THE DYING PROPERTIES OF ALIZARIN REDS WHEN USED FOR COLOURING THE DICHROMATED POLYVINYL ALCOHOL IN PHOTOSERIGRAPHY PRINTING

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Abstract: In this paper the authors examined the instant coloration of dichromated polyvinyl alcohol emulsions with alizarin reds in photoserigraphy printing. They examined also, the effect of the usual working parameters on the gained colour hue in the dichromated layers.

Introduction

Photoserigraphy is a usual term for the photographic preparation of silk screens (a kind of printing surface, mainly used for poster printing, packaging printing, textile printing, etc.) (1). In photoserigraphy printing the dichromated colloids (e.g., chromo gelatin, or chromo polyvinyl alcohol, etc.) have commonly been used for sensitizing the silk screen fabric (the gauze) to light, to make it ready for the light printing of the design (the drawing to be reproduced) (2).

Usually all these dichromated colloids are nearly colorless (figures 1 & 2), and their films become insoluble in water upon sufficient exposure to actinic light (ultraviolet and blue waves) (3).

Sometimes the spectral dyes (like methylene blue) used for extending the sensitivity of these chromo colloidal films to green and red waves (4), these films also remedied by spectral dyes still colourless in most cases.

In recent years, there are ready-made containers of coloured photopolymer emulsions suitable for preparing the silk screens, these containers manufactured in specialized factories and under complex techniques (like the direct

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photostencil emulsion -- Serise + B Sc - G10 -- produced by Sericol Group Co., England, figure 3). But on the other hand the chromo emulsions directly prepared inside the printing workshops are still uncoloured.

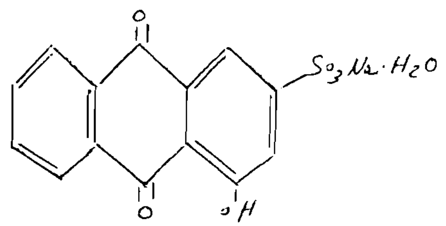
In this research study a method is presented for using alizarin reds to colour dichromated polyvinyl alcohol emulsion before usint it as photographic recording medium on silk screen surface (mulberry silk, polyamide or polyester, etc.). The aim of this dying process is not to increase the spectrogram of chromo polyvinyl film, but to improve its visibility and resolving power.

Experimental

I. Materials:

The following materials were used for preparing the coloured photocolloidal emulsion:

1- Alizarin reds (monohydrate), (5).



The formula weight of alizarin reds, based on carbon mass (F.W.) is 360?28, and the wave-length - in manometer - of alizarin reds (at which the maximum absorption of a stain or dye was observed, λ mass) is 556 (596) n;m.

2- Polyvinyl alcohol (molecular weight, M.W., is approximately 14000), (6), $\left[-CH_2 - \underset{\displaystyle OH}{\underset{|}{CH}}-\right]_n$

its layers possess a high absorption capacity for crystals of dichromates, and these layers also possess satisfactory swelling power.

3- Ammonium dichromates, (3), $(NH_4)_2 Cr_2 O_7$, all chromates or dichromates soluble in water when added to organic colloid emulsions (like polyvinyl alcohol emulsion), can form photosensitive layers, these layers become insoluble when exposed to actinic light. Most commonly used for sensitizing colloids is ammonium dichromate, the high solubility of ammonium dichromate in water permits high concentrations in the presence of colloids without crystalization taking place when the coating is dried. This may be one reason for the slightly higher sensitivity of solutions sensitized with the ammonium salt.

II. Methods:

The method of preparing the coloured photocolloidal emulsion can be summarized as follows:

1- Boil the determined value of water (1000 c.c.).

2- Add 5 gm of alizarin reds to the boiled water.

3- Continue the boiling with uniform stirring to obtain a complete solution of alizarin reds in water.

4- Add 50 gm of polyvinyl alcohol (powder) to the boiled coloured solution, and continue both boiling and stirring operations to make a honogeneous gel emulsion.

5- Add 12.5 gm of ammonium dichromate to the warm emulsion with a good stirring to make a uniform solution of dichromate throughout the coloured polymer emulsion.

6- Filter the coloured photocolloidal emulsion, and now it is ready for application.

