Performance hybridized process of coagulation-ultrafiltrationin discoloration of water charged by the textile finishing dyes.

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Abstract

In this work, we conducted a study that is to bleach wastewater model solutions loaded with dyes of indigo and sulfur black, while using and optimizing the process of hybridized treatment of textile effluents by torque of coagulation-ultrafiltration(CO-UF). According to the separate optimization of coagulation processes (optimum dose of the coagulant (lime) and ultrafiltration membrane (hydrodynamic characterization of the membrane based on polysulfone(PSU)), we combined the two methods in order to increase performance fading exploited colored waters.The results of the rate of discoloration separated by the methods of coagulation and ultrafiltration are respectively of the order of 33.55% and 80.36% for the water loaded with indigo and of the order of 25.33% and 60.78% for those charged with the black sulfur. While the results of the bleaching obtained by the hybrid method CO-UF have shown that the bleaching rate was calculated as around 98% for the indigo and of the order of 92% for the black sulfur, obviously very interesting with respect to the coagulation and ultrafiltration used separately.

Keywords:*Performance; hybridized process; coagulation-ultrafiltration; membrane; textile finishing effluents; optimization; rate of discoloration.*

1. Introduction

The textile finishing industry is the largest consumer of water sector, and synthetic dyes (reactive dyes, direct, scattered, indigo, sulfur, colored pigments ...). Which causes pollution of the aquatic environment through the discharge of effluent into waterways and that can lead to consequences through extensive destruction of aquatic wildlife, flora **[1-3]** and therefore the environment **[4**, **5-7**, **21]**, through the formation and accumulation of harmful and carcinogenic aromatic products when they exceed their vital threshold in surface waters **[8**, **9]**.This can have a direct and/or indirect adverse consequence the percussion of human health **[10**, **40]**. The pollution problem is a large area of research to conduct studies on filtration processes and techniques of treatment of wastewater from the textile industry **[9**, **21]**, that the regulations imposed on them by the reduction treatment according to the standards prior to discharge into the receiving environment.To provide a solution to the problem of water pollution set out several processing techniques

are used, among which we mention the processes of coagulation/flocculation [1-3, 11, 25, 26], adsorption clays, zeolites [12, 13] and activated carbon [14], techniques of electrochemical [12-15], degradation by UV radiation and advanced oxidation processes (POA)[18, 17], biological treatments [18], complexation [23, 24] and membrane processes [19] namely microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), reverse osmosis (RO) [20, 22], etc.. In order to improve the performance of the treatment of industrial wastewater, some authors have combined these treatment processes them [40-42] by setting out the process of ultrafiltration/reverse osmosis [30], nanofiltration/reverse osmosis [31], adsorption/ultrafiltration [32, 33], complexation/ultrafiltration [31] and coagulation-flocculation/ultrafiltration [27-29], ... The latter method is most commonly used in bleaching wastewater in textile finishing because of their ease of implementation.Hence the interest of this work is to increase the performance of the bleaching wastewater loaded with dyes of indigo and black sulfur, using the combined process of coagulation-ultrafiltration after optimizing each separate method, by determining the optimum dose of the coagulant used, the pH of the model samples of colored water and the conditions of the permselective asymmetric membrane exploited.

2. Materials and methods

2.1. Ultrafiltration membrane

The ultrafiltration membrane used in this work is flat and asymmetric polysulfone PSU UDELP1700 [34, 49], which was synthesized in our laboratory (TCOM/LARPPE). This type of polymers (PSU) of this stiffness and stability properties clearly superior to otherpolymers thermoplastics, particularly to chemicals and high temperature. The membrane exploitedwasobtained by the method of phase inversion [22, 43], after the preparation and optimization of colluding compound by weight of the polymer PSU (12%) and dimethyleformamide solvent (DMF) (88%).

2.2. Coagulant used

The coagulant used in the coagulation process as a primary treatment is lime (Ca(OH)2) of 97% purity[25]. Such that the solution of lime obtained was prepared at a concentration of 2 g/l. After measuring pH, we have a certain volume of this emulsion with different samples of colored water according to the values of pH.

2.3. Solutions colored waters models

Samples of colored water loaded with dyes operated in this study were prepared in our laboratory as followings:

• The first sample was prepared from the indigoid dye mass of 1.5 g, of water at temperature 30 °C, tenside and sodium hydrosulfite as reductant in an alkaline medium (NaOH) as the pH sample obtained is the valueof 11.80. The addition of sodium hydrosulphite will help to make soluble indigoid dye in the form of the leuco dyes (pre-reduced) [35]then the latter is oxidized by the addition of acetic acid.

