WASTE WATER ANALYSIS FROM A NEW GREEN PRETREATMENT OF COTTON FABRICS

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Abstract: *In the current context of sustainable development and environmental protection, finding and applying green technologies for textile finishing of cellulosic materials is a priority, being among the main objectives of current researches. Bioscouring treatment is one of the green processes for treating cellulosic textile materials that has successfully replaced classic alkaline treatment. Waste waters resulting from bio preparation are considered biodegradable and with low toxicity unlike alkaline treatment. An analysis and characterization of residual waters from the finishing processes is necessary in order to establish optimal parameters for disposal and low environmental impact, for reducing costs of waste water treatment and for efficient recovery and re-used. The paper presents a characterization of water resulted from a new bioscouring treatment of cotton fabrics using a commercial enzymatic product in ultrasound with sodium citrate as a chelating agent in comparison with bioscouring treatment were EDTA was and alkaline classical treatment. The main quality indicators of the residual waters analyzed were: pH, turbidity, conductivity, TSD, salinity, dry residue, total oxygen dissolved and chemical oxygen demand (COD-CCOMn). After analyzing the obtained data, similar values were observed for the two enzymatic treatments except the pH value which was lower for the process were EDTA was used, requiring a slight correction. For classical alkaline treatment, the obtained values exceeded the allowed limits for almost all analyzed parameters.*

Key words: *cotton fabrics, new green pretreatment, residual water, turbidity, TDS, chemical oxygen demand*

1. INTRODUCTION

Textile industry is a large water consumer, many of the technological steps involving wet processes. Such process is that of scouring which removes different impurities (wax, pectin and organic acids, minerals) from the natural fibres. In this situation the wastewaters have high temperature and contain large quantities of alkali with negative impact on the environment. An alternative is represented by bioscouring treatment which involves the use of pectinase to depolymerise and demethylate the pectin structure and release the cellulose active groups to properly interact with the whitening or dyeing agent in the following technological processes.

The tendency in our days is to obtain reusable waste waters with low toxicity. Waste waters resulted from cotton fabrics processing have a high content of salts and total dissolved solids, and also large amount of different types of dyes [1]. The treatment for the waste waters could be expensive. Although many recent researches have as main object the establishment of new methods to treat the waste waters from textile industry with the possibility of the reusing, it is preferable to decrease the chemicals used in the specific technological steps. One proposed method considers oxygen based procedure [2]. Studies in domain consider being efficient from economical and ecological point of view to integrate waste water in new technological step due to the fact that a high quantity of alkaline compounds remain in the treatment baths. It had been demonstrated that the quality of the fabrics presents a small improvement in such conditions [3].

There are attempts to reduce the values of the solid suspension and chemical oxygen demand of the waters resulted from cotton pretreatments by chemical methods. Utilisation of aluminium sulphate in optimum quantity could reduce almost to half the level of chemical oxygen demand and only to 15 % the solid state [4]. Even if this treatment shows promising result it implies the use of chemical compounds. The quantity of chemical compounds presented in the waste waters could be successfully decrease by using enzymatic treatments. Many researches focus on pectinases, their role being to hydrolyse the pectic wall presented in the first layer of the cotton fibres to release more reactive groups.

In the conventional alkaline scouring treatment, all the pectin is removed. It was also demonstrated that the structure of the cotton fibres are damaged. Compared with this hard chemical treatment, the enzymatic one is less harsh, removing the pectin to an optimum degree, the fibres resulted being characterised by mild surface and optimum strength retention [5]. Along with the fact the cotton fibres are less dameged during an enzymatic scouring procees, the costs and consumption of chemical is reduced, and the scouring baths have biodegradable characteristics [6].

It had been proven that good results are obtained also by using mixture of different types of enzymes, pectinases, cellulases and proteases [7].

2. EXPERIMENTAL PART

2.1 Materials

- 100 % cotton fabric characterised by: width (150 ± 3 cm), weight (200 ± 10 g/m^2), warp of 100 % cotton yarn with Nm 25/2 and weft of 100 % cotton yarn with Nm 25/1.
- Pectinolytic product Beisol PRO, the surfactant Denimcol Wash RGN supplyed by CHT Bezema Company.
- Sodium citrate, sodium hydroxide, sodium carbonate, sodium bisulfite, sodium silicate purchased from Sigma-Aldrich.
- Sulfolen 148 (S-148, alkyl polyglicol ether) from Rotta Company.
- The residual water resulted from the enzymatic pretreatments and alkaline one.

