

Influence of Binders and Thickeners of Pigment Printing paste on Light Fastness and Crocking Fastness of the Fabric

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Abstract: *It has been widely reported that the crocking fastness properties of pigment printed fabric is less than the crocking fastness of the reactive printed cloth, because of insolubility of pigments. However, the crocking fastness can be improved by selecting the appropriate Binder. There were twenty seven samples printed in this research. Nine samples were printed with Binder F, Nine samples were printed with Binder F.T and nine samples were printed with Binder 77. There were three different viscosities and three shades taken. The light fastness test and crocking fastness test of all samples had been performed according to ISO standard. The light fastness of the fabric printed with Binder F is best than the others and the rubbing fastness of fabric printed with Binder F.T is excellent.*

Keywords: Binder, Thickener, Light Fastness, Crock Fastness, Insolubility, Synthetic Thickening Ag.

1. Introduction

1.1 Back ground of the study

The beginning of art of decorating fabric by the stamping or printing is found from the earliest periods. The art is assumed to have originated in the Far East where the ancients were known to have practiced hand printing with wood blocks from the earliest times. They were known to have printed cloth as early as 500 B.C.

Ancients of Egypt and Moen Jo Daro (Sindh) were also acquainted with some form of textile printing. They produced linen cloths of fine construction. Their looms were nothing more than rectangular frames attached to four poles, which were driven into the ground. [1]

On the other hand the main objective in textile printing is the production of attractive designs with well-defined boundaries made by the artistic arrangement of motif (design) in one or more colors. In other words, dyes and pigments are applied locally or discontinuously to produce the various designs. In fact, printing is described as **localized dyeing**. The force, which operates between the dye and the fiber, is the same in dyeing and printing [2].

Textile printing is the branch of the textile wet processing industry & is becoming increasingly popular for all fibers & varieties of fabrics as well as garments. Basically, printing is a form of dyeing in which the colors are applied to specified areas instead of the entire fabric. The resulting multi-colored patterns have attractive and artistic effects which enhance the value of the fabrics much more than the plain dyed ones. This enhancement of quality and value does not come easily and cheaply and the modern print houses require high capital investment and specialized skills of a

large number of technologists and skilled workers as well as designers. The printing mills normally have their own pre-treatment and dyeing units besides the printing machines, thermal systems for dye fixation, screen making equipment and the usual finishing machines [3].

To restrict the coloring matter to the design area, it is pasted with a thickening agent which may be a natural or synthetic polymer. These polymeric products include such diverse products as starches, plant gums, seaweed Alginate, oil in water Emulsions, poly acrylics etc. After printing, the fabric is dried & then the color is fixed by a short heat. During steaming, the print absorbs water & under the influence of heat & moisture, the dye molecules penetrate the printed portion of the fabric & are also fixed. As the moisture content of the paste is low, a liquor ratio of about 1: 1, the printing paste usually contains a dye dissolving assistant along with the other reagents required for applying a particular dyer. After steaming, the printed goods are washed to remove the thickener & other chemicals & finished in the normal way. The pigments again are an exception because modern binders & thickeners are sufficiently soft to avoid the expensive washing and drying processes [10].

1.2 Pigment Printing Paste

Printing paste is the main constituent of printing which enables the formation of the predefined patterns. Printing paste contains Pigments, Thickeners, Binders, and Auxiliaries. It is therefore necessary to give individual consideration to each of the printing paste constituents. All the above constituents are not used simultaneously in any pigment printing paste depending on the class of pigment used and style of printing employed, suitable component are selected in making in printing paste [10].

1.2.1. Pigments

Pigments are substance in particular forms. They are essentially, insoluble in the media into which they are incorporated, and are mechanically dispersing there in order to modify the color and light scattering properties of such media. Ancient chimes were used pigments for coloring textile by the block pigment printing method. Cotton prints made some of the pigments in the 18th century [3] and used them in pigment printing it meet with limited with success due to

1) In adequacy of the binder as a fixing agent for pigment on the fabric.

2) Relatively poor pigment dispersion available at that time. They were also limited in the range of the colors, light fastness and fastness to alkali treatment. In the 1930s emulsion co-polymerization of olefin substances was discovered at the former IG Farben. These were integral steps in the development of the modern pigment printing. Another important step was the introduction of emulsion as printing paste thickener [2].

Different binders were also developed for the purpose, resulting finally in the use of water- in-oil, and oil-in-water emulsions. This greatly accelerated the use of pigments in textile printing and then pigments have become major coloring matters used in printings. Pigments suitable for pigment printing should have certain properties. For example, the shades produced should exhibits good fastness to light, crocking, washing, gas fading chlorine, Alkalis, perspiration and solvents.