Indigo (blue) reduced form (yellow) oxidized form (blue)

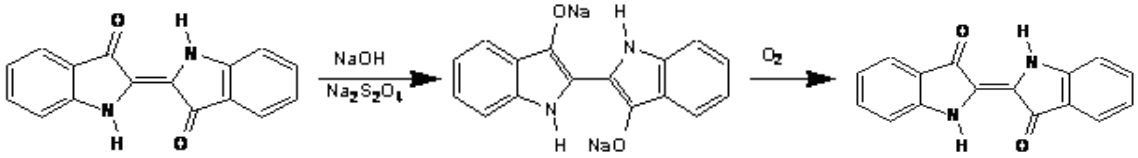

Figure 1: Dye solubilization reaction indigoid

• The second sample was prepared from the black sulfur dye mass of 1.5 g, of hot water at temperature 70 °C, tenside and acetic acid such that the pH of the resulting mixture of the around 11.20.

2.4. Colored water characterization method

Analysis of samples of colored water obtained was performed using a type JP.SELECTA.sa spectrometer, model 2100. By which, we determined the maximum wavelength and the optical density of each sample before and after discoloration, and therefore we determined fading rate (TD (%)) using the following equation[39]:

$$TD(\%) = \frac{DOi - DOf}{DOi} \times 100$$

With: DOi is the optical density of the colored water before fading and DOf is the optical density of the treated water after fading.

Note that the fading rate is influenced by several parameters, namely pH, light, temperature[47], ... That is why we have worked to 25 °C and at basic pH, adding sodium hydroxide.

2.5. Discoloration method of colored water models

During this step, we conducted a primary treatment with the coagulation method before bleaching colored water samples by the ultrafiltration membrane. The coagulation method used was performed by adding lime to the emulsion samples prepared from different colored water, very dilute concentrations rapidly stirring for 5 minutes at room temperature.This method allows to coagulate the organic matter, suspended matter and the charges contained in the model solutions form micro-flocks [37, 38], which was followed by the ultrafiltration membrane method after decantation in beaker, for 30 min. Given the size of the pores of the ultrafiltration membrane, it is not necessary to make the flocculation process, due to the retention of micro-flocks obtained by ultrafiltration [36], using an Amicon cell volume 36 cm^3 shown in Figure 2 below.

Note that the ultrafiltration membrane depends on the operating conditions of the pore size of the asymmetric membrane, the trans-membrane pressure, the filtration temperature and the sample flow rate to be decolorized.

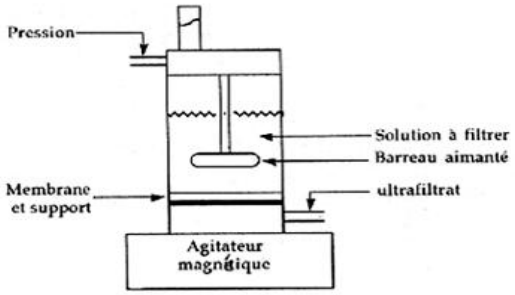

Figure 2: Amicon cell membrane ultrafiltration

3. Results and discussion

3.1. Sample characterization colorful patterns

The characterization in the normal state of the samples of colored water used in this study was given by measuring physic-chemical parameters grouped in the following table:

Table 1: Measured values of the physic-chemical parameters of the operated specimens.

Water colored with:	pH	λmax (nm)	DOi	Colouration
Indigo	11, 80	665	0,256	blue
Black sulphur	11, 20	597	0,375	black

3.2. Results of optimization the permselective membrane used

The characterization of the membrane used in the ultrafiltration process applied showed that this membrane having high performance mechanical properties and also important properties of the permeability to distilled water and selectivity dextran **[44]**, the rate of retention 88% at constant pressure 20 cmHg.

3.3. Results of discoloration from the coagulation optimized process

The results of optimization of experimental parameters (coagulant dose and pH stained specimens) by the coagulation method using lime emulsion are shown in the figure below:

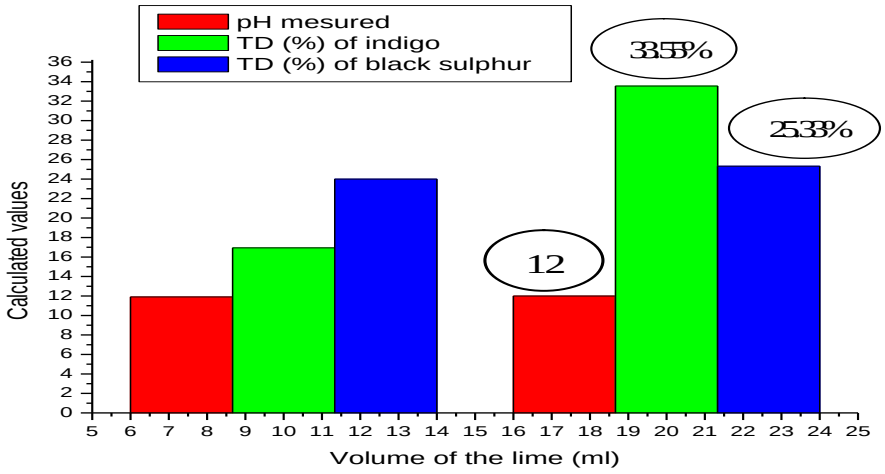

Figure 2: Rate of discoloration with the parameters optimized by the coagulation process

From this figure, it shows that at pH equal to 12, the optimal rate of discoloration has been registered in the percentage 33.55% for the indigoid sample and 25.33% for the stained sample with sulfur black, while setting the volume of the lime to 20 ml as optimum dose. This allows that the coagulation pH is a determining factor in bleaching textile effluents charged with vat dyes, and the separate process of coagulation is insufficient for the treatment of such effluents.