2.2 Methods

2.2.1 Pretreatments of the cotton fabric

The 100 % cotton fabric was subjected to tree types of pretreatments: two enzymatic treatments where the complexing agents were EDTA or sodium citrate and one alkaline treatment. Prior to the pretreatments, the samples were washed in order to eliminate dust and other impurities.

The procedure was done by using an AATCC Launder Ömeter, M228-AA model from SDL Atlas Company-USA. The following step was the conditioning of the samples which was made in an oven from Caloris Grup Romania.

All enzymatic treatments were done using pectinolytic product Beisol PRO (which consists of a mixture of enzymes) in water at a 20:1 liquid to goods ratio and a temperature of 55 ^{0}C. The enzyme concentration was varied between 1-3 % o.w.f (over weight fiber) at different action time (15 to 55 minutes). As auxiliary reagents, 2 g/L EDTA or sodium citrate (complexing agents) and 0.5 % Denimcol Wash RGN (surfactant) were used. The bioscouring treatments were conducted at 45 kHz in an ultrasound bath Elmasonic X-tra basic 2500 from Elma Company, Germany.

The alkaline treatment used for comparison was done at 100 ºC for 1 hour in AATCC Launder Ömeter with 10 g/L sodium hydroxide, 5 g/L sodium carbonate, 1 g/L sodium bisulfite, 2 g/L sodium silicate and 2 g/L Sulfolen 148 (S-148, alkyl polyglicol ether) as a wetting agent.

In **Fig. 1** are presented the steps of the green pretreatments (with enzymes and sodium citrate or EDTA).

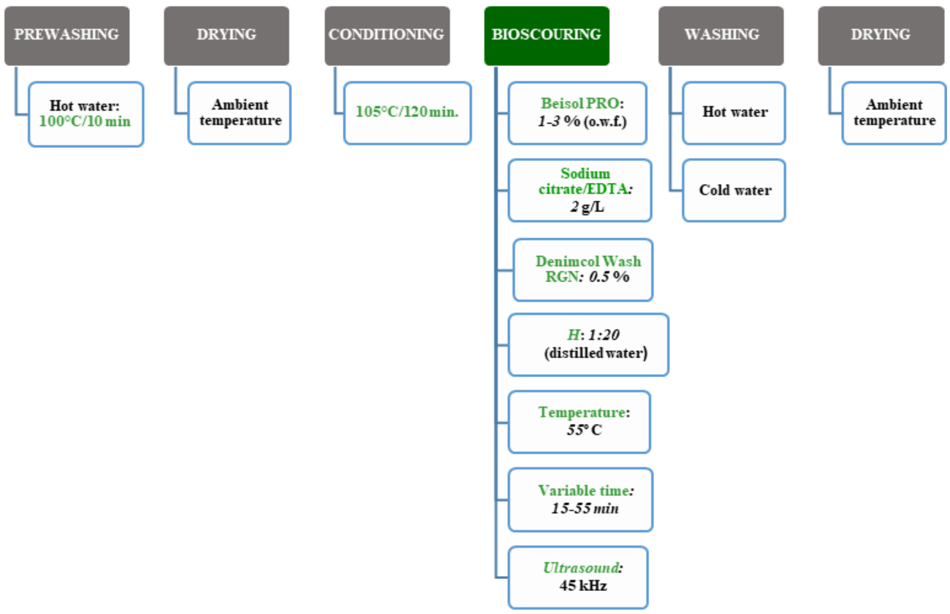

Fig. 1: *The steps of the green pretreatments of the cotton fabric*

2.2.2 Testing and analysis of the waste water

The main quality indicators of the residual waters analyzed were: pH, TDS (total dissolved solids), salinity, conductivity, total dissolved oxygen, turbidity, dry residue, and chemical oxygen demand (CCOMn). The pH, TDS, salinity, conductivity and total dissolved oxygen were determined by using a WTW multi-parameter INOLAB MULTI 740. For measuring the turbidity a HI 88713 Turbidimeter from HANNA Instruments was used. The dry residue was gravimetric determined as difference in mass before and after the drying process. The water samples were evaporated in a Pura 14 water bath from Julabo, Germany and dried at (105 ± 5) °C to constant mass in an oven from Caloris Grup [8]. The chemical oxygen demand was done using the titration method with $KMnO_4$ as described by R. Ballance [9].

