Project description

Background

Since the middle of the last century, the direct and continuous measurement of the content of pigments and other products present in dye baths has been an unresolved problem in textile dyeing techniques. This is necessary both to allow an automatic control of dyeing kinetics and, especially, to enable the correct reutilization of the residual dye baths. In textile finishing, dyeing processes are characterised by their high water consumption and for originating a substantial volume of residual baths with a high polluting load. It is for this reason that the direct reutilization of the dye baths has always been a key challenge. However, the market requirements with regard to the reproducibility and fastness of colour have allowed the reutilization of dye baths in very few cases. The available technology could not make the reutilization of residual baths compatible with the desired quality in subsequent dyeing processes.

Objectives

The main objectives of the project were: •To design and characterise a process for the direct reutilization of dye baths, building a trial prototype on an industrial scale that permits the automatic “on line” control of the whole dyeing processes. •To make-ready a self-monitoring system of processes “on line”, based on the application of laser spectroscopy as a measurement technique.
identify the exact composition of the residual bath, in order to determine the
“residual formula to apply” for subsequent dyeing. • To enable the direct
reutilization of practically all the residual dye baths, with a high reduction both
in water consumption and in the pollutant loads of the effluent. • To monitor the
exact evolution of the residual content of pigment in the bath throughout the
whole dyeing cycle. The direct reutilization of residuals dyeing baths would not
interfere with colour reproducibility (it would be possible to readjust
continuously the pigment absorption speed). The colourfastness would not be
modified. Therefore, this technique could be used for most textile fibres and
pigments.

Results

The project fully achieved the objectives foreseen and can be considered a
successful case from a technical point of view. In order to re-use the dyeing
baths for subsequent dyeing, it is necessary to determine precisely the volume of
residual colour in the bath, together with the concentrations of the other
products existing in it. With this data, it is possible to calculate the quantities of
pigment needed to be added to the residual bath in order to prepare a new
dyeing bath, thus obtaining a colour used previously or another colour, within
the limits established by the nature of the colour itself. Once the first dye has
been performed, the residual colorants are measured (those that suffer
variations in concentration during the dyeing process). The measurement can be
performed using two methods: UV-VIS spectroscope RAMAN Laser spectroscope
The UV-VIS spectroscope is a valuable tool when used for the dyeing processes
with a single colorant, but its imprecision increases when the number of
colorants increases. As for RAMAN Laser spectroscope (the technique tested in
this LIFE project), the measurement can be carried out on mixtures of colorants.
The systematic analysis of commercial ranges has permitted to establish the
existing limits of applicability and the incompatibilities. Two dyeing systems
were studied throughout the project: Cellulose fibres with direct colorants
Polyester with disperse colorants and demonstrated that: The re-use of residual
dye baths does not produce any effect on the quality of the new dye. The
technique to measure the residual baths using RAMAN spectroscopy permits the
preparation of the new dye bath with enough precision to ensure that the
differences in colour with respect to the envisaged and desired colour are kept
within the acceptable margins of tolerance for the reproduction of the colour.
For final users, i.e. textile finishing industries, the technology proposed in this
project means some improvements that directly affect both the reduction of
costs and increase in profitability of the process: Saving pigments: 10-15%
Saving auxiliaries: 90-100% Reduction on water consumption: 60-80% (applicable
to washing baths) Reduction on wastewater pollutant load: 70-90% Minimising
energy consumption: 20-25% Increase on correct dyeing: from 80 to 98% The
laser spectroscopy (RAMAN) technology does not focus on the global
characteristic of the molecules to be detected but rather on the specific nature of
each chemical type (functional group). This happens through identification by a
laser, the wavelength or frequency of which can be adjusted with the highest
levels of precision. The application of this technology in the textile sector, opens
new possibilities for objective and precise measurement of the content of both
inorganic and organic substances in dye baths, coloured or not, from the start to
the end of the process. This measuring technology could eventually be
transferred to other industrial sectors such as food, dairy products, wood, paints and varnishes, chemical processes, leather, etc., where the possibility of re-use has not been yet considered. These sectors are also faced with the difficulties of quick and reliable measurements and with the composition of the individual residual baths from each stage of the overall process. Final liquids are still discharged into public or natural waterways rather than re-introduced into the direct re-exploitation cycle. The textile sector, at Community level, suffers from an important social-economic problem and in the dyeing and finishes sub-sector, this problem is accentuated. This is an activity in which SMEs predominate, which makes it difficult to maintain a good level of competitiveness due to the high environmental costs, both in terms of the investment in effluent treatment processes and in terms of operating and maintaining the purification plants. These difficulties have a negative impact on employment and result in the stagnation of these industries, many of which end up disappearing. Considering the project’s current level of development, it is difficult to make an evaluation from a cost/benefit point of view, since the following aspects have to be considered: The RAMAN spectroscopy unit used, or other similar instruments on the market, still has a very high cost (about 80,000-100,000 €), due to the fact that it is a very recent measuring technique and has a limited demand on the market. The applicability to any type of dyeing is not sufficiently established and tested, since the “calibration” data for the colorants does not exist, with the result that the quantities of products and water that might be saved according to the production of a determined industry are not calculable. Nevertheless, the rapid advances in the optics and electronics sector suggest a rapid lowering of the costs of RAMAN units, which could be redesigned or re-engineered for the specific application proposed. At present costs, the initial investment, including the investment in state of the art technology (calibration of colorants and auxiliaries), can be estimated at around 15,000 - 18,000 €. The results obtained through this project and the rapid advances in laser light technology provide serious and well-founded hope for a rapid and effective development of the concept of closed cycle water re-use. The emission of liquid effluents imply growing risks of local or temporal accumulation of unknown and uncontrolled substances, with unpredictable effects on the terrestrial and maritime flora and fauna.

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Environmental issues addressed:

Themes

Water - Waste water treatment
Industry-Production - Textiles - Clothing

Keywords

monitoring system, water reuse, textile industry
Target EU Legislation

- Water
  - Directive 80/68 - Protection of groundwater against pollution caused by certain dangerous substances...
- Waste
  - COM(1996)399 - Communication on an updated "Community strategy for waste management" (30.07.1996) ...
- Industry and Product Policy

Natura 2000 sites

Not applicable

Beneficiaries:

Coordinator: Universitat Politècnica de Catalunya (INTEXTER)
Type of organisation: University
Description: The Institut d’Investigació Tèxtil i de Cooperació Industrial (INTEXTER) is a public university.
Partners: • Argelich, Termes y Cía, S.A. (ATYC)

Administrative data:

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Publication: Article-Paper
Title: Textile Research Journal: US
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Title: Revista Química Textil: Barcelona (Spain)
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Publication: Article-Paper
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