

A Review of Discharge Printing

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In discharge printing, the fabric must first be dyed with dyes that can be destroyed by selected discharging agents. The discharge paste is printed on the dyed fabric with the help of a printing machine, followed by a steaming process that brings about decomposition of the dye. The steamed fabric is then washed, dried, and finished. The processes involved usually occur in the following order:

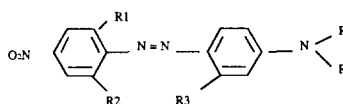
- Preparation of fabric to be printed
- Dyeing of fabric with dischargeable dyes
- Preparation of discharge paste
- Printing the discharge paste onto the dyed fabric
- Drying
- Steaming under atmospheric conditions or under pressure
- Washing and soaping as required
- Drying
- Finishing
- Packing, billing, and shipping

Dye Selection

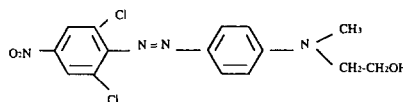
The choice of dyes is facilitated by the dyes manufacturers that usually classify their products on a dischargeability scale ranging from 1 to 5. A dye that is classified as 5 or 4-5 on the scale would be suitable for a white discharge. For a colored discharge, a dye classified as 4 would be acceptable or even a 3-4 with

very deep illuminating colors. Those dyes that have a dischargeability of only 1 are virtually undischageable and are therefore suitable as the illuminating colors in colored discharge styles. Only a trial under actual working conditions can provide full and final information on the suitability of a dye for discharge printing.

The correct choice of dye is of fundamental importance in successful discharge printing. Dyes that are suitable for dischargeable ground usually contain azo groups which can be split by reduction. For example, many mono-azodyes in the disperse dye range which are derivatives of azo benzene and have the general formula:



can be readily discharged. The suitability of these dyes for the production of discharge ground is, however, dependent on the substituents in the ortho position to the azo group, particularly in the R1 and R2 positions. The common substituents in the R3 position have less influence on dischargeability. A dye with a chlorine atom in the ortho position at R1 or R2 is more readily discharged than one with a bromine atom in the same position such as:



Other examples of dischargeable dyes include C.I. Acid Yellow 17 and C.I. Basic Blue 41. The great majority of discharge resistant dyes are not azo dyes. However, as mentioned previously, there are exceptions such as C.I. Orange 5. Most of the discharge resistant dyes are of the anthraquinoid, phthalolonyanine, or triphenyl methane type. The final choice of dye depends on the color required, the reducing agent being used, and the substrate used (Tables I-VIII).

Discharging Agent

Discharge style depends on the chemical destruction of the original dye in the printed areas to produce a given pattern. The discharging agents used can consist of oxidizing or reducing agents, acids, alkalis, or various salts. The main problem with using an oxidizing agent in the oxidation process is the adverse effect of the agent on the cotton substrate. Cotton can easily be tendered by an oxidizing agent if the proper conditions are not maintained.

The most important methods of discharging are based on reduction. This general method can be varied and adapted to give discharge with most classes of dyes in use and on most types of fabrics. The most widely used reducing agents are the formaldehyde sulphonylates. The stability of these compounds is such that only limited losses of sulphonylate occur during printing and

ABSTRACT

Technology involved in discharge printing is reviewed in detail. Process sequence, dye selection, discharging agents, as well as other chemicals such as thickeners are discussed. General problems encountered in the application process and cost considerations are also reviewed.

Key Terms

Discharge Printing
Printing

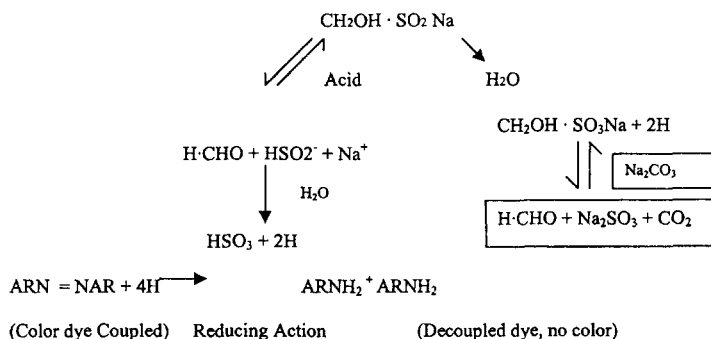


Fig. 1. Possible mechanisms for the reduction action of sodium formaldehyde sulphonylate.

prior to steaming. The use of sodium formaldehyde sulphonylate (sold as Formosul by Ciba or Rongalit by BASF) is very popular. Possible mechanisms for the reduction action of sodium formaldehyde sulphonylate are given in Fig. 1.

The actual amount of reducing agent required for optimum discharge will depend on:

- The dyes to be discharged
- The depth of the ground
- The fabric being printed

Other Chemicals and Auxiliaries

Anthraquinone

Anthraquinone is often used to improve the discharge effect of a reducing agent and is therefore used on fabrics dyed with those selected azo dyes that are difficult to discharge in its absence. During steaming this chemical catalyst is reduced to hydroanthraquinone which, in turn, reduces the dye and is itself reconverted to anthraquinone. This cycle is continued until reduction of the dye is complete. The use of anthraquinone also promotes reproducibility in fluctuating steaming conditions. However, to prevent subsequent

discoloration, all anthraquinone must be removed in the washing process.

Leucotropes

Leucotropes are compounds of certain tertiary bases with benzyl chloride and its substitution products. These compounds are used to improve whiteness in discharge portion.

Humectants and Penetrating Agents

Humectants and penetrating agents aid penetration during steaming and consist of chemicals such as glycerol, ethylene-glycols urea, thiodiglycol, glycerene, carriers, etc.