1.2.1.1. Types of pigments

The range of the pigments may be conventionally divided into five sub groups on the basis of preparation for use [2].

a) Organic Pigments: Approximately 60% concentrated non-ionic colorants of various chemical classes. Including 40% mono-azo and di-azo compounds (yellow, orange, brown red sectors) and 10, anthraquinone (mostly red-violet-blue).

b) Inorganic Pigments: Approximately 20% Colored insoluble materials also from inorganic sources; they include colored metal salts such as C.I. pigment yellow 34, complex salts such as C.I pigments blue27, metal oxides such as C.I pigments whites 6 and elemental carbon such as C.I pigments black 6.

c) Metal Toners: Approximately 15% concentrated anionic mono azo dyes (mainly yellow, oranges and especially reds) precipitated as there insoluble metal salts, typically those are barrium, aluminum, calcium.

d) Pigment Lakes: Approximately 5% insoluble metal salts of acids or mordant dyes ,basic dyes rendered by completing with copper, hexaacryanoferrate, phosphomolybdic acid or phosphotungstic acid, precipitated in the presence of an inert substrate such as alumina, the latter being a necessary and integral component of the product.

e) Extended Pigments: concentrated pigments are toner diluted with an extender such as alumina or calcium carbonate, which does not form an integral component of the product. Metal toners and pigments are the somewhat unstable under alkaline conditions owing to partial dis-association of the precipitated complex. Lakes and extended pigments are usually pictorially weaker than concentrated pigments or toner because of the person of the substrate

components. These limitations tend to restrict the versatility of the lesser sub groups especially lakes, which have steadily, decline in importance [2].

Most of the pigments used in textile printing are synthetic organic materials, except carbon black, titanium dioxide of the rutile and anatase types (for white pigments) copper and aluminum alloys (for metallic bronze pigments), and sometimes iron oxide (for browns) and titanium dioxide coated glimmer (for pearl luster pigments). When choosing synthetic pigments, the price, the fastness properties, the brilliance and the coloring power of the many products available are all taken into consideration. [3]

Among the organic pigments in use, the following are important:

- azo pigments (yellows, oranges, reds)
- Naphthalene, perylenetetracarboxylic acid;
- Anthraquinone, dioxazine and quinacridone pigments (very fast and brilliant oranges, reds and violets).
- Halogenated copper phthalocyanine derivatives (blues and greens) [2].

1.2.2. Thickeners

Thickeners used in textile printing are high molecular weight compounds giving viscous pastes in water. These impart stickiness and plasticity to the printing paste so that it can be applied to a fabric surface without spreading and be capable of maintaining the design outlines even under high pressure. Their main function is to hold or adhere the dye particles in the desired place on the fabric until the transfer of the dye into the fabric and its fixation are complete. As the printing paste is printed either by roller or screen by the squeegee pressure, the viscosity of the printing past should be sufficiently high to prevent rapid diffusion or flushing of the color through the fabric, which would result in poor print definition or mark. Further, the thickener should give a stable paste viscosity, which would allow an even and measured flow through the screen. If the viscosity changes during the run, the shade (depth) changes in the printed cloth. The viscosity stability must not only be durable in terms of the time during which the printed cloth is on the machine, but it must also hold during storage times in terms of week / months. [2][6]

1.2.2.1. Classification of Thickeners

Thickeners may be classified as natural or synthetic

i) Natural Thickening agents

Thickening agents produced from vegetable raw materials. Owing to differences in growing conditions, variation in their composition is unavoidable. For textile printing, the thickening agents must be soluble in water. For this reason, the water insoluble raw material is either etherified or esterifies to produce water soluble derivative [4].

- a) Bean gum ethers
- b) Sodium alginates
- c) Starch ethers
- d) Cellulose ethers
- e) Crystal gum

ii) Synthetic Thickening Agents

Synthetic thickening agents are molecular substances, generally co-polymers of unsaturated organic acids, such as acrylic and malic acids. They swell very considerably in water. Owing to their technical and economic advantages. These highly efficient products are becoming more important in textile printing and they have already become indispensable in solvent free pigment printing.

More recently, synthetic thickening agents have also begun to be used in polyester printing. Mainly with disperse dyes they have a low electrolyte finish.

