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Synthesis of Novel Disperse Dyes based on Arylazophenols: Part 4. Reuse of Dyeing Baths as an Environmentally Benign Method for Wastewater Treatment

Morsy Ahmed El-Apasery[1*], Mahmoud Elsayed Ahmed Abdellatif [2], Sara Morsy Ahmed[3]

[1]Dyeing, Printing and Textile Auxiliaries Department, Textile Technology Research Institute, National Research Centre, 33 El Buhouth St., Cairo 12622, Egypt.
[2]Department of Chemistry, Faculty of Science, Zagazig University, Egypt.
[3]Applied Biosciences and Process Engineering Department 7, Anhalt University of Applied Sciences, Bernburger Street 55, P.O. Box 1458 06366 Köthen, Germany.

Abstract

As a continuation of our strategy towards synthesis of new dyes, this has already been done in our previous study, and here we are presenting and studying the reuse of dyeing baths as an environmentally benign method for wastewater treatment of these new disperse dyes.
Keywords**:** Disperse dyes, Arylazophenols, *R*euse of dyeing baths

1. Introduction

Since the discovery of synthetic fabrics, the usage of dispersion dyes in industrial textile has steadily increased. Applying disperse colours is especially easy when employing straightforward exhaustion procedures on practically all synthetic materials [1-3]. The increasing usage of disperse azo dyes raises environmental concerns. Reusing water in textile processes has been the focus of research and development efforts in recent years. Given the ability to reduce both water consumption and wastewater treatment costs, there are strong incentives for water reuse [4-9]. When energy prices started to play a significant role in overall manufacturing costs in the middle of the 1970s, the idea of renovating and reusing dye baths was born. Reusing and renovating dye baths has been proven to be a successful way to cut costs. Reconstituting the dye bath by adding the necessary amount of dyes and chemicals after analyzing the dye liquor is one method for using the dye bath again. Only if the dyeing process does not alter the characteristics of the remaining dye in the bath, such as disperse dyes, is the aforementioned method applicable. Reusing dye baths has long been acknowledged as a method of reducing costs and pollution. In this work, after the initial dyeing procedure, polyester fibres were coloured with dispersion coolers in a dye bath reuse system [10-14]. The study's goal was to limit the amount of effluent released during the dyeing of polyester fibres while also conserving chemicals, water, and dye. Rather than flushing the dye bath out after each dying session.

2. Materials and Methods

General Procedure for the Synthesis of Disperse Dyes 5a-f

The disperse dyes were prepared according to the method that we published in our previous study [1].

*Corresponding author e-mail: elapaserym@yahoo.com.; (Morsy Ahmed Elapasery).
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Dyeing procedure

A- First dyeing

The dye bath (liquor ration 1:30) contained (1.5%) of levegal MDL as dispersing agent and (3% of) TANAVOL EP 2007 as anionic eco-friendly carrier in case of dyeing at 100 °C or just use dispersing agent in case of dyeing at 130 °C. The dye bath's pH was raised to 5.5 using aqueous acetic acid before the addition of the wetted-out polyester textiles (3 gramme). We carried out dyeing by gradually increasing the dye bath's temperature to 100 or 130°C and maintaining it there for 60 minutes. The coloured fibres were reduced (1 g/L sodium hydroxide, 1 g/L sodium hydrosulfite, 10 min, 80°C) and cleared after being cooled to 50°C. The samples were cleaned in both hot and cold water before being dried by air.

B- Dye bath reuse

After dying, the dye bath was examined and reconstituted with the required volume of fresh water to preserve the original volume's consistent liquor ratio. In order to maintain pH at 5.5, the pH of the dye bath residue was determined. The same steps as the previous two processes were used to reuse dye baths during dyeing. To increase washing fastness, a reduction-cleared using sodium hydroxide (3 g/L) and sodium hydrosulphite (2 g/L) was followed by a 15-minute soak in 2% nonionic detergent (pH 8) at 50 °C.

