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Synthesis of New Disperse Dyes Based on Enaminones Derivatives: Part 1. Reuse of Dyeing Baths

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Abstract

We studied the reuse of dyeing baths as a safe and environmentally friendly way to treat wastewater for these new dispersed dyes and studied them here as a continuation of our strategy towards the synthesis of new dyes, the results of which show that the process of reusing dyeing baths after the first dyeing process is a promising process.

***Keywords*:** disperse dyes, reuse of dyeing baths

1. Introduction

Since the development of synthetic fibres, dispersion dyes have been utilised more frequently in industrial textiles. Applying disperse colours is incredibly straightforward when using straightforward exhaustion procedures on nearly all synthetic materials [1-3]. The ecosystem suffers as a result of the increased use of dispersion azo dyes. Recent research and development has centred on the reuse of water in textile processes. There are considerable incentives for water reuse given the potential to decrease water usage and wastewater treatment costs [4-13]. Recycling dye baths can reduce expenses and pollution, as is well known. In this work, after the initial dyeing phase, polyester fibres were coloured utilising dispersion coolers in a dye bath reuse system. The objective of the project was to reduce the quantity of effluent generated while dying polyester fibres while also preserving chemicals, water, and colour. Instead of removing the dye bath from the washbasin after each dyeing 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].

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 checked and reconstituted with the necessary amount of new water to maintain the consistent liquor ratio of the initial volume. The pH of the dye bath residue was determined to preserve pH at 5.5. In order to reuse dye baths while dyeing, the same steps as the previous two processes were followed. 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 in order to increase washing fastness.

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Colour Measurements

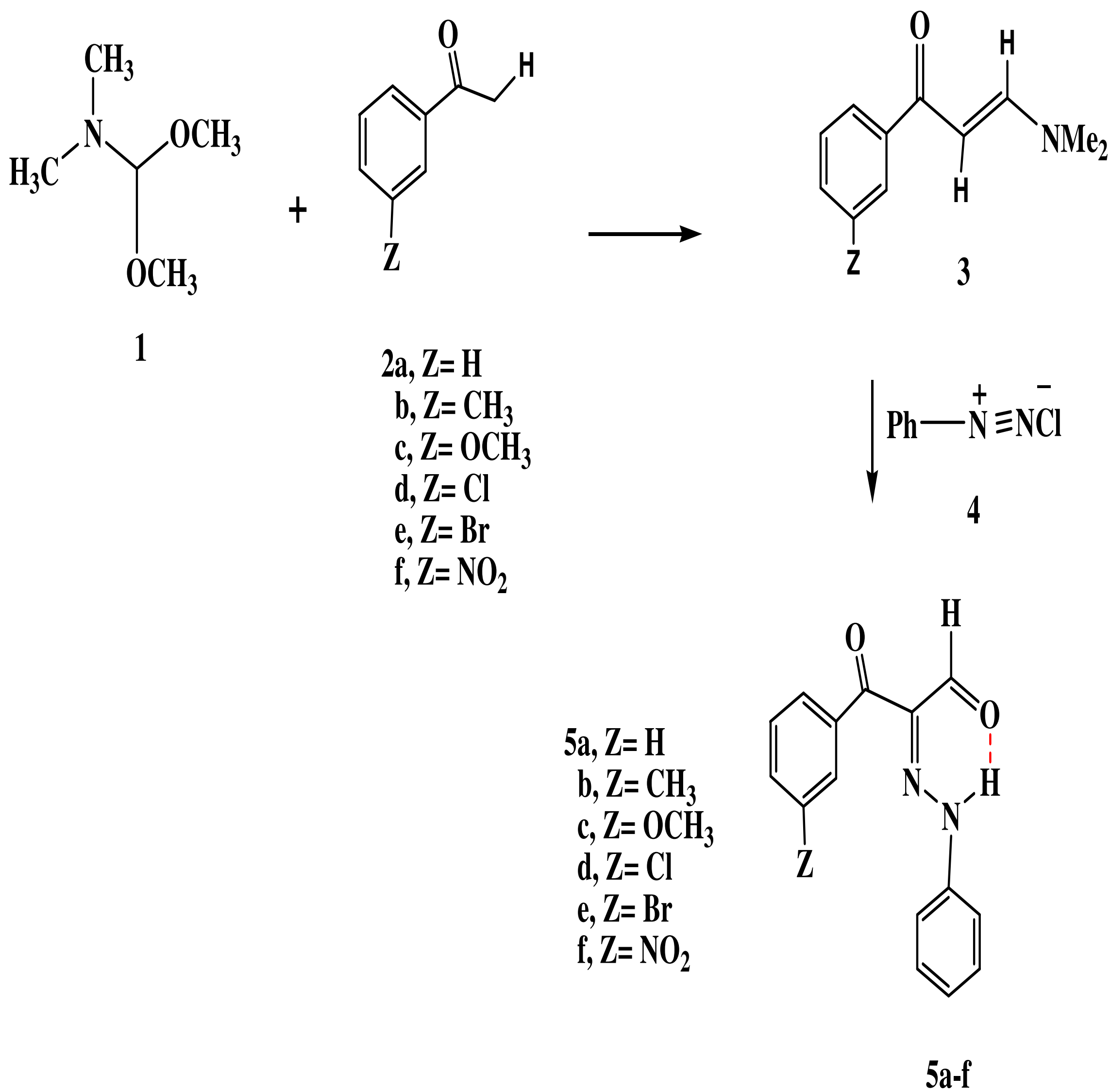
The colorimetric parameters of the dyed polyester fabrics were determined on a reflectance spectrophotometer. The color yields of the dyed samples were determined by using the light reflectance technique performed on an UltraScan PRO D65 UV/VIS Spectrophotometer. The color strengths, expressed as K/S 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 study, polyester fabrics were initially dyed at low and high temperatures utilising these novel disperse dyes based on enaminones. (scheme 1).



