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Bioprocessing for Sustainable Production of Coloured Textiles: focus on water consumption and energy saving

February 14th, 2017 | 2nd RESET Seminar on “Water consumption and energy saving” - Matosinhos (Porto)
The textile and clothing industry is an important part of the European economy with more than 146,000 (source Eurostat) companies and is responsible for 10% of global GHG emissions, mainly CO$_2$ and CH$_4$, owing to the use of energy in the textile processes and transportation, and the production of chemicals applied in the finishing step. Therefore, it is necessary to reduce these emissions generated.
Sustainability and textile industry

**Water consuming**
At least 40 litres are required to produce 1 kg of textile.

**Chemical consuming**
About 60 million tonnes of fibres and 6 million tonnes/year of chemical auxiliaries are consumed (source: Chemical Finishing).

**Energy consuming**
Around 30 Tjoule per year (source: UNIDO Japan).
Sustainability and textile industry: BISCOL project case

BISCOL project (CIP-EIP-Eco-Innovation-2009) will be focused on the dyeing industry proposing a new dyeing process as global alternative for the bioconversion of raw materials into competitive eco-viable final products.

To reach this scope different expertises optimized during other research projects by partners of consortium will be combined, in particular:

- **Synthesis of bio-dyes:** new bio-dyes will be synthetised at industrial scale by scale-up of bioreactor containing laccase enzyme, able to bio-synthetised new coloured compounds.

- **Textile pre-treatments:** scale-up of technologies abling to increase dyeability of selected textiles versus bio-dyes.

- **Synthesis of new auxiliaries:** new auxiliaries at lower environmental impact, will be synthetised at industrial scale and combined with bio-dyes.

- **Optimisation of dyeing process:** reduction of energy demand of dyeing process (e.g. lowering temperature and time of treatments) will be combined with the use of new bio-dyes and auxiliaries and treated textile in order to validate at industrial scale the proposed new dyeing process.
ECO-efficiency in textile manufacturing

Changing how energy is managed by implementing management program is one of the most successful and cost-effective ways to bring about energy-efficiency improvements, including a revision of:

- Facilities
- Process Conditions (lower temperatures; reducing time)

Reducing non renewable sources consumption in the production process:
- Replacing wet processing
- Using safer chemicals
- Use of waste materials as primary resources
In the production of a sportswear apparel, fibres is contributing for the 53% of the overall impact (30% is due to the usage of natural fibres despite the fact it is just 20% in the total composition of the final fabric) and finishing is contributing for the remaining 46%.
ECO-efficiency in textile manufacturing

Production of a finished textile for sportswear

82%

Finishing = 34%

Dyeing = 23%

Fibres = 42%

6.65 kg CO₂ eq/m²
Ecofriendly approaches in Textile Industry

Energy Consumption Reduction

**Conventional Dyeing process for wollen fabrics**

- Wet process replaced with dry process
- Eco-designed products
- Energy Consumption Reduction

**BISCOL Dyeing process for wollen fabrics**

- Purge
- Antifelting
- DBD Plasma

**Biodegradable**

\[ \Delta = -59\% \]
Ecofriendly approaches in Textile Industry

Energy Consumption Reduction

Conventional Dyeing process for wollen fabrics

- **Purge**: 20 L water, 5 g surfactants, **562.5 kJ energy**
- **Antifelting**: 20 L water, 20 ml acetic acid, 10 mg dyestuff, 25 g surfactant, **13.65 MJ energy**
- **Dyeing**: 20 L water, 200g BASOLAN, 120 g acetic acid, **518 kJ energy**
- **Washing**: 20 L water, 5 g surfactants, **562.5 kJ energy**
- **Drying**: 1.1 MJ energy, **16.5 MJ**
Ecofriendly approaches in Textile Industry

Energy Consumption Reduction

*BISCOL Dyeing process for wollen fabrics*

- **Purge**
  - 20 L water
  - 5 g surfactants
  - 562.5 kJ energy

- **DBD Plasma**
  - 89.1 L N₂
  - 82.5 L He
  - 148.5 kJ energy

- **Dyeing with new auxiliaries**
  - 20 L water
  - 20 ml acetic acid
  - 10 mg biodyestuff
  - 18 g eco surfactant
  - 8.92 MJ energy

- **Washing**
  - 1.1 MJ energy

- **Drying**
  - 11.5 MJ
  - - 30%
Ecofriendly approaches in Textile Industry

Energy Consumption Reduction

Carbon footprint is reduced up to 3.2 kg CO$_2$eq/kg (-52%)
Fossil depletion is reduced up to 0.45 Kg oil eq/kg (-70%)
Water depletion is reduced up to 45 L/kg (-59%)
Sustainability and textile industry
Thank you!

Questions welcome

http://www.biscol.unisi.it/

Project smedia