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RECOVERY OF REACTIVE COLORANT WITH HYDROTHALCITE AND REUSE FOR PRINTING

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Abstract: *In this work, the adsorption capacity of hydrotalcite on the Reactive Yellow 2 textile dye has been verified. Nanoclays are elements with a high capacity for adsorption of dyes and can be reusable as printing pigments. For this, the Lambert-Beer lines of each dye have been previously made. A dye concentration of 1 g/L and a clay concentration of 3 g/L have been used. Then the dye has been introduced into the clay by stirring for 24 hours in 100 mL of solution of the dye, to later filter it and allow to dry. The adsorption of the dye by the nanoclay has been almost absolute, leaving the initial solution very clean, which are excellent results from the point of view of cleaning wastewater. After drying and collecting the clay, a stamping paste in a substrate of PES/CO 50%/50% was made with the hybrid obtained, using a concentration of 1.5 g/kg and 7.5 g/Kg. They were then heat-set at 180ºC for 30 seconds. Finally, the samples obtained are analyzed on a Minolta CM-3600d reflection spectrophotometer to assess the color achieved. There is a difference in color when comparing the two samples, as expected, the printed sample with higher concentration of hybrid shows a greater intensity of colour. The color difference was calculated and the Kubelka-Munk theory was taken as a reference to make an assessment of the strength of the color obtained.*

Key words: *nanoclay, dye recovery, clay pigment, stamping, printing, reactive dye recovery.*

1. INTRODUCTION

There are more and more environmental alerts that ask us to intervene to end all the adverse effects caused by pollution. The textile industry stands out notably for the amount of effluent discharges of both organic and non-biodegradable inorganic products that consequently produce high bioaccumulations. Within the textile industry, chemistry is the one that has the greatest environmental impact and is the one with the most chemical activity on the planet [1]. One of the most common discharges is that of colorants, of which we can find concentrations of about 50-1000 ppm, although in some cases they may be lower [2]. One of the recovery methods that are being widely used by researchers are nanoclays since they have a great adsorption capacity, are cheap, reusable and have many possibilities for reuse and recovery of adsorbed dyes.

The natural base of this mineral can be natural or synthetic and in all cases it shows hydrophilic character. Many of these synthetic nanoclays have been improved in the laboratory to increase their adsorptive characteristics [3]. The aim of this study is to confirm the adsorption

capacity of nanoclays, as has been demonstrated in previous works [4]–[9] and also demonstrate experimentally how the hybrid obtained after adsorption can be used to carry out pigment printing on PES/CO polyester cotton textiles. The properties of hydrotalcite make it a very adsorbent element and it also establishes very strong binding forces, allowing the colorant to fix in the clay. In addition, it has been shown that the color resistance to external agents is much higher when it has previously been fixed in a clay, achieving better fastness values.

2. MATERIALS AND METHODS

Reactive Yellow 2 was used as a colorant for this study. As clay we used calcinated hydrotalcite (HC) which was prepared according to Dos Santos R.M.M. [10]. Cotton and polyester plain fabric with 100 g/m^2 was used to perform the printing process.

Dilutions of each of Reactive Yellow 2 were prepared to obtain the Lambert-Beer line [11]. With this line we can know the concentration of dye after adsorbion for the clay. Table 1 shows the equation of the lines and the regression (R).

Table 1. *Lambert-Beer line equations and R^2*

Colorant	Equation	R^2
Reactive Yellow 2	y = 5,8593x + 0,0428	0.9806

The aim is to obtain a clay with a high color intensity for the subsequent realization of the printing paste, for which the adsorption phase is made in the following form. 1000 mL of concentration solution 1 g·L^{-1} were taken by the dye. We introduce 3 g·L^{-1} of the clay were introduced and mixture was put under stirring [12], two hours at maximum stirring and then it went to lower speed 600 r.p.m. The solution was then filtered with the clay for 24 hours to separate the clay-dye hybrid from the rest of the solution and measure with the spectrophotometer to calculate the concentration of dye that has not been adsorbed by the clay [13,14]. The hybrid obtained was measured in a Jasco V-670, double beam spectrophotometer between 190-2700 nm and the color differences were calculated. The residual dye solution that has not been adsorbed was also measured with the spectrometer Zuzi model 4251/50 to know the amount of dye that has not been adsorbed.

