - Stage 1: Restricted Substance List (RSL) and Manufacturing Restricted Substance List (MRSL) screening; - Stage 2: Analytical verification performed in an OEKO-TEX® member institute laboratory Products passing the requirements of all two processes earn the ECOPASSPORT by OEKO-TEX® certification and will be entered into the OEKO-TEX® buying guide which is the OEKO-TEX® central sourcing platform of pre-certified articles and materials.

Certifications

Bluesign This is an independent industrial textile standard developed in Switzerland in 2000, based on the principles of resource productivity, consumer safety, emissions, water usage and quality and health and safety of the workplace. This is an increasingly recognized standard for sustainable wet processing, and an instrument that consents improving the raw materials' efficiency along the entire supply chain of textile products. The popularity of this system of certification is largely due to the integrated vision it proposes by not taking into consideration a single product, but its entire production process and the working conditions of workers involved in its production.

Global Organic Textile Standard – GOTS It is a standard developed by leading international organizations in organic farming to guarantee the consumer that organic textile products are obtained according to the rigorous environmental and social criteria applied to all levels of production, from the harvesting of natural fibers to the following manufacturing phases, to the labelling of the finished product. Certification may be obtained by textile products that can be shown to contain at least 95% of organic natural textile fibers (vegetable and animal), that is obtained in accordance with the criteria set by organic agriculture. Therefore, this excludes man-made fibers and natural fibers obtained by standard or OGM procedures. Among the prerequisites considered are also the conditions in which the fibers and the products are made (respect of the rules for workers' safety and rights and of the principles of social equity). As well as textile products and manufacturing activities, also chemical products used in textile industry can be certified as GOTS.

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Technologies & processes –Intro 1/2

Concerned processes

Conventional textile dyeing and printing are water intensive and generates highly polluted water that must be subject to costly treatment processes prior to discharge into rivers and oceans.

The textile finishing industry gives fabrics and garments their final appearance and properties. It employs traditional processes that are not environmentally friendly (chemical, water & energy consumption).

Emerging technologies

The impact of Emerging technologies for sustainability of nano materials and Artificial Intelligence in Fashion, Textiles and Design seems to be part of the solution. In the era of new technologies Biotechnology, Nanotechnology, Artificial Intelligence the world discovers a new way of work and these technologies contribute immensely in diverse fields such as clothing, new materials and entirely a new line of biomaterials in textiles like, highly tensile, unique surface structure, self-cleansing fabrics, dye ability, flame retardant fabrics, Ultra Violet protection, anti-static, anti-bacterial, soil resistance, wrinkle resistance, stain repellant, Antimicrobial, fire retardant, water repellent, durability 3-D technology, and bulletproof fabrics, etc. All these technologies revolutionize the textile industry.

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Technologies & processes –Intro 2/2

Impact of Dyeing, Printing & Finishing processes

Spinning raw materials into textile, weaving them into fabrics and applying finishing techniques such as dyeing or giving the fabrics strength and shine **are energy-intensive** processes in which large amounts of water and **chemicals are used**.

More than 1 900 chemicals are used in the production of clothing, of which 165 the EU classifies as **hazardous to health or the environment**. Wastewater of the textile industry is hot, has strong odor, and colored by dyestuffs, which are used as a part of dyeing and/or printing process.

How to minimize the pollution effects

New ecofriendly and clean production methods offer new possibilities to minimize the pollution provoked by the wet processing of textiles and save water and/or energy.

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Technologies for dying – 1/3

What are they ?

Dry- Dye process

This new process **utilizes supercritical fluid carbon dioxide (CO2)** for dyeing textile materials. The revolution is that this process is **a completely waterless** dyeing process using only nominal amounts **of recycled CO2**. Fabrics dyed with this unique waterless process will have the same quality of dyeing as current, conventionally dyed fabrics.

