Novel Dyes for Ink Jet Applications

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Abstract

For office printing with water based inks, magenta dyes with good fastness properties have been developed. In addition the results from the development of black trisazo dyes with good thermal stability and water fastness are summarized. Modified black heterocyclic dyes for industrial ink jet printing exhibit good solubility in alcohol based solvents, superior light fastness and bar code readability using infrared lasers.

Introduction

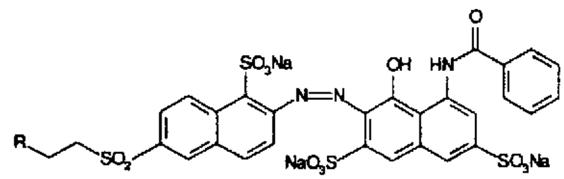
Within the competing nonimpact printing technologies ink jet printing has made considerable progress due to its suitability to print monochrome and color on any surface. Continuing innovation in the field of ink jet dyes and inks is reflected by an increase to more than 250 patent applications in 1993. In this paper our results from the development of water soluble magenta and black dyes for office and industrial applications are presented.

Water Soluble Ink Jet Dyes

The development of magenta dyes having good light fastness combined with high affinity to cellulosics has proved to be difficult[1,2]. In accordance with narrow absorption bands, C.I. Acid Red 52 exhibits the desired brightness but moderate light and poor water fastness[3]. C.I. Direct Red 81 shows improved light and water fastness; due to secondary absorptions this disazo dye is not suited as a primary color for the subtractive color system[3]. An access to magenta dyes exhibiting acceptable brightness and good light and water fastness is provided by displacing the sulfate group in C.I. Reactive Red 180 with aliphatic amines[4].

Black water soluble polyazo dyes comprise an important class of dyes for monochrome printing[1].

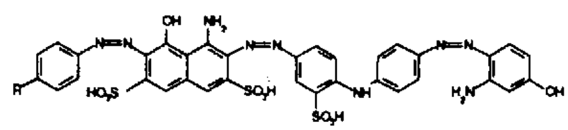
Safe replacements of black dyes based on benzidine and its 3,3' - dimethyl and dimethoxy derivatives have been developed including trisazo dyes using 4,4'-diaminodiphenylamine-2-sulfonic acid as precursor. As shown in Figure 2 the solubility of C.I. Direct Black 168 is improved by conversion of the sodium into the lithium salt and by introducing hydroxyethylsulfonyl substituents which also improves water fastness.



Product	R	Light Fastness	Water Fastness
C.I. Reactive Red 180	OSA_3Na	4	66%
Development	$NH(CH_2)_4NH_2$	4	80%

Figure 1. Modification of C. I. Reactive Red 180

Other key advantages of C.I. Direct Black 168, lithium salt include high print optical densities and good thermal stability which makes this dye suitable for bubble jet application.



Cation (Ref.)	R	Solubility (H_2O, 25 °C)	Water Fastness
Na (5)	H	8%	75%
Li (6)	H	15%	75%
Li (7)	$SO_2CH_2CH_2OH$	20%	80%

Figure 2. Modification of C. I. Direct Black 168

C. I. Direct Black 171[8] is mainly used for nonthermal ink jet systems using piezo technology; for thermal ink jet systems its thermal stability is insufficient and kogation usually occurs.

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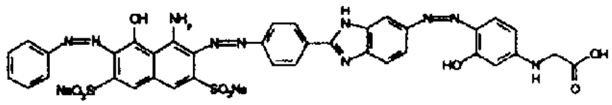

Figure 3. C.I. Direct Black 171

This dye exhibits reasonable light fastness combined with enhanced water fastness (85%) which can be explained by hydrogen bonding of amidine and carboxylic acid groups to cellulose units.

Recently, other dyes bearing carboxylic acid instead of sulfonic acid groups have been developed showing improved water fastness on slightly acidic papers due to differential, pH - dependent solubility[1].

Solvent Soluble Ink Jet Dyes

Both aqueous and solvent based inks are used for industrial applications, mainly for marking, addressing and coding. For printing onto nonporous substrates such as metals and plastics, fast drying inks based on organic solvents are prevalent.

Predominant for industrial labeling are 2: I chromium azo complex dyes of the type C. I. Solvent Black 27 which shows the required high light fastness and solubility in methyl ethyl ketone but poor solubility in alcohols.

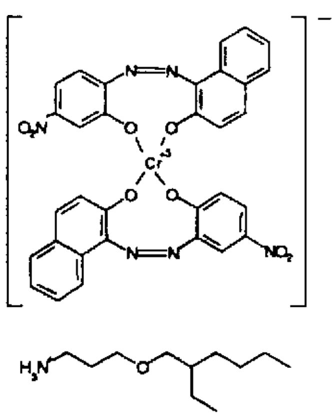

Figure 4. C.I. Solvent Black 27

For ecological and toxicological reasons novel chromium-free dyes with good solubility in alcoholic solvents have been developed. These dyes exhibit superior light fastness and absorption bands in the near infrared which provide readability of bar codes using infrared lasers.

The novel dyes are obtained by modifying black sulfur and nitrogen containing polycyclic dyes[9]. Special oxidation processes and subsequent cation exchange with alkyl ammonium salts result in ethanol soluble dyes.

Figure 5 shows that the tailor-made development product surpasses the chromium complex dye C.I. Solvent Black 27 with respect to light fastness and solubility in ethanol.

Product	Solubility (Ethanol, 25°C)	Light Fastness
C.I. Solvent Black 27	4%	6
Development	15%	7-8

Figure 5. Black Solvent Dyes for Industrial Ink Jet Printing

Summary

Selecting conventional azo and polycyclic dyes and tailoring these dyes for ink jet applications, magenta and black dyes for office and industrial applications were developed:

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