Scheme 1: Structures of new disperse dyes

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

Dye No.	K/S	*L**	*a**	*b**	*L**	*c**	*h*
5a	11.20	77.94	1.51	58.27	77.94	58.29	88.52
5b	12.07	77.32	4.32	65.91	77.32	66.06	86.25
5c	14.29	77.34	0.04	63.80	77.34	63.80	89.96
5d	16.06	82.99	-7.66	69.52	82.99	69.94	96.29
5e	10.69	78.30	1.38	58.43	78.30	58.44	88.65
5f	12.06	80.48	-1.91	60.51	80.48	60.54	91.81
After First re-dyeing							
5a	4.29	88.29	-13.66	38.76	88.29	41.10	109.41
5b	4.07	84.19	-5.44	46.30	84.19	46.62	96.70
5c	3.45	84.02	-6.40	39.62	84.02	40.14	99.17
5d	2.78	87.63	-11.39	34.85	87.63	36.67	108.09
5e	6.22	84.01	-8.61	49.79	84.01	50.52	99.81
5f	6.87	85.81	-10.82	51.36	85.81	52.49	101.90
After Second re-dyeing							
5a	0.54	88.76	-5.55	11.22	88.76	12.52	116.34
5b	0.81	87.20	-5.73	21.23	87.20	21.99	105.10
5c	0.52	88.04	-5.10	13.93	88.04	14.83	110.10
5d	0.25	88.39	-2.72	6.71	88.39	7.24	112.05
5e	2.80	86.32	-10.37	36.58	86.32	38.02	105.82
5f	3.25	86.83	-11.42	39.14	86.83	40.77	106.27

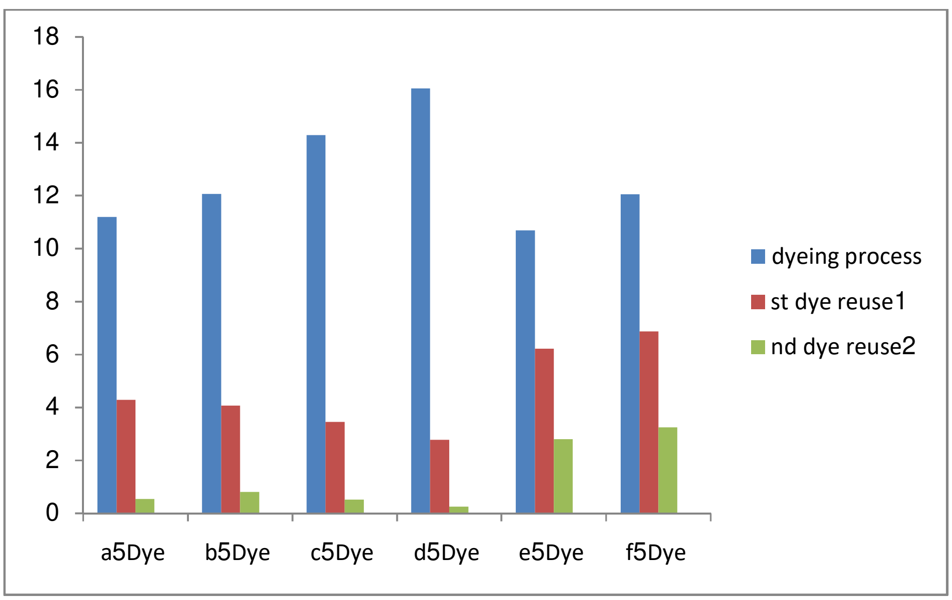


Figure 1: K/S of first and dye baths reuse of the disperse dyes dyeing process at 100 ºC