Each sample tested in this research study consisted of a thin layer of coloured photocolloidal emulsion coated onto a completely white serigraphic nylon fabric (nylon gauze) using a suitable trough especially made for silk screen coating.

After drying the samples in a suitable drying cabinet, they were exposed to ultra-violet waves (in suitable exposure unit) for photo-hardening purposes.

III. Performance Tests:

Before exposing the investigated samples to ultra-violet waves and also after developing the exposed samples in water, the samples were put through several performance tests in order to confirm the suitability of the dying properties of alizarin reds in dichromated polyvinyl alcohol layers. Of course there was an individual sample for each test.

These performance tests were carried out through this research study as follows:

1- Absorption test: This kind of performance test was carried out on the unexposed sample, its aim is to measure the amount of light absorption through the coloured photocolloidal layer. A suitable spectrophotometer was used for these kinds of measurements (like Shimadzu double beam spectrophotometer, U.V. 200, 202 - 32368/Kyoto, Japan).

2- Colour fastness tests: These performance tests were carried out to measure the fastness of the dye against (a) washing in caustic soda solution (sodium hydroxide, Na OH), of different concentrations (2% or 5%) and a subsequent rinsing in acetic acid CH_3 COOH (solution 10%); (b) immersion in acetone CH_3CO. CH_3 or toluene $C_6H_5.CH_3$ (organic solvents).

The colour intensity of each sample was measured both before washing (or immersing) and after to establish the amount of loss in colour intensity caused by washing or immersing. The Shimadzu spectrophotometer was also used for these colour fastness measurements.

Results and Discussion

1- Our preliminary experiments showed that there are fundamental conditions that must be found in the dye used for colouring the photocolloidal emulsions:

(a) The dye must be a water-based type (i.e., water soluble dye) to be soluble completely through the photocolloidal emulsion, subsequently a uniform colour intensity through all parts of this emulsion can be obtained; for example, thioindigo red is not suitable for this kind of colouring processes because it is not soluble in water.

(b) The dye must not affect the rheological properties of the photocolloidal emulsion (e.g., viscosity); for example, the dichromated gelatin emulsion coagulates when coloured by alizarin reds, and it becomes unsuitable for use.

(c) The dye must not affect the photographic and functional properties of both the dichromate and the colloid. For example, the malachite green (Oxalate) causes some problems to the photohardening reactions between dichromate ion and colloid particles.

(d) The dying properties of the dye in the photocolloidal layer must be stable, to a satisfactory degree, against the usual working parameters on the processing flow-chart of the photoserigraphy printing. For example, the dying properties of both aniline blue (figure 4) and titan yellow (Clayton yellow, figure 5) are not stable into the dichromated polyvinyl alcohol; these properties change from one operation to another throughout the production line (processing flow-chart) of photoserigraphy printing.

(e) After removing the coloured colloidal layer from the surface of the gauze (serigraphic fabric), no dying effects must be remarked in this surface.

All these fundamental conditions can be found in alizarin reds to a reasonable degree.

2- The suggested method for colouring the dichromated polyvinyl alcohol emulsion by using alizarin reds is a direct method and does not need any unusual arrangements.

3- A concentration of 0.5 gm of alizarin reds per 100 c.c. of the photocolloidal emulsion is suitable, because the excessive colouring concentration will cause unsuitable dimness in the photocolloidal layer on the gauze, subsequently this layer will not be able to absorb the sufficient amount of actinic waves during the light printing operation. This will result to incomplete solidification in the exposed area of the layer and the preparing operation of the gauze becomes unsuccessful.

4- The colour hue obtained by colouring the photocolloidal emulsion (dichromated polyvinyl alcohol) with alizarine reds makes the layers of this emulsion visible to a satisfactory degree (figures 1, 2, & 6), hence the worker can judge easily the success of light printing and developing processes of these photographic layers. But this gained visibility is not equal to the marked visibility of the ready-made photostencil emulsion (Seriset B Sc - G10), figures 3 & 6.

5- The wavelength, at which the maximum absorption of alizarin reds is 556 (596) nanometers, for that the dying properties of alizarin reds increase the absorption of the actinic light through the coloured photocolloidal layer, subsequently an extra light solidification will be obtained in the exposed parts of this layer; this is a positive result.