3. RESULTS AND DISCUSSIONS

It is important to study all characteristics of the textile effluents to improve environmental performance and also to sustain considerable quality of the individual companies. The physico-chemical parameters of waste water resulted from all tree type of pretreatments have been analyzed.

The acidic and basic nature of the effluents can be identified by pH value. The toxicity of waste water increases due to variations of the pH. Hence low or high strength of the pH in effluent can affect the quality of clean water and alters the rate of biological reaction with survival of various microorganisms. The strength of the pH also alters the soil permeability which results in contaminating underground water resources. As a result it is necessary to evaluate the waste waters with respect to pH value then it can be neutralized with acidic or basic solution. In **Fig. 2** the pH and salinity values for the enzymatic pretreatments are presented.

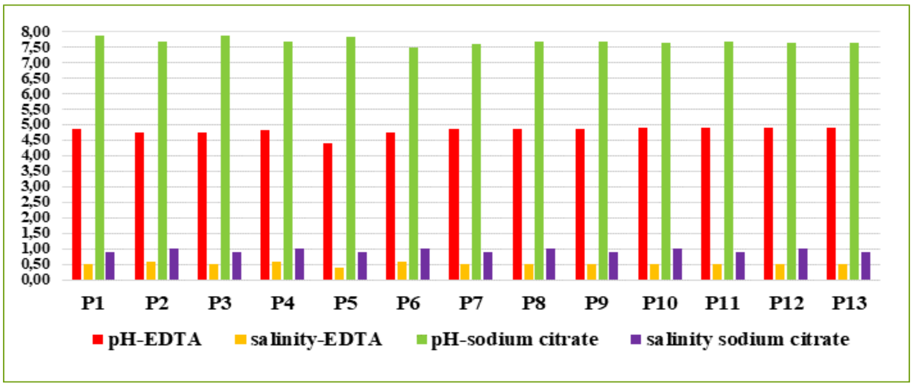

Fig. 2*: The pH and salinity of the waste waters from the green pretreatments of the cotton fabric*

It can be noticed that the pH of waste water resulted from the enzymatic treatments were sodium citrate was used is almost neutral in comparison with EDTA were the pH values are below 5, requiring a slight correction. As for salinity, this shows higher values for sodium citrate treatments.

Generally textile industries shows higher TDS value than the other industries mainly due to the fixing, bleaching and dyeing agents used for fabric processing on different stages. The high TDS value of water is not recommended for drinking and irrigation purposes as it may cause salinity problem. **Fig. 3** shows the obtained values for TDS and conductivity in the case of the two green pretreatments. Both TDS and conductivity have similar values for both types of pretreatment within the admissible limits.

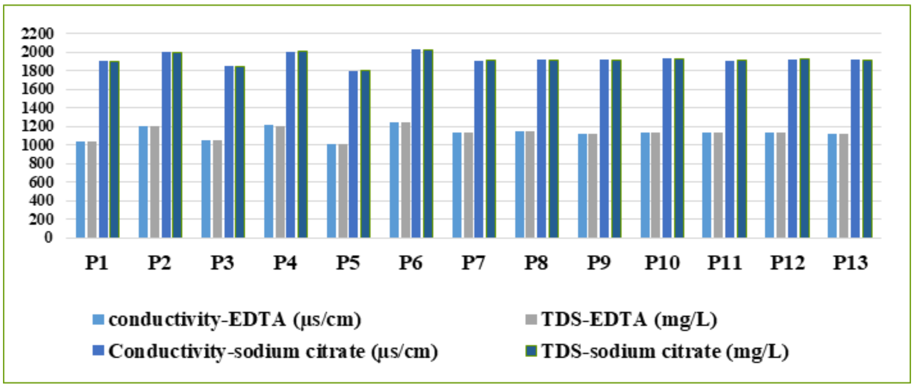

Fig. 3*: The TDS and conductivity of the waste waters from the green pretreatments of the cotton fabric*

From **Fig. 4** the maximum COD values (CCOMn) were recorded for treatments were EDTA was used with higher values for P6-P13 samples. Ussualy, organic strength of the effluent can be identified by COD values. Increases in COD can be due to detergents, softeners, non biodegradable chemicals, etc. Higher concentration of COD in water implies toxic conditions and the presence of biologically resistant organic substances. Hence the effluent is incompatible for the survival of water living organisms due to the reduction of DO content.

