STANTEX project

STatistical methods and stANDard procedure correlation between ZDHC guidelines and Pt-Co measure of color in TEXtile ETPs

B.M. D'Antoni, M. Tessarollo, M. Romero, F. Iracà

Panta Rei Srl Water Solutions, via Camillo Benso Conte di Cavour 17, Fiesso d'Artico, (VE) – Italy.

INTRODUCTION

The textile industry consumes huge volumes of water and chemicals for its different wet processing operations. Chemicals like acids, alkalis, dyes, surfactants, dispersing agents, soap and metals are contained in effluent wastewater coming from this source, generating high BOD/COD concentrations (Paul et al., 2012). The textile industry is rated as one of the most polluting and chemically-intensive industrial sectors (Uzal, 2015). Most textile wastewaters are highly colored because they are typically discharged with dye contents in the range of 10-200 mg/L, and many dyes are visible in water at concentrations as low as 1 mg/L (Cervantes, 2009). There are many structural varieties of dyes, such as: acidic, direct, disperse, azo, diazo, sulfur-based, reactive, basic, mordant, Vat and metal complexes. Many of them are designed to be chemically stable, so that they are difficult to decolorize due to their complex structure and synthetic origin (Robinson et al., 2000). The main challenges are the mineralization of dyes, organic compounds, and toxicity of the wastewater generated by the textile industry (Holkar et al., 2016). Many treatment alternatives have been reported in lab as well as full scale, including physical, chemical, biological, Advanced Oxidation Process (AOP) and a combination of them (Robinson et al., 2001).

Among the different technologies used or proposed, chemical treatment using DCA for color removal is still the most common approach. In the past, the identification of the color in the water was made by dilution (1/40) through a visual inspection. The Pt-Co scale, at a wavelength of 455 nm, is widely used but doesn't represent a standard measure depending on the different types of dyestuff.

Recently, the ZDHC foundation has introduced a new unit of measure depending on 3 different wavelengths at 430 nm, 525 nm and 620 nm. This research aims to identify a statistical correlation which allows the final user to calculate the color based on the ZDHC guidelines starting from the Pt-Co scale.

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4. Robinson, T., McMullan, G., Marchant, R., Nigam, P., 2000. Remediation of dyes in textile effluent: a critical review on current treatment technologies with a proposed alternative. Bioresour. Technol. 77, 247-255
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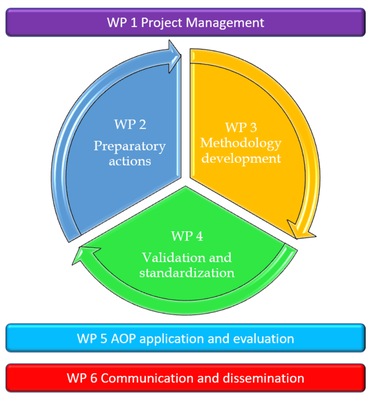
IMPLEMENTATION

The **STANTEX** work-plan has been set up taking into account the requirements described in the background section. According to such requirements, the work has been divided into 6 work packages (WP) that will be carried out in 7 months.



WP1: project management.
WP2: preparatory actions.
WP3: methodology development.
WP4: methodology testing, validation and standardization.
WP5: implementation of a new approach on colour removal.
WP6: communication and dissemination.

WP1 aims to implement a correct management of the project and will last for all the project duration. The day by day activities will be managed by the Project Coordinator (B.M.D.) and his technical team at Panta Rei.

The management structure, techniques and procedures to be applied in the project need to ensure that:

1. The project is carried out according to the established time schedule and budget.
2. A procedure to provide continuous evaluation and a constant project monitoring is created.
3. An effective, coordinated structure is created and maintained.
4. The project is managed according to the guidelines given to the involved parties.

The overall legal, contractual, ethical, financial and administrative management of the project is carried out.

WP2 aims to identify the chromophore groups and a representative correlation between different dyestuff and ETP effluents in terms of the Pt-Co scale and the ZDHC guidelines.

The working structure, techniques and procedures to be applied in this WP need to ensure:

1. Identification of reactive dyestuff chromophore group at different wavelength and evaluation of the correlation between ZDHC guideline and Pt-Co Units.
2. Identification of disperse dyestuff chromophore group at different wavelength and evaluation of the correlation between ZDHC guideline and Pt-Co Units.
3. Identification of ETP effluent chromophore group at different wavelength and evaluation of the correlation between ZDHC guideline and Pt-Co Units.

Statistical considerations for the identification of the most suitable correlation.