Color Measurements

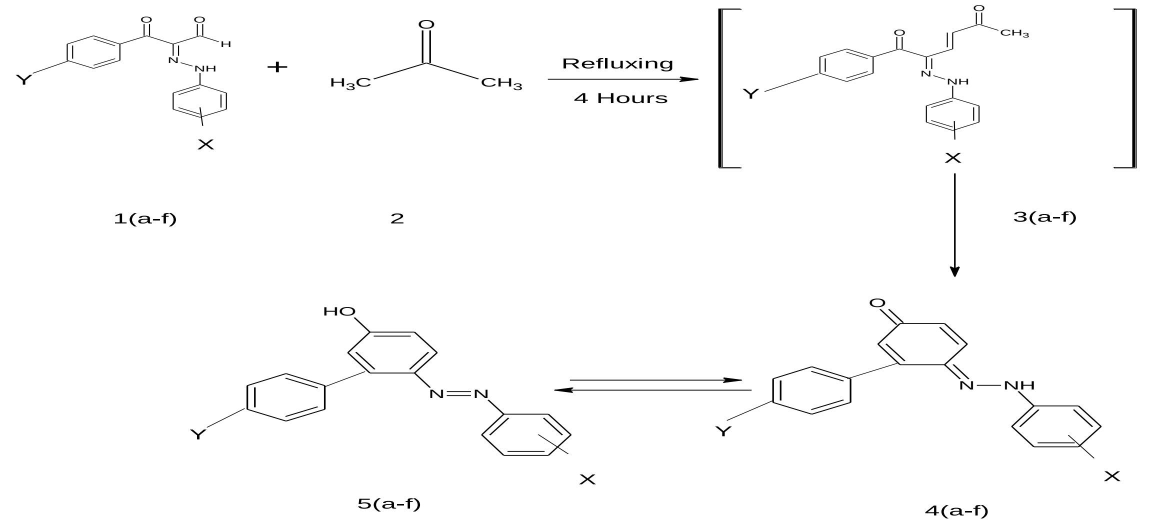
The colorimetric parameters of the dyed polyester fabrics were determined on a reflectance spectrophotometer. The color yields of the dyed samples were determined by using the light reflectance technique performed on an UltraScan PRO D65 UV/VIS Spectrophotometer. The color strengths, expressed as K/S values, were determined by applying the Kubelka-Mink equation.

$$K/S = (1- R)^2 / 2R$$

Where, R is the reflectance of colored samples and K and S are the absorption and scattering coefficients, respectively

3. Result and discussion

In this investigation, polyester fabrics were firstly dyed using these new disperse dyes based on 3-oxo-3-phenyl-2-(2-phenylhydrazono)propanals at a low and high temperatures (Figure 1).



5 (a) X,Y= CL, H
5 (b) X,Y=CL,CH_3
5 (c) X,Y=CL, Br
5 (d) X,Y=No_2,H
5 (e) X,Y=No2,CH_3
5 (f) X,Y=No_2,Br

Scheme 1: Structures of new disperse dyes

Table (1) Colour Strength of the new dyes 5(a-f) shade 3% at 100 °C dyeing process.