6- As shown in figure 7, dyed layers of dichromated polyvinyl alcohol have a good light absorption than the uncoloured layers, especially at wave-length 570-620 mμ, but the absorption of the ready-made photostencil layers (Seriset B. Sc - G10) still much better in all spectral regions of the visible wavelength (400-700 mμ). It is generally agreed that when the light absorption of the photosensitive layer increases the light scattering through this layer decreases, that means the resolving power of the photosensitive layer becomes good and the sharpness quality of the photographic print on this layer increases.

7- After the developing of the exposed coloured photo-colloidal layers with water, it suffers from slight decreasing in the colour hue especially at wavelengths 400-500 and 600-700 mμ (figure 6), this decreasing has insignificant effect because the visibility of the photohardened coloured colloidal layer still sufficient on the white surface of the gauze.

8- Usually after exposure to light and the developing with water of the photocolloidal layer on the gauze, there are two successive steps:

(a) Washing the gauze with an alkaline solution (sodium hydroxide) to clean it from the greasy matters and dirts.

(b) Rinsing the gauze by a weak acid solution (acetic acid) to neutralize the alkaline effects on the gauze.

Therefore one of the performance tests which was carried out through this research study was to investigate the effect of these cleaning operations on the colour intensity of the coloured photohardened colloidal layer. From figures 6 & 8, it is evident that when the concentration of sodium hydroxide solution reaches about 5% a dangerous decreasing in the colour intensity of the coloured layer should happen in all spectral regions of the visible wavelength (400-700 mμ) and the visibility of this layer will nearly disappear. As a practical limit, the concentration of sodium hydroxide solution must not exceed 2%, and the concentration of acetic acid solution is around 10%, then no dangerous decreasing can affect the colour intensity of the coloured layer (see figures 6 & 8).

9- After pulling the prints from the gauze by using an aromatic based ink, there are organic solvents (like acetone or toluene) are commonly used for cleaning this gauze from the traces of this ink. When we investigated the effect of these organic solvents on the colour hue of the coloured photohardened colloidal layer, it was found that:

(a) In the case of acetone, there was slight decreasing in colour intensity, especially at wavelengths 400-550 and 620-700 mu.

(b) In the case of toluene there was slight dimness in all the spectral regions of the visible wave-length (400-700 mμ). However, both acetone and toluene have insignificant effect on the visibility of the coloured photohardened colloidal layer, figure 9.

Summary

From this research study, we can state that the colouring operation of dichromated polyvinyl alcohol emulsion by using alizarin reds improves.

1. The visibiliey of the layers of this photographic emulsion on the white surface of the gauze (like the white nylon gauze).

2. The resolving power of these photographic layers: These two positive results increase the success probabilities in the photographic preparation of the gauzes (the photoserigraphy). The resulted spectrograms show that the dying properties of alizarin reds in dichromated polyvinyl alcohol are stable to a satisfactory degree against the common working parameters on the processing flowchart of photoserigraphy process. Also, we can state that this colouring operation is fast and not expensive.

References

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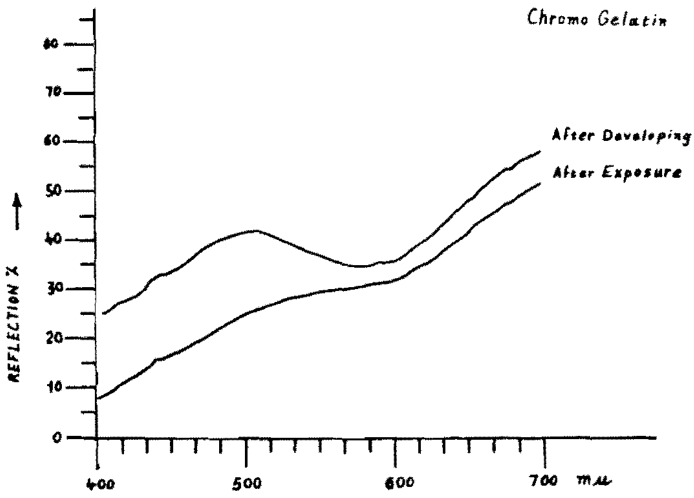