Synthetic thickening agents have the following properties;

- 1) High degree of purity
- 2) Rapid preparation of the stock thickening
- 3) Simple printing recipe
- 4) Good running properties
- 5) Optimum depth of shade and brilliance of the prints
- 6) Excellent stability of the print paste

iii) Emulsion Thickening

The emulsion is used to describe a distribution of two immiscible liquids within one another. One liquid (the inner phase) is suspended in the form very fine droplets in the other liquid (the outer phase). Essentially these are dispersions of inner hydro carbon oil (white spirit, mineral sprits) in a continuous phase oil-in-water (o/w) emulsion, or dispersion of an aqueous phase in hydro carbon oil-in-water (w/o) emulsion. A stable emulsion is formed in the persons of an emulsifying agent. The viscosity the emulsion is determined with prescribed limits by the relative volume of the inner and outer phases. The o/w emulsion can be thinned by the addition of water and thickened by addition white sprit. Conversely, w/o emulsions are thickened with water and thinned with white sprit. The role of emulsion thickenings is to wet the surface of the textile material very rapidly. They have good running properties, short dyeing times and because of their low solid content a readily washed out [6]

1.2.2.2. The essential qualities of a thickener

1) Stability to keeping (physico - chemical stability) should be good. Aqueous dispersions / pastes of high molecular weight thickeners (carbohydrates) may undergo fractional crystallization on standing, upsetting the flow property and concentration of the dye in the printing paste, leading to the interference with the regular distribution of the dye [7].

2) It should have certain physical and chemical properties such as viscosity, flow property, ability to wet and adhere to the internal surface of etchings of the engraved roller. The flow property must be such that the print paste should remain in the engravings for a short time. It should not adhere to these engravings too fast so as not to allow transfer of the paste to the fabric [2].

3) It must be compatible with the other ingredients of the printing paste, e.g. Compounds such as oxidizing and reducing agents, electrolytes, dispersing and wetting agents, solvents, hygroscopic substances, acids and alkalis and dyes and pigments [2].

4) The thickener film should dry properly on the fabric to prevent spreading of the color by capillary action beyond the boundaries of the design (to ensure print sharpness). [7]

5) Proper extraction of water from steam during steaming should be ensured to provide free space for the dye molecules to move towards the fabric and free water to carry it.

6) The thickener should not have affinity for the dye and should not keep the dye from the fabric.

7) The thickener molecule should have a control over the free water pick-up and not carry the dye beyond the boundaries of the impression (flushing).

1.2.2.3. Viscosity

Viscosity may be defined in two ways

(a) Viscosity is the ratio of shearing stress to the rate of shearing, or

(b) Viscosity is the measure of the resistance of a liquid to flow:

$$\text{Viscosity} = \text{Shear Stress} / \text{Shear rate}$$

Shear stress is the resistance of the liquid to flow under the influence of an applied force:

$$\text{Shear stress} = \text{Force} / \text{Area Sheared}$$

$$\text{Shear rate} = \text{Velocity} / \text{Clearance}$$

When a liquid is sheared assuming laminar flow, the layers of the liquid move at different rates. The relative rate of motion of the layers is only one factor in the rate of shear. The other is the distance between the shearing planes.

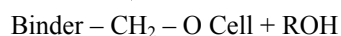
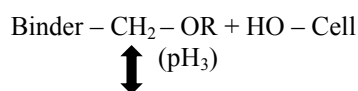
1.2.3. Binders and Fixers

Binders and fixers play important roles in pigment printing achieving optimum fastness properties. During the earlier stages of the development of binders for use in pigment printing polyvinyl acetate was considered a good binder. However, it was realized that it produced too stiff a handle. On other hand acrylate resins gave soft effects but pigments bound with them were not fast to rubbing [4]. Binders are high molecular weight film forming agents produced by the polymerization of simple intermediates initially present in the paste in a homogeneous, dissolved or dispersed state. After evaporation of the solvent or other liquid vehicle, heating produces a thin coherent coating or film. The film, several microns in thickness encloses the pigment particles and adheres to the fiber. The rubbing, washing and dry - cleaning fastness of a pigment print are, the incorporation of reactive groups in the macromolecule enables linking to occur within the binder after film formation by a simple heat treatment thereby improving its resistance to chemical and physical agencies. The important monomers used in modern binders are [4]:

- (1) Derivatives of acrylic acid, especially its esters.
- (2) Butadiene and
- (3) Vinyl acetate

Urea - formaldehyde, melamine formaldehyde and other similar products are significant as raw materials for the manufacture of formaldehyde condensates suitable as fixes. The water -insoluble high molecular weight substance is present as 0.1 to 0.5 droplets dispersed in water.

The reaction between the binder and the fiber may be represented as follows:



Where R is CH₃ or H

It is seen that reaction is catalyzed under acidic conditions & that it is reversible reaction. Since methanol or water is a product of the forward reaction, leading to the fixation of the binder onto the fiber, this reaction is favored by the removal of methanol or water. Curing with fresh air at high temperature effectively removes this product and ensures fiber - binder bond formation. Acrylate copolymers have high binding power and are marked by ease of manipulation and are used in almost all pigment printing operations. The binder must have certain qualities. For example, it should not get coagulated due to shear forces operating during printing. If coagulation takes place clogging of the screen and blocking of the engravings of the printing rollers take place during the actual printing. The binder film must be clear, of even thickness, smooth, and neither too hard not soft. It should be elastic in nature, should have good adhesion to the substrate without being tacky. It should have good resistance to chemical and mechanical stresses and should be readily removable from the engravings of the printing rollers, screens, back grays and blankets. Among these properties, one can be improved at the cost of others.