Dye No	Dyeing method	*L**	*a**	*b**	*C**	*h**	K/S
5a	First dyeing	81.08	-0.91	4.12	4.22	102.43	5.41
	1st dye bath reuse	68.71	5.08	23.44	23.99	77.77	3.73
	2nd dye bath reuse	73.72	1.12	27.39	27.41	87.66	2.94
	3rd dye bath reuse	72.25	3.76	44.58	44.47	85.19	0.69
5b	First dyeing	82.12	-0.22	0.20	0.29	137.75	3.54
	1st dye bath reuse	80.49	-0.33	4.37	4.38	94.35	2.16
	2nd dye bath reuse	73.90	2.27	17.14	17.29	82.44	0.73
	3rd dye bath reuse	70.32	4.02	23.76	24.09	80.39	0.45
5c	First dyeing	81.07	-0.70	3.12	3.20	102.67	4.02
	1st dye bath reuse	77.32	-0.09	13.86	13.86	90.83	2.36
	2nd dye bath reuse	72.69	1.43	24.40	24.44	86.65	1.31
	3rd dye bath reuse	69.72	1.74	37.34	37.38	78.33	0.54
5d	First dyeing	80.84	-0.26	3.50	3.51	94.21	4.26
	1st dye bath reuse	69.72	3.67	18.86	19.21	78.99	2.27
	2nd dye bath reuse	68.63	6.23	34.06	34.63	79.63	0.63
5e	First dyeing	79.44	-0.25	6.42	6.43	92.27	3.74
	1st dye bath reuse	74.68	1.07	17.43	17.47	86.48	2.10
	2nd dye bath reuse	71.00	3.21	26.39	26.59	83.07	0.89
5f	First dyeing	81.58	-0.46	2.41	2.45	100.87	5.66
	1st dye bath reuse	75.02	1.16	19.84	19.87	86.85	2.13
	2nd dye bath reuse	73.07	2.95	35.60	35.72	85.26	0.55

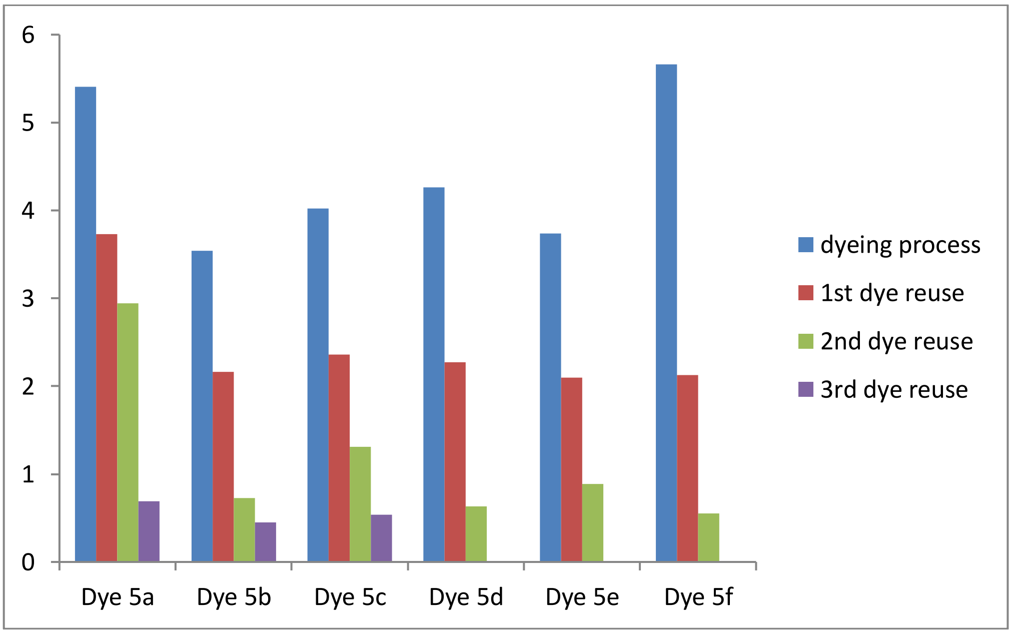


Figure 1. K/S of first and dye baths reuse of the disperse dyes dyeing process at 100 °C

Table (2) Colour Strength of the new dyes 5(a-f) shade 3% at 130 °C dyeing process.