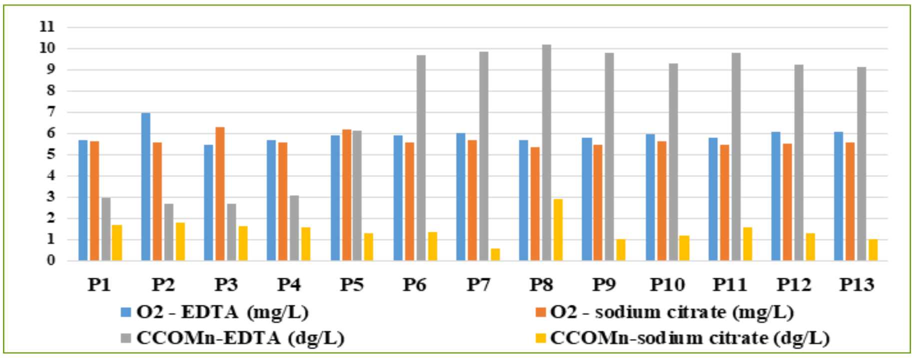

Fig. 4*: The COD (CCOMn) and O_2 values of the waste waters from the green pretreatments of the cotton fabric*

The turbidity an dry residue are presented in **Fig. 5**. Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particles. The values for turbidity were recorded in the interval 1.7 - 3 NTU for sodium citrate and 1.0 – 2.2 NTU for EDTA which were been found to be in the BIS limit. A higher turbidity prevents the penetration of sunlight and oxygen transfer process and as result, the process of photosynthesis is hindered. Thus turbidity should be measured and treated carefully before waste water final disposal. The dry residue values are the same for both biocouring treatment within the admissible limits.

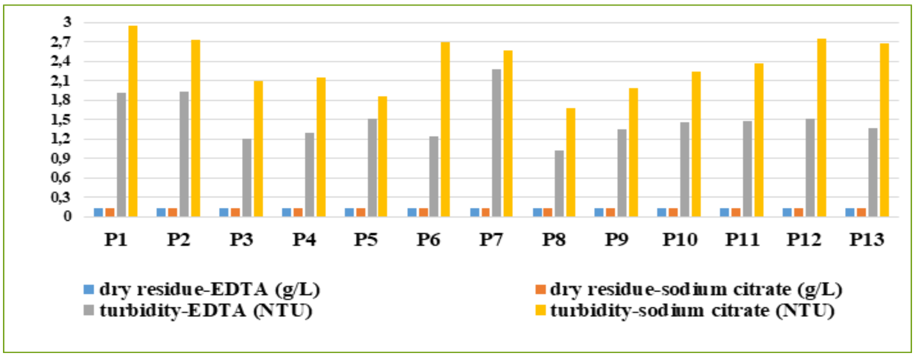

Fig. 5*: The dry residue and turbidity of the waste waters from the green pretreatments of the cotton fabric*

Table 1 presents all parameters of the waste water from the clasical alkaline treatment. As it can be seen, for all measurements, the obtained values exceed admissible limits.

Table 1*: The waste water parameters from the clasical alkaline treatment*

Conventional alkaline treatment	pH	Salinity	Conductivity (μs/cm)	TDS (mg/L)	Dry residue (g/L)	Turbidity (NTU)	O_2 (mg/L)	CCOMn (mg/L)
	12.70	32.50	39000	39000	2.313	72	3.53	13000

4. CONCLUSION

The present study clearly enlightens the physico-chemical parameters of the waste water resulted from tree type of pretreatment of cotton fabrics, which is useful to analyze the nature and types of pollutant concentration present in the effluent. Based on the obtained experimental data it is concluded that for enzymatic pretreatments (EDTA or sodium citrate) all the parameters are in the limits given by BIS except the pH for treatments were EDTA was used. We can not say the same thing in the case of classic alkaline treatment were higher values were obtained for all analyses. A constant monitoring of water quality is necessary to avoid further dreadful conditions. The effluents which are toxic in nature are needed imperative treatment before disposal on water bodies to create less pollution and a eco-friendly environment.

ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS-UEFISCDI, project number PN-II-RU-TE-2014-4-1370,

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