FIG. 1

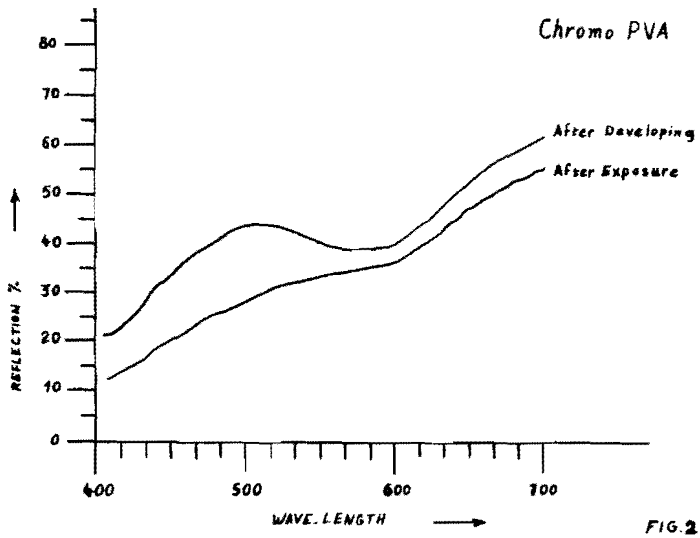


FIG. 2

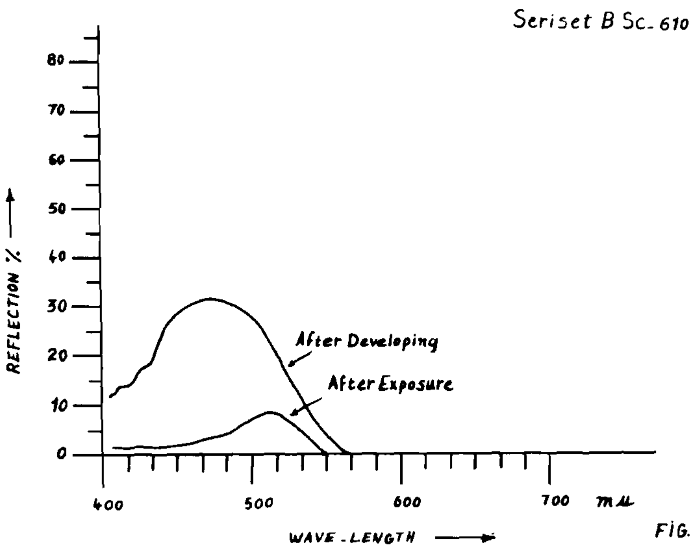

Seriset B Sc-610
REFLECTION %
80
70
60
50
40
30
20
10
0
After Developing
After Exposure
400
500
600
700
mμ
WAVE-LENGTH

FIG. 3

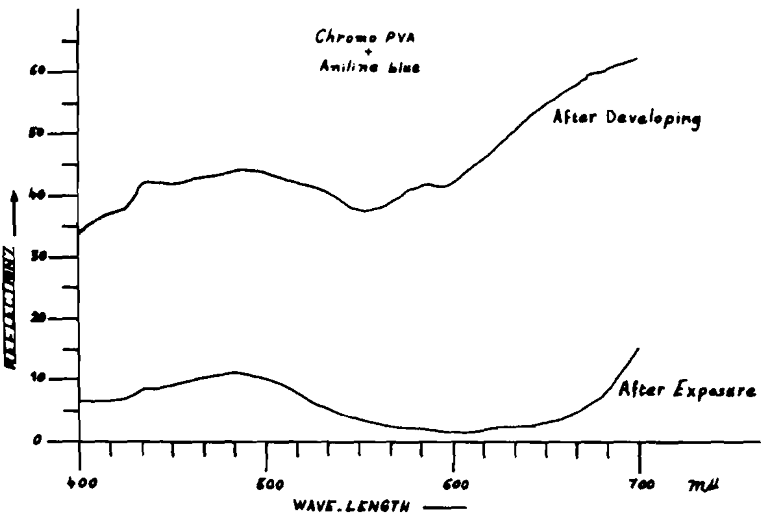

Chromo PVA
+
Aniline blue
60
50
40
30
20
10
0
After Developing
After Exposure
400
500
600
700
mμ
WAVE-LENGTH

