Effects of Binder and Thickeners of Pigment Printing Paste on fastness properties of printed fabric

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Abstract: In this study crocking fastness of pigment printed fabric was improved by the application of synthetic pigment printing thickener EM-PTE (Anionic acrylic polymer).Moreover different percentage of binder with different viscosity of printing paste was taken into consideration. In addition to effect of curing time on K/S, impact of thickeners viscosity on wicking, effects of thickeners viscosity and binder concentration on crocking fastness was investigated. Through analysis K/S values of printed fabric were decreased with increasingcuring time of pigment printing. Moreover thickener viscosity (2%) gave good crocking effect on pigment printed fabric .Furthermore binder concentration of 15% showed optimum results of crocking fastness on pigment printed fabric.

Keywords: Binder, Thickener, Anionic acrylic polymer, Viscosity, Crocking fastness.

Introduction

Printing of textile materials is probably best described as an industrial art, having a long history and an assured future. Textile printing is the most versatile and important of the methods used for introducing color and design to textile fabrics. Considered analytically it is a process of bringing together a design idea, one or more colorants, and a textile substrate (usually a fabric), using a technique for applying the colorants with some precision. Several techniques have been used and the colorants available have multiplied[1]. There are of course limitations to balance against the substantial advantages of pigment printing. The printer should be fully aware of these, since the use of pigments in applications where dyes are required can bring about a negative attitude to pigments, even in suitable applications [2].In pigment printing, insoluble pigments, which have no affinity for fibers, are fixed on to the fibers with binding agents or binders [3].In textile printing, dyes or pigment are transferred to textile fabric by printing pastes. The rheological properties of pastes are principally determined by thickeners. Success of a printing process is established by the sharpness of mark, levelness, correct color, good hand and high fastness, which are directly influenced by the rheology of the thickener. Three factors are responsible for the flow properties of print pastes: viscosity, fluidity and viscoelasticity. Viscosity is defined as a constant coefficient of frictional resistance to flow for every liquid having a simple structure[1, 4-7].High viscosity of print pastes are usually required to give level printing effects, with sharp outlines and even penetration of the print. These effects are to a large extent; depend on the thickeners used in the paste. It is often assumed that the main factors in influencing the quality of print are the viscosity and rheology of the paste, as modified by the thickener[8-10].It is commonly assume that the increased viscosity of the paste, resulting from the addition of thickeners, provides the main mechanism for preventing the phenomenon of “haloing” the transverse wicking of dyes across the edges of a printed pattern. A related line of reasoning is that thickeners which recover their viscosities most rapidly after the removal of high shear (which they are subjected to during printing) will be most effective in resist wicking[9, 10].Binders are the mechanism used to keep the color on the fabric when using pigments for printing textiles. The choice of binders will always depend upon the final fastness requirements as well as the cost requirements of the process. Choosing a binder for pigment coloration is a complex but critical step in developing a recipe which will meet very specific requirements. The place to start to determine which final fabric properties are important as various end user applications may require a different polymer to achieve the desired results[11]. Almost all the binders used in textile pigment printing are the addition polymerization products. They are actually polymer type; the structure may be represented as **Figure 1**[12].

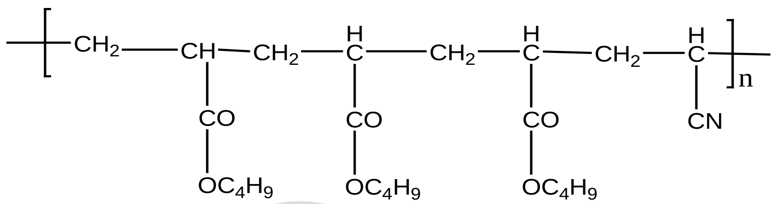

Figure 1: General structure of Acrylate copolymer

The binder is a film forming substance made up of long chain macromolecules, which when applied to the textile together with the pigment , produce a three dimensionally network. The links are formed during some suitable fixing process, which usually consists of dry heat and change in pH value, bringing about either self cross linking or reaction with other suitable cross linking agent [13].While the prints are being dried, a film is formed from the dispersed binder. Its formation take place in two stages: flocculation (or coagulation) and coalescence. During the first stage of film formation, water and surfactants are removed from the binder by absorption and evaporation. The dispersed solids coagulate to form a gel like layer of very tightly packed balls, which only have poor solidity and adhesive properties. During the second phase of drying, the gel particles flow together to form a continuous film. The lowest temperature at which a film can be formed depends upon chemical constitution, but for pigment printing it is usually around 5C. The speed at which the film is formed depends upon the range of particle size [1]. The reaction between the binders and the cellulosic substrate may be representing as follows in**equation(1)**

$$\text{Binder-CH}_2\text{-OR + HO-Cellulose} \leftrightarrow \text{Binder-CH}_2\text{-O-Cellulose + ROH} \quad (1)$$

Where, R is CH_3 or H.