Other Additives

Other chemical additives used in the discharge printing process include TiO_2 , ZnO_2 , $ZNSO_4$, thiourea dioxide, and fluorescent brighteners.

Thickeners

In discharge printing, the correct choice of thickener is very important. The printing manager must know and should have hands-on experience about the

thickener's stability in the presence of reducing agents under steaming conditions. Nonionic thickeners are necessary and anionic thickeners, such as the carboxymethylated types, should be avoided. A low pH (2-3) can bring about hydrolysis of thickeners with subsequent loss in viscosity. Low pH can also give rise to speckled prints. It is very important to use the low viscosity thickeners and a high solids content. The thickeners that have been used in discharge printing include nonionic locust bean-gum ethers, sodium carrageenates, starch ethers, and crystal gums.

An essential criterion for successful discharge printing is the correct balance between penetration of the fabric and control of flushing and halloing. Flushing of a white discharge results in blurred edges and a loss of fine details. The control of penetration with humectants and use of high solids content thickeners will help. To achieve a good printing pattern, controlling the viscosity of the discharge-print paste, the amount of print paste applied, and the steaming conditions will help.

TABLE I.

Vat Discharge on Cellulosic Fibers

Substrate	cellulosic fibers (cotton, rayon, etc.)
Colored ground	dyed with selected azoic direct and reactive dyes
White discharge	reducing agent
Illuminating colors	selected vat dyes

TABLE II.

Pigment—Illuminating Discharge

Substrate	cellulosic, nylon, and polyester
Colored ground	dyed with azoic, direct, reactive, acid, and disperse dyes
White discharge agent	selected reducing agent
Illuminating colors	selected pigments

TABLE III.

Discharge on Wool and Silk

Substrate	wool and silk
Colored ground	selected acid and reactive dyes
White discharge	water soluble zinc formaldehyde, sulphonylate, C.I. reducing agent 6
Illuminating colors	selected basic acid and disperse dyes

TABLE IV.

Discharge on Secondary Cellulose Acetate

Substrate	secondary cellulose acetate
Ground dye	selected disperse dye
White discharge	thio urea dioxide
Illuminating colors	selected basic vat and disperse dyes

TABLE V.

Discharge on Cellulose Triacetate

Substrate	cellulose triacetate
Colored ground	selected disperse dyes
White discharge	thio urea dioxide
Illuminating colors	selected vat, disperse and basic dyes

TABLE VI.

Discharge—Resist Process on Polyester Fiber

Substrate	polyester
Colored ground	selected disperse dyes
White (discharging) agent	a) reducing agent b) alkali
Illuminating colors	discharge—resistant disperse dyes
Process	This process is very difficult and only experienced printers can carry out this process. I have done a few styles using this process but dyes that have diffused into polyester fibers are virtually impossible to discharge; however, it is possible to use discharge resist process.

TABLE VII.

Discharge on Nylon

Substrate	nylon
Colored ground	selected acid, disperse, basic, and direct dyes
White (discharging) agent	zinc formaldehyde sulphonylate
Illuminating colors	selected acid, direct, and basic dyes

TABLE VIII.

Discharge on Acrylic Fibers

Substrate	acrylic
Colored ground	selected basic dyes (dischargeable)
White (discharging) agent	sulphonylates, stannous chloride
Illuminating colors	selected basic dyes

Conclusion

With any industrial process, there must be sound technical and commercial reasons for the conception and continuation of the process. In the case of discharge printing, the following considerations determine the usefulness of the process compared with other printing techniques:

- Printed materials with large areas of ground color can be produced
- Color depth, levelness, and penetration would be difficult to obtain by other styles of printing

- Delicate colors and intricate patterns can be reproduced on grounds of any depth, with a clarity and sharpness that have become the hallmarks of this style of printing

The extra process required and the additional cost of discharge pastes means production costs are higher. However, the aesthetically superior results give the product a higher value, therefore enabling profit margins to be maintained or improved. The higher cost of discharge printing is often offset

when applied to long-lasting designs used for scarves, ties, cravats, and dressing gowns.

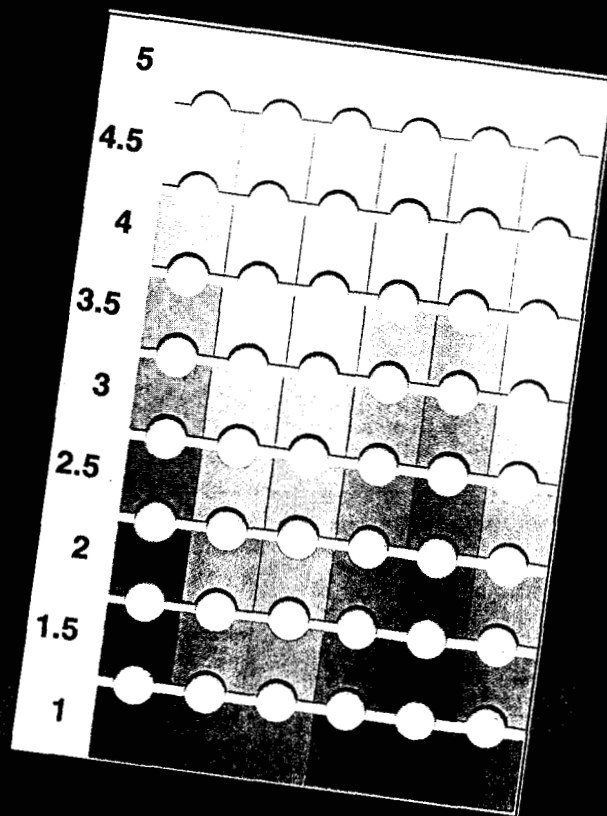
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1. *Textile Printing*, edited by L. W. C. Miles, Dyers Co. Publications Trust, 1981.

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