FIG. 4

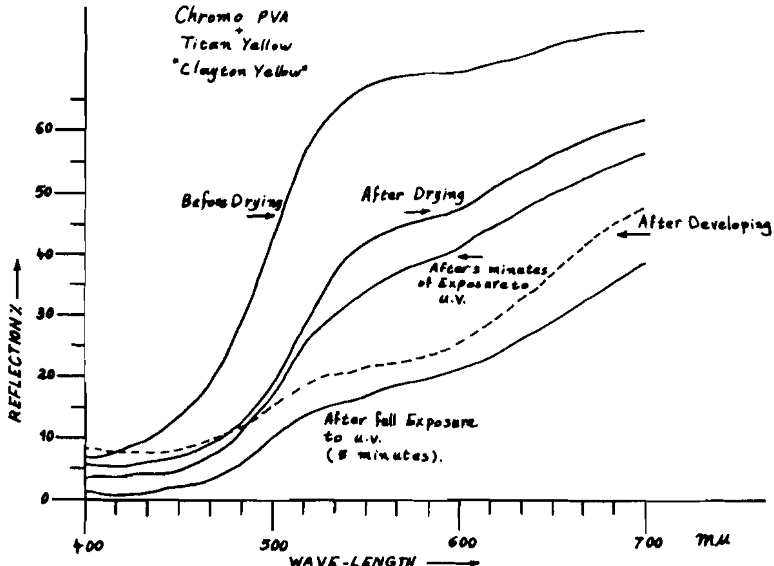

Chromo PVA
+
Titan Yellow
"Clayton Yellow"
Before Drying
After Drying
After Developing
After 3 minutes of Exposure to u.v.
After full Exposure to u.v. (8 minutes).
REFLECTION %
WAVE-LENGTH
mμ

FIG. 5

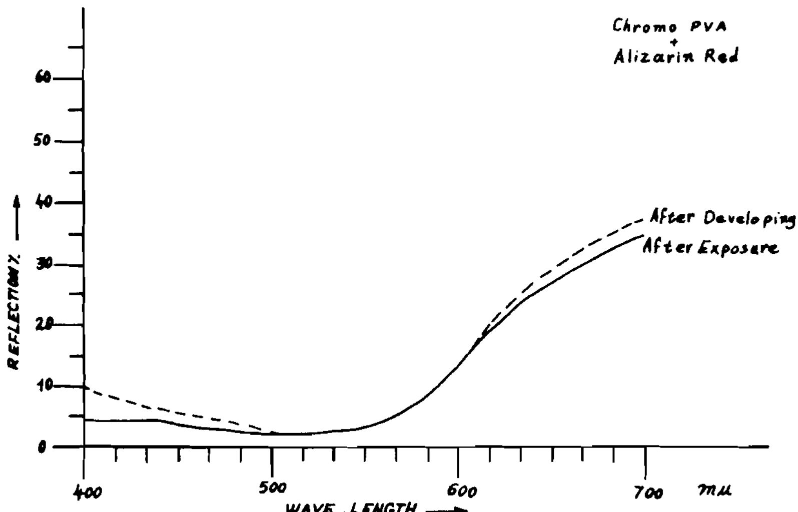

Chromo PVA
+
Alizarin Red
After Developing
After Exposure
REFLECTION %
WAVE-LENGTH
mμ