For the printing procedure, Lutexal CSN was used as a synthetic thickener, STK / 100 center resin and Luprintol SE fixative. Two printing tests were carried out with the hybrid described above, following the following recipes shown in table 2.

Table 2. *Printing recipe*

Sample nº	Lutexal CSN	Resin STK / 100	Luprintol SE	clay-dye hybrid
1	30 g/Kg	10 g/Kg	10 g/Kg	1,5 g/Kg
2	30 g/Kg	10 g/Kg	10 g/Kg	7,5 g/Kg

The printing was carried out on a PES / CO fabric 50% Cotton and 50% Polyester with 4 passes of a scraper, it was dryed for 15 minutes at 60 ºC and then heat-set at 180 ºC for 30 seconds on a pressure plate. The samples obtained are analyzed on a Minolta CM-3600d reflection spectrophotometer to assess the color achieved. In the spectrophotometer, 3 measurements were made of each sample and the average was obtained in the maximum reflectance peaks.

3. RESULTS AND DISCUSSSION

The results in Table 3 show how after the clay action the dye concentration have gone from 3 $g \cdot L^{-1}$ to values between $3.08 \cdot 10^{-4}$ and $3.21 \cdot 10^{-4}$ $g \cdot L^{-1}$. Thus, a good adsorption behavior of the nanoclay is observed as expected and the obtaining of a functional hybrid for the printing phase.

Table 3. *Difference in concentration after HC absorption*

	Sample ref.	HC conc. $g \cdot L^{-1}$	Initial conc $g \cdot L^{-1}$	Final conc $g \cdot L^{-1}$	% absorption
Reactive Yellow 2	1	3	1	$3.08 \cdot 10^{-4}$	99.85
	2	3	1	$3.21 \cdot 10^{-4}$	99.36

The stamping carried out according to the method described in the previous section has been a complete success. It can be seen how it has been possible to carry out a printing with the hybrid and the printing paste, leaving the colored fabric in the area of application.

To have a quantitative assessment of the color obtained, the reflectance has been measured and the Kubelka-Munk theory (K/S) has been taken as a reference, which defines two parameters that explain the interaction phenomena of light with matter K: absorption coefficient and S: diffusion coefficient [15]. The results obtained in the visible range of 400-700 nm and under the illuminant D65 show that the maximum reflectance peak is at 400 nm. The reflection results and the calculated mean color strength is expressed in Table 4. Regarding the colorimetric parameters, the L* a* b* values and the color difference ΔE_{ab}* are shown in Table 4.

Table 4. *Chromatic coordinates L, a, b , Value of color strength K / S, and Color difference*

Sample	L*	a*	b*	K/S (400 nm)	ΔE_{ab}*
White	88.6925	-0.5089	2.2863	0.0942	-
Sample 1	87.7489 ± 0.2842	-2.4045 ± 0.1752	10.0666 ± 0.7453	0.1926 ± 0.061	8.0689 ± 0.7287
Sample 2	87.4025 ± 0.2561	-4.5439 ± 0.2137	23.9254 ± 2.9868	0.4552 ± 0.0712	22.0520 ± 2.9829

4. CONCLUSION

In view of the results, we can conclude that the results and interpretations provided in other studies are reproduced in our trials. The HC shows a great capacity for absorption and fixation of the dye within its structure. Furthermore, it has been shown that the obtained hybrid can be used successfully as a textile printing pigment. The samples obtained show good coatings, use and intensity of color, fulfilling the intended objective.

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