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

Dye No.	K/S	L*	a*	b*	L*	c*	h
First dyeing							
5a	16.55	83.37	-9.72	74.00	83.37	74.64	97.49
5b	15.83	77.30	1.52	73.74	77.30	73.76	88.82
5c	15.79	78.48	-1.65	70.36	78.48	70.38	91.35
5d	16.32	81.87	-6.71	75.37	81.87	75.67	95.08
5e	15.64	78.38	1.13	71.56	78.38	71.57	89.09
5f	15.51	77.41	2.03	71.72	77.41	71.75	88.37
After First re-dyeing							
5a	2.71	88.57	-11.61	31.08	88.57	33.18	110.49
5b	1.72	87.11	-7.49	27.86	87.11	28.85	105.04
5c	1.18	88.90	-8.60	22.59	88.90	24.17	110.84
5d	1.76	88.89	-10.44	26.90	88.89	28.86	111.22
5e	1.63	91.01	-9.40	31.06	91.01	32.45	106.84
5f	2.93	87.58	-11.02	36.43	87.58	38.07	106.84
After Second re-dyeing							
5a	0.13	89.38	-1.90	4.06	89.38	4.48	115.06
5b	0.19	89.60	-2.46	4.85	89.60	5.44	116.95
5c	0.07	89.68	-1.00	1.15	89.68	1.52	131.01
5d	0.09	89.72	-1.36	1.88	89.72	2.32	125.97
5e	0.10	88.85	-1.12	2.35	88.85	2.61	115.53
5f	0.14	89.21	-1.91	4.51	89.21	4.89	112.94

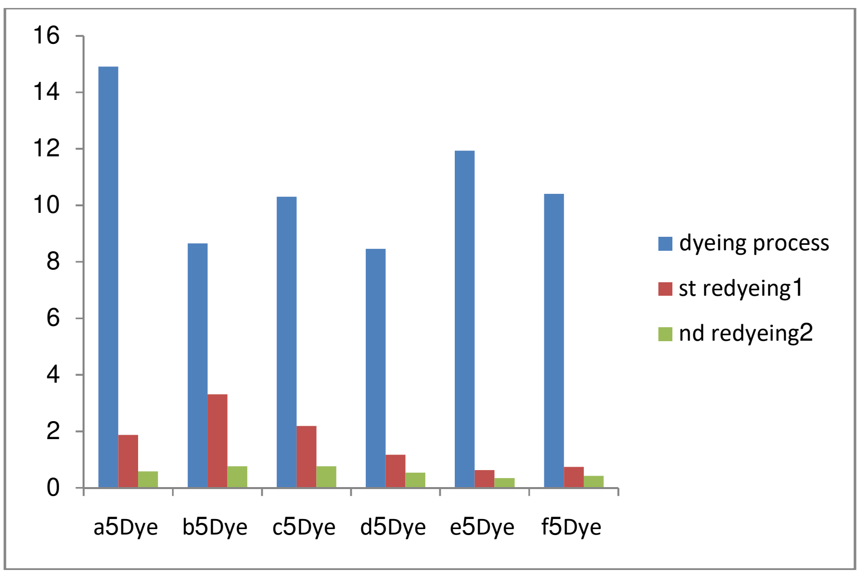


Figure 2: K/S of first and dye baths reuse of the disperse dyes dyeing process at 130 ºC

When we dyed polyester fabrics with dispersion dyes prepared at 100 or 130 degrees Celsius, we found that the dye residue contains a large amount of dye that is harmful to the environment, especially at a temperature of 100 degrees Celsius. Therefore, in order to make the most of the dye that was used while preventing the disposal of any colored waste that has a very harmful effect on the environment, our strategy was to use the dye waste residue in dyeing polyester fabrics, thus achieving two goals at the same time.

Based on the data from Table 1 and Figure 1, we can see that for all dispersion dyes, the colour strength measurement K/S value of the dye bath reuse procedure varies from 17 to 58% from its original value acquired in the dyeing process at 100 ^{0}C.

From the data from Table 2 that is depicted in Figure 2, we can see that for all dispersion dyes, the colour strength measurement K/S value of the dye bath reuse procedure varies from 18 to 7% from its original value obtained in the dyeing process at 130 ^{0}C.

3. Conclusions

In this study, we showed that the reuse of dyeing baths reduces expenses, pollution, water consumption, energy and chemical use, and gives bright colors at no cost, especially after the process of using dyeing baths for the first time after the first dyeing process.

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