Major Advantages

- Elimination of water & wastewater discharges
- Elimination of drying and dryer effluent
- Reduction in energy consumption
- Reduction in air emissions
- Reduction of chemical substances
- Dyeing time significantly reduced
- Unused dye can be recaptured and reused
- Approximately 95% of CO2 can be recycled
- Fewer re-dyes are required

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Technologies for dying – 2/3

Benefits for textile industry

-Using supercritical fluid CO_2, polyester and other synthetics can be dyed with modified disperse dyes.

-The supercritical fluid CO_2 causes the polymer fiber to swell allowing the disperse dye to easily diffuse within the polymer, penetrating the pore and capillary structure of the fibers.

-The viscosity of the dye solution is lower, making the circulation of the dye solutions easier and less energy intensive. This deep penetration provides effective coloration of polymers which are characteristically hydrophobic. Dyeing and removing excess dye are processes that are done in the same vessel.

-Residue dye is minimal and may be extracted and recycled. Supercritical CO_2 dyeing gives excellent results as far as dye levelness and shade development, and the physical properties of dyed yarns are equivalent to conventional methods.

Big business is key to change…

Big business is key to changing the landscape of the dye industry and there have been some technological advances by some big brands (which of course are the only ones who can afford it).

NIKE entered a strategic partnership with Dye Coo Textile Systems B.V. that manufactures machines for waterless textile dyeing. By using recycled carbon dioxide, Dye Coo's technology eliminates the use of water in the textile dyeing process. NIKE, Inc. considers this as a significant step towards its long-term commitment to ensure sustainable business and cleaner environment.

Major business as IKEA and Adidas can afford to use these technologies.

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Technologies for dying – 2/3

Air dye Process

Air dye process employs air instead of water to help the dyes penetrate fibers, a process that uses **no water** and requires **less energy** than traditional methods of dyeing; the technology works only on synthetic materials and is currently available only in the United States.

Air dye technology manages the application of color to textiles without the use of water. It was developed and patented by Colorep, a California-based sustainable technology company.

Advantages

-Does not pollute water in the color application process (no hazardous waste in the water)

-Reduces energy requirements, thereby lowering costs and satisfying the strictest standards of global responsibility.

-Does not use boilers, screen printing machines, drying ovens, or cleaning step and simplifies the process, creating revolutionary possibilities of new industry and employment in unfarmable, arid regions of the world.

-Gives consumers a way to choose style and sustainability at a realistic price at the point of purchase.

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Technologies for printing – 1/3

Digital Printing ..a technological innovation

Printing is one of the important phases of production for the management of sustainability in the use of chemicals in textile production processes. The use of digital technologies allows, in comparison to traditional printing, a reduction of the amounts of colorants and inks used. Brands respect either the regulations or those of voluntary RSL/M-RSL set by the brands.

Printing companies are recommended to use only the strictly necessary quantity of ink. Research has also been conducted on systems for reducing pollutants in refuse through the use of biomasses and techniques for separating urea and retrieve it for use in subsequent production processes.

Major Advantages

- Environmentally friendly, efficient use of natural resources
- Very high fixation, with low discharge of unfixed dye
- Low water and energy usage compared to traditional dye baths
- Consistency of product quality
- Consistent quantity of dye is laid down
- Does not rely on pick-up of dye from dye bath
- Different color possible on each side of the textile

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Technologies for printing – 2/3
Benefits for the textile industry

1. Efficiency (producing what is needed in the necessary quantities and with the required variables)

2. Chemical safety (Reduction of the environmental impact of the chemical substances used in the printing process)

3. Innovation

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Technologies for printing – 3/3

Digital Printing Success Stories

- Intech Digital introduced a new "waterless" textile printing technology using Blackjet reactive pigment textile inks (nanopigment ink) to provide coloration.
- **Blackjet textile inks** use a pigment that is insoluble in the ink carrier, rather than a dye, and contains resin binders that help the pigment particles adhere to the fabric.
- This technology uses a four-step process consisting of: 1. a fabric pretreatment, 2. digital printing with reactive pigment inks, 3. fabric heating for fixing the pigment onto the fabric, 4. a post-treatment process.
- DuPont Artistri digital textile inks are formulated with similar pigments and dyes to those used in conventional textile printing to provide high-level results in digital printing.