FIG.6

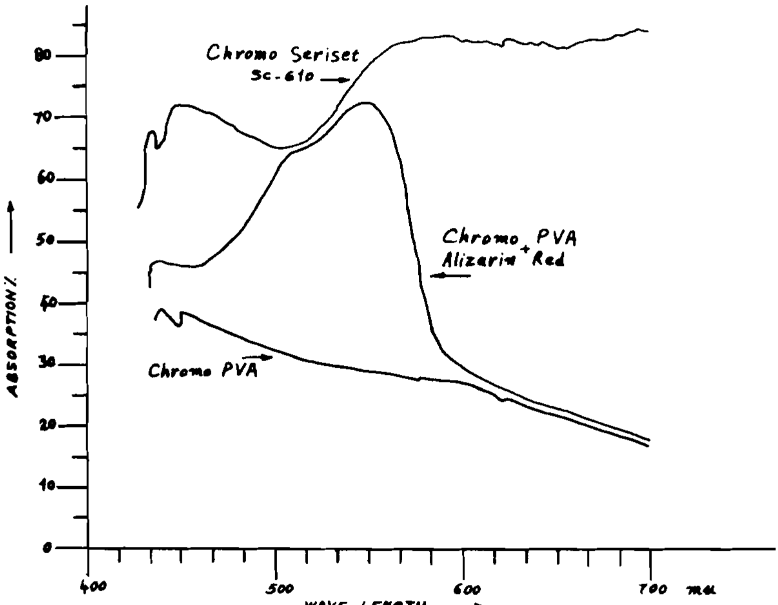

Chrome Seriset
Sc-610
Chromo PVA + Alizarin Red
Chromo PVA
ABSORPTION%
WAVE_LENGTH
mu

FIG.7

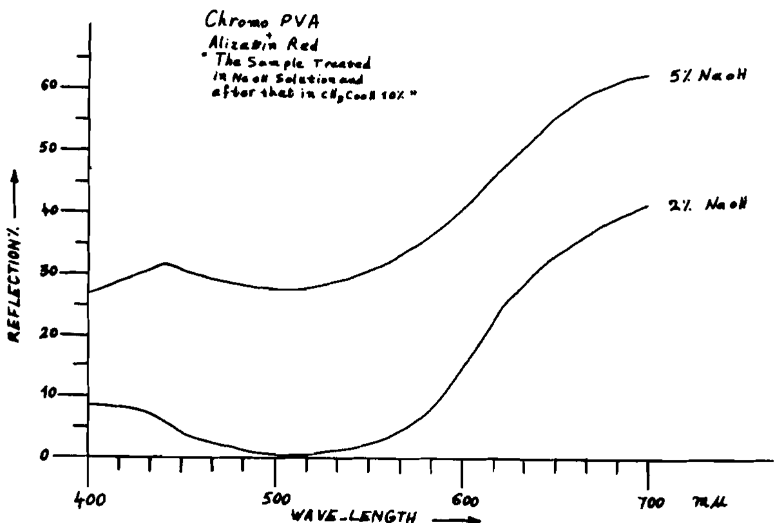
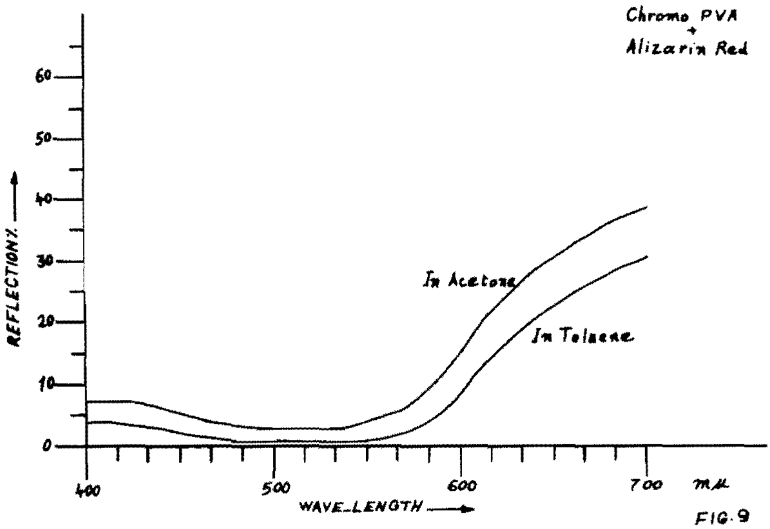

Chromo PVA + Alizarin Red
"The Sample Treated in NaOH Solution and after that in CH_3COOH 10%"
5% NaOH
2% NaOH
REFLECTION%
WAVE_LENGTH
mμ

FIG.8



Chromo PVA
+
Alizarin Red
60
50
40
30
20
10
0
REFLECTION%
In Acetone
In Toluene
400
500
600
700
mμ
WAVE LENGTH

FIG. 9