The difference between dyeing processes and pigmentation is that the pigment colored textiles requires a curing procedure. Since pigments do not have an affinity to textiles, pigment fixation on textiles relies on binders that require a curing process to hold the pigment on a textiles. Conventional curing is a thermal process where pigment colored textiles must be dried and then cured with heat to convert the soft organic base (monomer and/or oligomers) to a tough polymer [14].

The aim of this paper is to investigate the possibility of using same pigment printing paste with different fabric as well as their fastness properties. Thickeners viscosity that affects the sharpness of pigment printed fabric design i.e wicking properties of printing paste. Also there is a binder percentage variation that affects the crocking fastness (dry and wet) properties of pigment printed fabrics and curing time variation which slightly affects the K/S values.

Materials and methods

Materials

An optical brightener free, 100% cotton knitted fabric of 110 GSM, 100% Nylon (polyamide) knitted fabric of 150 GSM and 100% polyester woven polyester fabric of 80 GSM supplied by a private sector was used for pigment printing.

Chemical & colorants

Commercial Pigment Red- 8111, Pigment Blue -8301T, Synthetic pigment printing thickener EM-PTE (Anionic acrylic polymer) and Pigment printing Binder EM-893A was supplied by Foshan SanshuiDatang Resin Co. Ltd. Foshan,Guangdong, China.

Equipment

Hand screen printing. Curing machine (HUIBAO). High speed stirring machine (JB300-D)Brookfield viscometer (NDJ-5S).Spectrophotometer (data color 650).

Method

Printing paste preparation

The Pigment printing pastes were prepared according to the following recipe which was presented in **Table 1**and **Table 2**

Auxiliaries	Range of viscosity	Range of viscosity	Range of viscosity
	21000mpa.s	30000mpa.s	42000mpa.s
Thickener (%)	1	2	3
Binder (%)	15	15	15
Liquor ammonia (ml/L)	2	2	2
Color(g)	10	10	10
Distilled water(g)	156	155	154
Total(g)	200	200	200

Table 1 : Recipe with thickener percentage variations

Auxiliaries	Range of viscosity	Range of viscosity	Range of viscosity

	31000mpa.s	32000mpa.s	32000mpa.s
Thickener (%)	2	2	2
Binder (%)	10	15	20
Liquor ammonia (ml/L)	2	2	2
Color(g)	10	10	10
Distilled water(g)	156	155	154
Total(g)	200	200	200

Table 2: Recipe with Binder percentage variations

Printing method

All pigment printing auxiliaries and colors were mixing with motorized high speed stirrer. After preparation of printing paste were applied onto fabric by using laboratory hand screen printing technique. The printed fabric dried at 110°C for 3 minutes and cured at 150°C for 5 minutes.

Analysis of colorfastness to Dry & wet rubbing

Color fastness to dry and wet rubbing of pigment printed fabric was done according to AATCC 116-1995 method.

Determination of K/S of pigment printed fabric

The relative color strength (K/S)of the pigment printed fabric was determined by spectrophotometer (data color 650).

Results & Discussion

Effects of thickeners viscosity on wicking in textile printing

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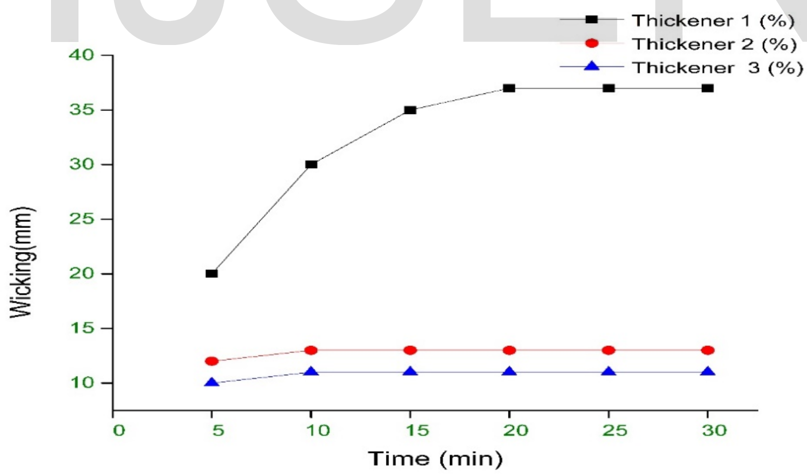

Figure 2: Wicking behavior of printed fabric with time change at various thickener concentrations.

In textile printing, high viscosity print pastes were usually required to give level printing effects, with sharp outlines and even penetration of the print. All the thickeners concentration wicking occurred with time but after passing critical level its reached into equilibrium condition .Furthermore 3% thickener concentrations showed best result in printed fabric .Typical wicking curve was shown in Figure 2 for various concentration of thickener

Effects of thickeners viscosity on crocking fastness

There was an effect of printing paste thickeners viscosity on wet and dry crocking fastness properties of printed fabric. It was observed from Table 3 that the wet and dry crocking fastness half grade varies with the increase of thickener viscosity into pigment paste. Moreover 2% thickeners print paste gave good crocking fastness on printed fabric.