Time & space savings

The time needed for resetting the machine to change the fabric or the design is much shorter. The speed of the printing process itself can reach high levels of productivity own to a few hours.

A machine using printing plates can be up to 40 meters in length, while a digital printer takes up an average of 40/50 sq. m.; it can be installed in a much smaller space and since the plant's layout determines its energetic costs, to obtain the best result while reducing the areas used makes the entire production more ecologically and economically sustainable. Even cleansing of the printer's belt in a digital machine (today about 4 meters in size) compared to that of a rotary or flat printer requires smaller volumes of water and energy. Digital printers allow a saving of 40 to 75% compared to traditional printing, depending on the type of equipment and on the design's complexity.

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Technologies for finishing (1/3)

Other alternatives to traditional finishing methods

Processes like desizing, bleaching, washing (roll-to-roll systems on fabrics) and dip-coating fictionalization or dyeing (batch systems on garments) are currently developed by wet application systems and chemicals that require huge amounts of water and treatment of the wastewater released. The use of alternative chemistry like ozone for fabric treatment in a continuous way and use of nanobubble technology for garment finishing is able to reduce the chemical consumption – also water consumption – in comparison with traditional systems.

Plasma treatments

- This technology offers an environmentally friendly method for fabric finishing and modification. The process uses plasmas, gases in a highly excited state consisting of ions and free radicals, to interact with polymer surfaces and radically change the nature of those surfaces.
- The use of high energy plasma creates a continuous non-aqueous fabric treatment system, encompassing desizing, scouring, dyeing and especially finishing.
- It is low pressure technology. Plasma treatments have been used to induce both surface modifications and bulk property enhancements of textile materials, resulting in improvements to textile products ranging from conventional fabrics to advanced composites.
- Low use of water - Energy efficiency- Low pressure

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Technologies for finishing (2/3)

Ozone Technology

Ozone processing systems generate zero waste because the ozone is transformed back to regular air once the process is done, but this requires a few minutes, just as the charging and discharging of the garments does.

G2 is the latest and most eco efficient ozone textile technology, the result of 15 years of constant innovation in the garment finishing industry.

This mechanical recycling system does not consume water or produce chemical waste. Developed by Novetex Textiles Limited, the patented system is almost entirely automated, thereby reducing the high labor costs associated with textile recycling.

Benefits for the textile industry

In **textile** industry, **ozone** is utilized in various processes such as: **denim** applications, cotton pretreatments, dyeing and finishing, polyester dyeing and clearing, treatment of various **textile** ...

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Technologies for finishing (3/3)

Micro-nano bubbles (MNB) technology

This technology is able to treat raw garments and apply different chemicals, transferring them employing micro-nano bubbles (MNB) as the vehicle of the chemical products, which can get inside the fibers directly. Current technologies for garment finishing are based on distributing the chemicals in a bath inside of industrial washing machines. The innovative aspect by using this new technology is that such products get in contact with the garments with a minimal amount of water, being transported to the fibers through micro-nano bubbles by means of a flow of wet air.

Benefits for the textile industry

Micro Nano Bubble technology is able to treat raw garments and apply different chemicals, transferring them employing micro-nano bubbles (MNB), inside the fibers directly. Current technologies for garment finishing are based on distributing the chemicals in a bath inside of industrial washing machines.

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Technologies to reduce the impact of materials used

Improved natural fibres (1/2)

The traditional ones

Wool: Conventional wool dominates the wool market but the adoption of non-mulesing and preferred wool programs, such as the Responsible Wool Standard, is increasing. Transitioning to wool programs with both animal welfare and responsible land use criteria in place offers the potential to create positive impacts in terms of animal welfare, land use, and biodiversity. The use of recycled wool can be another key lever. While it has a long tradition, the market share is still low, but the impact potentials are very high.