3.4. Rate of discoloration of the samples stained by ultrafiltration

During this step, the samples of colored water were put in their normal state to membrane ultrafiltration, the results obtained from the fading rate shown in the following figure:

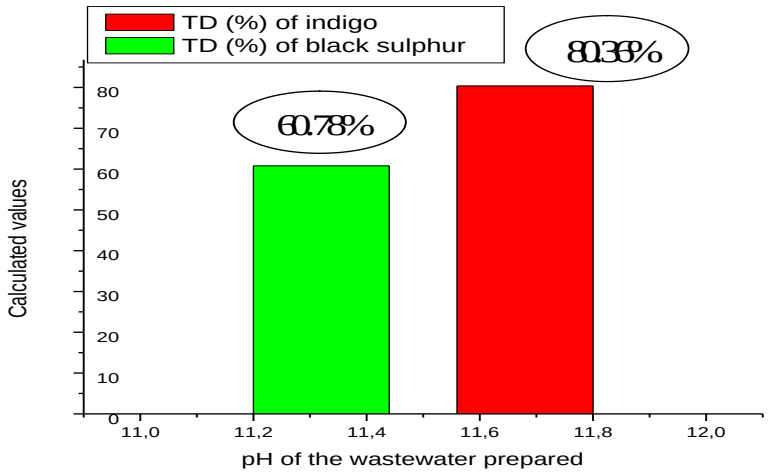

Figure 3: Rate of discoloration the samplesultra-filtered models

Figure 3 shows that the bleaching rate was respectively 60.76% and 80.36% percentages in the case of water colored with black sulfur and indigo. This indicates that the ultrafiltration membrane is important in the processing of wastewater loaded with textile finishing dyes **[45**, **46**, **48]** and that the difference obtained at the level of discoloration of percentages is due to the solubilization of dyes operated in water. From this difference it shows that indigo dye is not completely dissociated in water in contrast to the black sulfur dye which is substantially water soluble, first, and that pore size of the membrane used is limited, on the other hand.

3.5. Results of discoloration the colored samples by the combined process CO-UF

The bleaching results obtained by the colored water hybridized CO-UF process at the optimum pH 12, are well illustrated in the following figure:

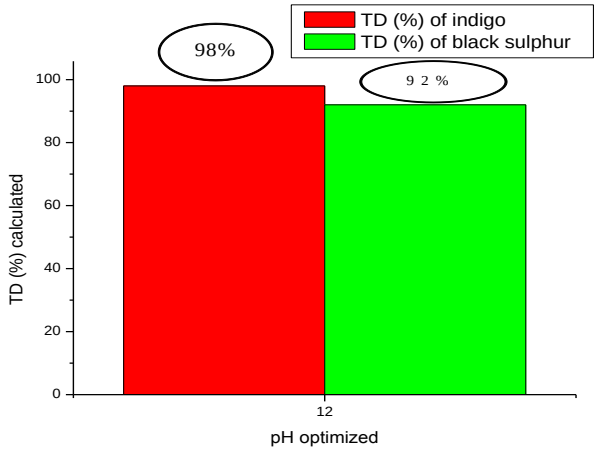

Figure 4: Rateof decolorizing the model samples obtained by CO-UF

From this figure, it shows that the rateof discoloration obtained by the combined process of coagulation-ultrafiltration is the percentages 98% and 92% respectively for samples loaded with indigo and sulfur black. This is explained by the addition of coagulant in these samples which generates precipitates that will encompass and adsorb particles and colloidal organic matter causing precipitation of organic colloids.

4. Conclusion

This work is designed to improve the performance of bleaching colored models waters with textile finishing dyes including indigo and sulfur black, using the combined process of coagulation-flocculation using the lime as a coagulant agent and membrane permeable asymmetric polysulfone membrane for ultrafiltration.
The results obtained in this work, it shows us that:

✓ Discoloration of colored samples by separately operated methods is not important, particularly in the case of the coagulation process.

✓ The combined processCO-UF eliminates a significant rate vat dyes namely indigo and sulfur black.

✓ Optimizationparameters of the dose of the coagulant, the pH, permeability and selectivity have improved the performance of processCO-UF for bleaching of colored water model samples.

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