RESEARCH PROJECT OUTLOOK WITHIN THE HIGH TECHNOLOGY TEXTILE LABORATORY IN BI ELLA

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Politecnico di Torino, Biella, ITALY
Outline of the presentation

- The Biella district
- Research at the High Technology Textile Laboratory
- Autex 2008
The Biella district

- The most important Italian district on wool
- About 1300 companies, 25,000 employees
- 4.3 billion turnover
- Export quotas over 40%
- About 80% of the world's cashmere products made in Biella
• Research activity in close co-operation with the local factories:

- Wastewater recycling
- Atmospheric plasma treatment
- Diagnostic of the dyeing process
- Assessment of comfort
- Dry washing with carbon dioxide
Wastewater recycling

• In Biella industries require some 30x10^6 m³/year of freshwater, compared to about 20x10^6 needed for domestic uses.

• Aim of the project: set up of a modular process scheme for wastewater treatment according to the results obtained from in-field pilot plant experimentation.

• Dye-house wastewater was considered as dyeing is the most water-demanding operation among the textile processes.

• Extensive research project which involved 18 textile industries and 10 technology providers.


**Wastewater recycling**

An updated process flow diagram of the water system in a dye-house.

In grey the experimentally investigated unit operation that were *in-field interconnected to the existing industrial plants* to closely implement the scheme in figure.

The goals of the complete treatment were:
- reduce COD to such a low concentration at which the reducing potential did not affect dyeing;
- eliminate residual colour from previous operations;
- clear the treated water from any fine suspended solid.
Wastewater recycling

The pilot equipment experimented throughout the research project were:

- Granular Activated Carbon
- Continuous backwash upflow sand filter
- Automatic controlled down flow sand filter
- Fixed Bed Biofilm Reactor (FFBR)
- Mobile Bed Biofilm Reactor
- Dissolved Air Flotation (DAF)
- Electroflotation
- Settler
- Reverse osmosis
- Nanofiltration
- Thermal compression
- Comparative aerobic digestion set: Bioflotation + Flow jet aeration + Activated sludge + FFBR

Dyeing and finishing testing was carried out with 100% recycled water in order to run every trial in the most severe conditions: over 500 industrial tests were carried out by expert dyers with a success rate close to 90%.

Atmospheric plasma treatment

- Wettability enhancement
- Water repellent finishing
- Sterilization (alternative to chemical, thermal and UV methods)
- Adhesion enhancement (composite materials)
- Dyeability enhancement
- Anti-shrinkage finishing
- Flame retardant finishing
- …many other!
Atmospheric plasma treatment

- Materials: Fabrics, polymeric films, non-wovens, etc.
- Gas consumption: 0.360 ÷ 0.700 Nm³/min.
- Maximum treatment high: 400 mm
- Process gas: Nitrogen (and Oxygen)
- Fabric speed: 0 ÷ 20 m/min.
- Power: 3.0 ÷ 5.0 kW.

Miniweb 380s by AcXys Technologies (France)
Atmospheric plasma treatment

A wool fabric was plasma-treated (5 kW) to enhance:

- wettability...
- ...and reactivity.

Atmospheric plasma treatment

No morphological modification (plasma effect probably at nano-scale rather than at micro-scale).

No modification of the mechanical resistance.
Diagnostic of the dyeing process

• The entity of not-evenly dyed yarn in the package may reach 4 to 6% of the mass.

• Need for a more comprehensive understanding of yarn package dyeing.

• Diagnostic approach to identify pressure drop distribution in yarn packages: 12 capillary probes inside the package.

Diagnostic of the dyeing process

- Study of the temperature profile inside the yarn package. Two types of stimulus-response tests were carried out: a ramp and a step function.

- Plug-flow was demonstrated to onset in the fibre package, while a well-mixed hydrodynamics prevailed upstream and downstream of the textile material.

- Occasional by-pass at the interface between two packages.

Diagnostic of the dyeing process

- Design and setting up of an industrial scale plant able to hold 12 yarn packages equipped with instrumentation for diagnostic of the dyeing process.

- Reservoir for the storage of the exhausted bath (to be reused for a following dyeing).
Assessment of comfort

- Challenging subject many researchers are dealing with.

- The aim of the project is the identification of some criteria for clothing design which are related to comfort.

- The project is at early stage and is organized in different steps: the selection and measurements of the chemical and physical properties of the clothing, the design of experiments on a panel of volunteers, the tests in the climatic chamber.
Assessment of comfort

- Climatic chamber (56 m³) with a wide operation range:
  - temperature  -40/+60°C
  - relative humidity 20/90%
  - air velocity 10/40 cm/s

- Portable system for the acquisition of environmental and physiological temperature and humidity.

- Cyclo-ergonometer to perform tests under fixed metabolic rate.

- Device for the measurements of skin physiological parameters.
Assessment of comfort

Corneometer CM 825
Cutometer MPA 580
Tewameter TM 300
Skin pH meter PH 905
Mexameter MX 18
Sebumeter SM 815
Temperature and relative humidity probes
Assessment of comfort

• Preliminary work on the relationships between some physiological parameters (TEWL, hydration, skin temperature) and environment conditions (air temperature, relative humidity).

• Mild conditions: 20-30°C, 25-85% RH

• Non linear relations. TEWL is strongly affected by temperature and weakly affected by relative humidity; hydration is affected by both environmental parameters.

Cravello B., Ferri A., Relationships between skin properties and environmental parameters, Skin research and technology, 2007, in press.
Dry washing with carbon dioxide

- Aim of the project: setting up of a process for dry cleaning in liquid carbon dioxide at room temperature.

- EPA has included perc in the list of substances suspected to provoke cancer since 1995 and NIOHS affirms that long term exposure toperc causes chronic disease to the nervous system.

- A new concept pilot plant where fresh carbon dioxide is continuously recycled in the washing vessel (different from existing plants having a batch washing cycle).
Dry washing with carbon dioxide

Flow diagram of the washing cycle

- Compressor
- Filter
- Cyclonic separator
- Heat exchanger
- Valve
- Rotating drum

CO₂ reservoir

Liquid phase
Gas phase
Dry washing with carbon dioxide

- Parameters to be investigated:
  - duration of the washing cycle
  - rpm of the rotating drum
  - addition of specific additives and surfactants

- Possibility to wash sensor-including textiles.

- Particular attention to the hand of valuable fabrics.
AUTEX Conference 2008

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