WP3 aims to develop the methodology according to the statistical results obtained in WP2 and identify the suitable amount of DCA to be used in order to achieve the ZDHC guidelines indication. The working structure, techniques and procedures to be applied in this WP need to ensure:

1. Determination of DCA quantity, for reactive dyestuff color removal, to achieve ZDHC guidelines indication.
2. Determination of DCA quantity, for disperse dyestuff color removal, to achieve ZDHC guidelines indication.
3. Determination of DCA quantity, for ETP effluents color removal, to achieve ZDHC guidelines indication.

Statistical considerations for the identification of the most suitable DCA dosage.

WP4 aims to validate and standardize the methodology according to the results obtained in WP2 and WP3.

The working structure, techniques and procedures to be applied in this WP need to ensure:

The validation of the methodology using different ETP effluents.

The application of the methodology using denim dyeing effluents, denim washing effluents, knit dyeing effluents, home textiles & towel effluents and sweater washing effluents.

WP5 aims to apply a suitable alternative to the DCA. A cost-benefit analysis has to be performed to evaluate the application of novel Advanced Oxidation Process.

The working structure, techniques and procedures to be applied in this WP need to ensure that:

1. The AOP reactor is to be used in a lab-scale application.
2. The comparison of the results, obtained in WP4 is carried out.
3. Cost-benefit analyses are performed.

WP6 aims to communicate and disseminate through the PRWS website, the reports related to each WP.

The working structure, techniques and procedures to be applied in this WP need to ensure the following outputs:

R1 – Technical report of WP2
R2 – Technical report of WP3
R3 – Technical report of WP4
R4 – Technical report of WP5
R5 – Final project report of WP1

METHODOLOGY

To identify and evaluate the final tool to correlate the U Pt-Co at different wavelengths, several laboratory tests and statistical procedures have to be carried out.

The fist step will be the measurement, through a spectrophotometer, of the absorbance and the U Pt-Co value for each dyestuff and ETP effluent at different dyestuff concentrations.

After the raw data collection, the followings steps will be performed:

1) Starting from the raw data, try to find a correlation function between the U Pt-Co value and the absorbance at 436 nm, 525 nm and 620 nm for each dyestuff and ETP effluent at different concentrations.
2) After obtaining the correlation functions, identify the linearization function for each dyestuff and ETP effluent at the different wavelengths, which will be used for the predictive model.
3) Fisher analysis using the ANOVA approach, between observed and predicted Lambda at different wavelengths and for each dyestuff and ETP effluents, which will be tested to identify the robustness of the statistical procedures.
4) With the given results, the aggregation model of each data set at different wavelength will be applied in order to identify one representative data set for each wavelength.
5) The obtained aggregate data set for each wavelength will be correlated to the U Pt-Co data in order to identify the final linearized function able to predict the absorbance at different wavelengths, independently from the sample used, starting from the U Pt-Co value.
6) A final statistical weights set for each wavelength will be identified in order to calibrate the model.
7) Weighted data set will be transformed according to ZDHC guidelines units of measure [m^{-1}].

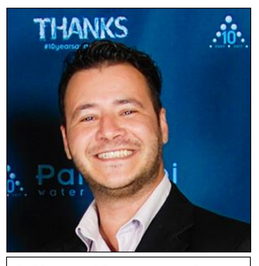
The preliminary model will help the user check the ZDHC value at 436 nm, 525 nm and 620 nm using only one on-line sensor giving U Pt-Co values.

In this regards, on the second step of the project, the exact quantity of DCA that has to be dosed to comply with the ZDHC guidelines will also be determined. The preliminary predictive model will be used to find the correlation between the actual U Pt-Co value and the DCA dosage to achieve foundational, progressive and aspirational limits respectively. The preliminary model will be calibrated in the field adjusting the statistical weights.

A final stage of the project consist of an alternative cost/effective approach which will be used to achieve ZDHC limits using an AOP technology, which will not have any chemical use or by-products generation.

A comparison between DCA dosage and AOP application will be carried out to validate the application of the novel AOP technology.

ACKNOWLEDGEMENT



Mirko D'Antoni:
Project Coordinator

Felice Iracà:
Project Director

Manuel Romero:
Project Supervisor

Monica Tessarollo:
Project Manager

EXPECTED RESULTS

The final aim of the project is to validate a standardized tool which can predict the absorbance at 436 nm, 525 nm and 620 nm starting from the value of U Pt-Co.

The results will be weighted and converted in ZDHC units of measure [m^{-1}].

The obtained results will be used for the automatization of the DCA dosing pumps in order to avoid any chemicals wasting, thus creating savings on operational costs.

The same results will be used for the automatization of the AOP technology.

INFORMATION

For further information about the ongoing STANTEX project, please contact: research@pantareiwater.com