Dye No	Dyeing method	*L**	*a**	*b**	*C**	*h**	K/S
5a	First dyeing	79.98	-0.66	4.75	4.80	97.97	14.92
	1st dye bath reuse	75.71	-0.51	19.54	19.55	91.94	1.87
	2nd dye bath reuse	60.27	8.44	44.33	45.13	79.22	0.58
5b	First dyeing	82.71	-0.19	10.83	10.83	90.98	8.65
	1st dye bath reuse	69.13	5.51	21.27	21.98	75.48	3.31
	2nd dye bath reuse	60.75	6.29	29.18	29.85	77.82	0.77
5c	First dyeing	80.56	-0.55	6.80	6.82	94.60	10.31
	1st dye bath reuse	73.01	1.12	20.96	20.99	86.94	2.19
	2nd dye bath reuse	60.15	5.27	38.96	39.32	82.29	0.73
5d	First dyeing	81.48	-0.73	4.06	4.13	100.21	8.46
	1st dye bath reuse	81.45	2.09	15.46	15.61	82.31	1.17
	2nd dye bath reuse	58.88	7.96	31.27	32.27	75.21	0.54
5e	First dyeing	82.80	-0.22	0.58	0.62	100.73	11.94
	1st dye bath reuse	81.15	-0.87	4.85	4.93	100.18	0.63
	2nd dye bath reuse	56.73	7.22	28.78	29.67	75.92	0.35
5f	First dyeing	82.45	-0.69	1.01	1.22	124.50	10.40
	1st dye bath reuse	79.94	-0.32	6.39	6.40	92.90	0.74
	2nd dye bath reuse	59.42	8.35	33.65	36.67	76.05	0.43

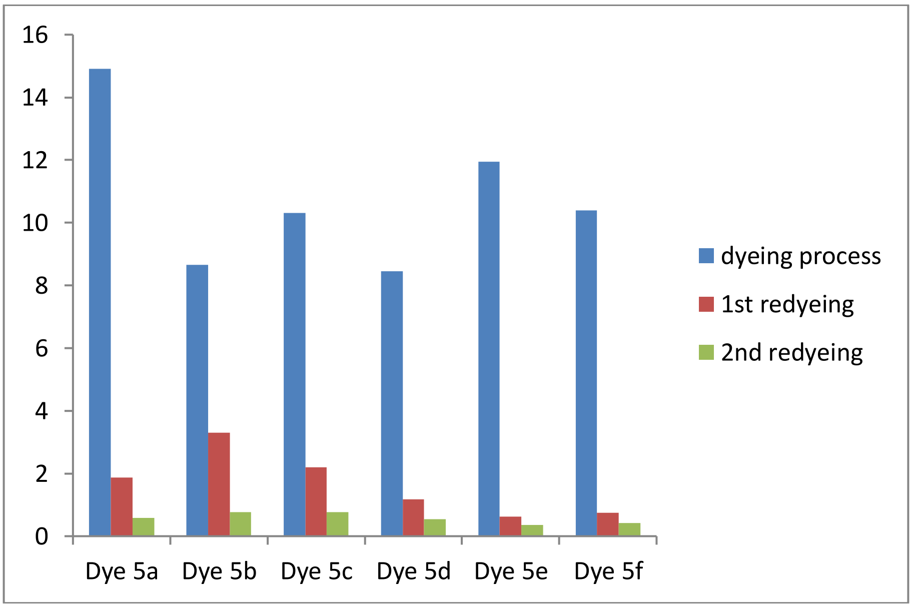


Figure 2. K/S of first and dye baths reuse of the disperse dyes dyeing process at 130 °C

The prepared disperse dyes were used to dye polyester fabrics at 100 or 130 °C, and it was discovered that the dye effluents contained a quantity of dye that had a negative impact on the environment. As a result, our strategy was to use the dye effluents waste in dyeing new polyester fabrics in order to make the best use of the dye that was used while avoiding the disposal of any coloured waste that had a negative impact on the environment.

From the data obtained in table 1 that represented in figure 1, we observed that color strength measurement K/S value of the dye bath reuse process in 1st, 2nd and 3rd re-dyeing process at 100 ^{0}C vary from (70, 50 and 15) % from its original value obtained in the dyeing process for all the disperse dyes.

From the data obtained in table 1 that represented in figure 1, we observed that color strength measurement K/S value of the dye bath reuse process in 1st and 2nd re-dyeing process at 130 ^{0}C vary from (12 and 6%) from its original value obtained in the dyeing process for all the disperse dyes**.**

4. Conclusions

In this study, we presented that dyeing reuse is an effective method of reduction costs, pollution, water, energy and chemicals.

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