Sample	Fabric type	% of Thickener	Crocking fastness	
			Dry	Wet
01	**100% CTN Knitted fabric**	1	4-5	4
		2	4-5	3-4
		3	4	3
02	**100% Nylon Knitted fabric**	1	4-5	3-4
		2	4-5	4
		3	4	3-4
03	**100% PES woven fabric**	1	4	3-4
		2	4	4
		3	3-4	3

Table 3: Colorfastness to crocking (AATCC-08) at different thickener concentration.

Effects of binder concentration on crocking fastness

Through analysis it was seen from **Table 4** that when binder concentration increased that increased the wet and dry crocking fastness .Moreover at a binder concentration of 15% showed optimum results of crocking i.e. both wet and dry rubbing fastness. For the consequence it did not make printed fabric hand feel harder.

Sample	Fabric type	% of Binder	Crocking fastness	
			Dry	Wet
01	**100% CTN Knitted fabric**	10	4	3-4
		15	4-5	4
		20	4-5	4
02	**100% Nylon Knitted fabric**	10	4	3-4
		15	4-5	4
		20	4-5	4
03	**100% PES woven fabric**	10	3-4	3
		15	4	3
		20	4	3

Table 4: Colorfastness to crocking (AATCC-08) at different binder concentration.

Effects of Curing Time on K/S Values

According to Figure 3 it was obvious that the K/S values decreased with increased in curing time of the printed fabric treated with binder and thickener. The maximum K/S values, 13.86 had been recorded after

2 minutes of curing time. The curing time slightly affected K/S values, the binder which enclosed the pigment molecules, formed a film under curing conditions. The improved adhesion of the film to the substrate could be achieved by cross linking. The reaction should be activated in dry hot air.

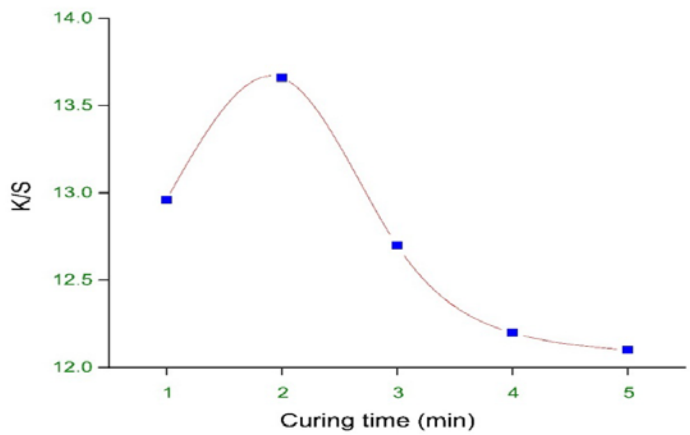

Figure 3: Effect of curing time on K/S Value.

Conclusion

Thickener concentration 2% gave good result with printed design sharpening and crocking fastness. The maximum K/S values of printed fabric color founded after 2 min curing at a binder concentration 15%. Moreover at 15% binder concentration showed optimum results of crocking i.e both for wet and dry rubbing. However when the curing time increased the value of K/S slightly decreased.

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References

1. Miles, L.W.C., *Textile Printing,2nd edition.* Society of Dyers and Colourists,West Yorkshire, 1994: p. 240-274.
2. Poehlmann, A., *Pigment Printing System.* Textile Industries Dyegist, 1992. **11**(10): p. 4-9.
3. Christie, R.M., *The Chemistry of Color Application".* Blackwell Science, England, , 2000.
4. Guion, T.H. and J.R. Hood, Textile research journal, 1985. **55**(8): p. 498-507.
5. Guion, T.H., Textile Chemists and Colorists, April 1984. **16**(4): p. 79-84.

6. Laba.D, *heological Properties for Cosmetics and Toiletries*, . Marcel DekkerInc., New York, N.Y, 1993: p. 9-33.
7. Caulson, J.M. and J.F. Richardson, *Chemical Engineering.* Pergamon press, Oxford,, 1975. **3**: p. 405-425.
8. Cooney, J.A., Textile Chemists and Colorists, January 1970. **2**(1): p. 17.
9. Barnhardt, G., in *AATCC National Technical Conference*. 1978. p. 209.
10. Cooney, J.A., Textile Chemists and Colorists, October 1974. **6**(10): p. 9.
11. G. Hammonds, *Pigment printing Handbook.* American Association od Textile Chemists and Colorists, Research Triangle Park, N.C, 1995.
12. Shenai, V.A., *Technology of Textile Printing*. 2nd ed. 1990: Sevak Publisher,Mumbai.
13. Iqbal, M., *Effect of Cross Linking in Textile Pigment Printing and Enhancement of Fastness Properties*,. ournal of Chemical Society of Pakistan, 2009. **31**(1): p. 145-150.
14. S, L., B. H, and N. Stewart, AATCC Rev, 2004. **4**(8): p. 44-9.