Bio Cotton versus cotton

Cotton, which according to a 2015 by European Clothing Action Plan (ECAP) accounts for more than 43 % of all fibers used for clothes on the EU market, is considered especially problematic because it requires huge quantities of land, water, fertilizers and pesticides. The environmental impacts of bio cotton can be drastically reduced compared to conventional cotton, as it uses less water and pollutes less

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Technologies to reduce the impact of materials used

Improved natural fibres (2/2)

Bio-based fibers

The production of raw materials is responsible for a large share of the environmental impact of the textile and clothing industry, not least from growing crops for natural fibers.

The natural fibers are textile fibers of plant, animal (protein), or mineral based origin. Man-made cellulosics/fibers are also classified as natural fibers. Major difference from the synthetic one that are man-made textile fibers produced from chemical substances (petroleum, coal).

Textile industry tests new fibers

The industry test less frequently used natural fibers, such as hemp, flax, lin and nettle, that require less water, fertilizers and pesticides. Polyester, which is made of fossil fuels and is non-biodegradable, accounted for 16 % of fibers used in clothes according to European Clothing Action Plan ECAP. Its main advantages are that, unlike cotton, it has a lower water footprint, has to be washed at lower temperatures, dries quickly and hardly needs ironing, and it can be recycled into virgin (new) fibers.

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Technologies to reduce the impact of materials used

New more sustainable fibers (1/2)

Manmade cellulosics (MMCs)

Manmade cellulosics (MMCs), derived from cellulose made from dissolved wood pulp of trees, make around 9 % of fibres used in clothes on the EU market. Most used is viscose, also known as rayon. They are made from renewable plants and are biodegradable, but the main challenge is also the sustainable sourcing of cellulose, as the global production of MMCs more than doubled from 1990 to 2017. The industry is therefore working with innovative materials that are more sustainable, such as lyocell (also known under brand name of Tencel, made of cellulose from eucalyptus, which grows quickly and requires no irrigation or pesticides), bemberg (also known as cupro, made of cotton linterthat cannot be used to spin yarn), and Piñatex (made of pineapple leaves).

Bio based Polyamide

Due to technical challenges and less attention due to lower volumes, the market share of preferred polyamide is still low compared to polyester. As the second-highest used synthetic fiber, polyamide offers significant impact potentials by transitioning to recycled and biobased polyamide. Most recycled polyamide is currently made from pre-consumer waste, some also from discarded fishing nets. Increasing the use of post-consumer textiles is needed.

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Technologies to reduce the impact of materials used

New more sustainable fibers (2/2)

Biobased polyester

The industry is currently experimenting with biobased polyester (also known as biosynthetic), made at least partly from renewable resources such as starches and lipids from corn, sugar cane, beet or plant oils. While the challenge is to find feedstocks that do not compete with food production and that do not require large amounts of water and pesticides.

Spider silk

Spider Silk Spider dragline silk is a marvelous material that has been engineered to be five times as strong as steel, twice as elastic as nylon, waterproof, stretchable, and exhibit the unusual behavior that the strain required to cause failure increases with increasing deformation.

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Going further...

New standards for leather

Leather: Until recently, leather processing risks (tanning, chemical use) have been the primary focus, but there is a growing interest in animal welfare, deforestation, land use (and associated biodiversity loss), and climate change issues.

Textile Exchange has developed the Leather Impact Accelerator (LIA) to speed up positive actions along the full beef/leather value chain.

Down: Awareness of animal welfare issues has led to successful growth in the use of standards, such as the Responsible Down Standard. While influencing at farm level is challenging, the use of preferred down standards helps to reduce the risks along the supply chain.

The new tools

An ideal tool that reduces energy and material consumption and minimizes the generation of waste and emissions is modern biotechnology. Industrial biotechnology uses microorganisms and biological catalysts (enzymes) to produce clean industrial products and processes that will bring great benefits to industry over the next decade.

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Conclusion

All these technologies continue to revolution the textile industry, which is basic component of fashion and design industry, and they participate to an ecofriendly production.

However, even if all these innovations are very promising and environmentally friendly, there are still barriers to overcome. The textile industry being a manufacturing industry working under pressure, there is a continuous competition for garment prices. The consumer need to know, and he decides.

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