High light fastness disazo dyes for inkjet printing

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Abstract

Water-soluble dyes have good solubility, brightness and long shelf life, but higher penetration, poor water and light fastness compare with pigment colorant on printing paper. How to increase light fastness of dyes is always an important issue on inkjet printing for photo. Dye containing carboxyl groups could improve water fastness had been studied but lacked off light fastness information [1,2,3].

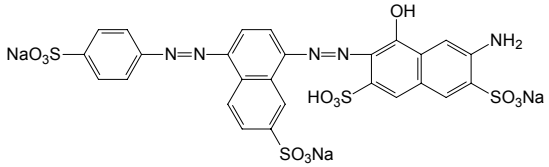
In this paper, a series of disazo dyes which diazonium group contained carboxyl groups and methoxyl groups included navy blue, red and yellow components were synthesized and evaluated showing good light fastness and high color strength.

These diazo compositions form deep black shade and have been approved with high color strength and light fastness performance compared with commercial market product. This range of product is easy dissolved in aqueous and has good printing performance on inkjet application.

Introduction

Ink jet printing is a non-impact printing method; its features include sharp, non-feathering patterns, good water-fastness and light-fastness and optical density. Printing properties are also desirable, such as fast drying and good storage stability, printing smoothness and non-clogging. Dyes for inkjet printing should display high water solubility, thermal and chemical stability, good light stability and performance, high purity and low toxicity. The work described here on black dye compositions aimed at neutral black with good light-fastness to gas fading, as presented by Mario Fryberg [4].

Food Black 2 (**1**) is a heavy black dye used commercially in ink jet printing is still widely used. This dye has good solubility but poor water fastness and light fastness [5]. C I Reactive Black 5 (**2**) has strong chromophore but poor storage stability. This dye hydrolyses and releases sulphate during storage thus affects printing performance. In order to improve light-fastness, US Patent No. 7387667 discloses a black dye composition; however, the light-fastness of this black dye composition needs to be further improved.



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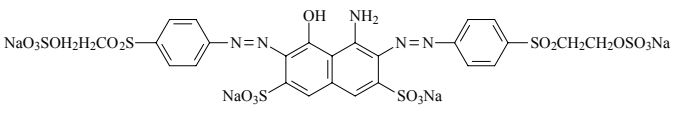
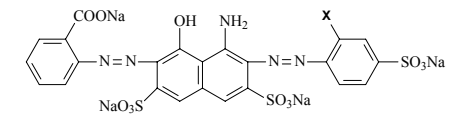
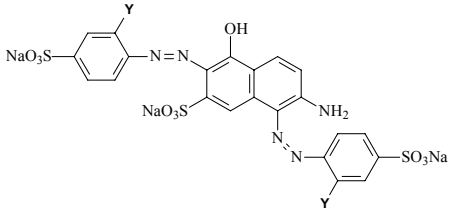


2

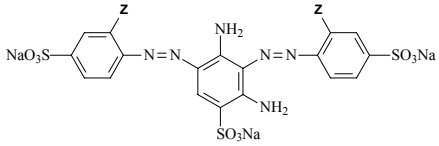
This study aimed to producing deep black dye compositions with high light fastness performance, which based on the disazo components could have strong color strength. The diazonium compounds contained carboxyl or methoxyl groups were found having high light fastness properties. These black dye mixtures contained Navy (I-1 and I-2), Red (II-1 and II-2) and Yellow (III-1 and III-2) components. Structures are showing as below.



X	
I-1	-COONa
I-2	$-OCH_3$



Y	
II-1	-COONa
II-2	$-OCH_3$



Z	
III-1	-COONa
III-2	$-OCH_3$

Experimental

Dye preparation and composition

Dyes were synthesized through the diazotization and coupling process to obtain requiring Navy, Red and Yellow crude dyes. All crude dyes must be purified to remove all impurity and inorganic contain through the R.O. unit and purification process.

The dye compositions of Embodiment 1 and 2 are showed as below, which comparison is the general market black compositions Bayscript Black SP.

	Dye composition (%)						
	I-1	II-1	III-1	I-2	II-2	III-2	Bayscript Black SP
Embodiment 1	3.53	2.54	1.52				
Embodiment 2				5.33	3.26	1.84	
Comparative							20

Ink formulation

The ink compositions and formulation used for printing are described in Table 1.

Table 1: Ink composition

	Embodiment 1	Embodiment 2	Comparative
Dye contains	7.52%	10.43%	20%
DEG	10%	10%	10%
DEGMBE	10%	10%	10%
Glycerine	7%	7%	7%
S-465	1%	1%	1%
PROXEL-XL2	0.3%	0.3%	0.3%
DI-water	64.18%	61.27%	51.7%
Abs	0.180/613nm	0.185/609nm	0.184/567nm

The above Abs./λmax(100ppm): denotes the above preparation of the ink composition having a concentration of 100ppm(100mg/l), and is tested at the wave length where the greatest UV absorbing wave length is λmax, and the UV absorbance of it is Abs.

Printing Test

Printer: EPSONSTYLUS PHOTO 830U PRINTER
Printing paper: PLAIN PAPER
Printing setting: Normal printing

Light Fastness Test

The printed-paper was illuminated by a xenon arc lamp, wherein the total energy is 50 kJ, and then the color difference of the printed-paper after the illumination was measured by DATACOLOR. The greater DE value means more color difference after illumination, i.e. worse light-fastness. The test results are shown in Table 2.

Table 2: Light fastness test

	Light-fastness (50kJ)	
	DEL E	ISO-A05
Embodiment 1	1.262	4
Embodiment 2	1.380	4
Comparative	5.434	2-3

Note 1: Change of DE under light fastness --- the smaller the change in DE the smaller the color difference is between before and after exposure, meaning good light fastness.

Results and discussion

It can be seen that the ink compositions of Embodiment 1 and 2, which has lower DE variation compare to Bayscript Black SP. It means the novel black compositions have much better light fastness compare to comparative samples, even 4 grades at ISO-A05 test. Moreover, the real dye contain amounts are lower than the comparative, it means dye has high color strength. From above data show disazo dye containing carboxyl group or methoxyl group in ortho-position by azo chromophore may be formed interact hydrogen boding or statistic effect to protect chromophore decomposed under testing light.

Conclusion

The black compositions are derived from the novel Navy, Red and Yellow components display good light fastness, and demonstrate satisfactory color strength compare to commercial product. These new dyes present an opportunity in resolving the light fastness for long-term stability issue commonly seen in the inkjet ink industry.

Reference

1. U.S. Patent No. 5,053,495
2. U.S. Patent No. 4,963,189
3. U.S. Patent No. 5,062,893
4. Mario Fryberg, Rev. Prog. Color., 35(2005) 2.
5. Stephen F. Pond, Inkjet Technology and product development strategies, (2000) 177.

Biography

Hsiao-San Chen received his Bachelor and Master Degrees from Fun-Cha University (Taiwan) Textile Department in 1990 and 1992, respectively. He joined Everlight Chemical Industry Corporation (ECIC) R&D Department since 1994 focus on the reactive dyes development. He received Ph.D. degree in 2001 from UMIST (U.K) Textile Department by ECIC's financial support. Dr. Chen now serves as Inkjet Group Leader in ECIC R&D Center.