1.2.3.1 Cross - Linking

Cross - linking increases the rubbing, washing and dry - cleaning fastness properties, but it detrimentally affects the handle of the final print. When a binder molecule has no self - cross - linking groups, an additional cross - linking agent such as urea - formaldehyde or melamine - formaldehyde condensates, methylated urethane compounds etc., having at least two reactive groups per molecule is incorporated in the binder system. These are used in small quantities even when the binder has self - cross-linking groups, since they help in cross - linking and improve the fastness properties. This reaction (cross-linking) require high temperature and acid catalysis, Ammonium phosphate is the most widely used catalyst in pigment printing. When used in correct quantities, it produces pH3 in the fabric and brings about the cross - linking reaction. The catalyst is generally used in concentration of 0.5% and 0.8% in screen printing and in roller printing respectively. [4]

1.2.4. Catalysts in pigment printing

Catalysts promote the crosslinking reaction, leading to the fixation of the binder to fabric. These catalysts are acid - liberating compounds, which, under suitable conditions of temperature, lower pH to the require value initiate the crosslinking reactions. Ammonium salts (sulphatic, chloride, nitrate, phosphate) are used successfully. These require high temperatures for fixation (140oC to 150°C for 5-4 min). Some of the strongly acidic catalysts, like ammonium chloride, affect the print paste stability, in that the

crosslinking of the binder molecules starts taking place in the print paste itself leaving in sufficient amount of reactive groups in the binder for the subsequent reaction with the fiber substance during curing. This results in inferior rubbing fastness of the prints due to incomplete fixation of the binder on the fabric.

The use of sulphatic acid and its ammonium salt as catalysts for pigment prints has been suggested. These catalysts have been found suitable for low temperature cure catalysts at low pH values. When neutralized with ammonia to a pH level of 8 to 8.5, they need a higher temperature of 140°C to 145°C and they need 2 min of curing of pigment prints as compared with 4 min for di ammonium phosphate. This substantial reduction in the time of cure shows an approximate 30 to 35% saving in the operation cost. Storage stability of print pastes using the new catalysts found quite good. Tensile strength of printed fabrics both initially and after 3 months of storage shows that no degradation of the fabric took place when the new catalysts are used. For this study both sulphamic acid and ammonium sulphamate as such and after neutralization with liquor ammonia were used as catalysts along with 10%binder and 4% pigment emulsion (A cramin Blue FFG Ex Concentration) in the printing paste. After printing, drying (100°C, 1 min) curing was done for 2 min at 110, 125 & 150°C. Fastness to wet scrubbing & to soap- soda boil was determined. It was found that for low temperature curing (110° & 125°C), the pH of the printing paste has to be low (1.3) to get a satisfactory fastness to wet scrubbing. At the higher temperature of curing (150°C), satisfactory results are obtained at higher pH values of 4 and above. At pH 8 a rating of 3 is obtained in this test at 10g/kg catalyst. Increasing the catalyst concentration to 20g/kg neither improves the fastness nor does it deteriorate. When 40g/kg catalyst was used, there was a fall in the fastness to wet scrubbing.

1.3 Rheological behavior of printing paste

The water soluble pastes may be divided into four groups, depending on their viscosity response to an applied force in an aqueous media - [4]

- i) Newtonian flow
- ii) Dilatent flow
- iii) Thixotropic flow
- iv) Pseudo- plastic flow

i) Newtonian flow

The viscosity is not dependent upon the time or shear rate. It is, however, dependent upon solution concentration and temperature. Solution of high polymers is very rarely Newtonian. In this flow, the shear rate is directly proportion-al to the applied shearing stress. The proportionality of viscosity remains constant with the shear rate.

ii) Dilatent flow

This is rarely encountered except in dispersions having about 50% solids. It involves an increase in viscosity with increasing shear rate. Starch exhibits dilatent flow.

iii) Thixotropic flow

This involves a decrease in viscosity as a function of time. Thixotropic systems re-establishes their structure upon standing undisturbed. Thixotropic flow never exists alone; it is a superimposition of the viscosity time relationship upon either Newtonian, dilatant or pseudo plastic flow. The most common is the thixotropic-pseudo plastic flow combination. Solutions of CMC, pydroxyethyl cellulose etc. can be thixotropic or pseudo-plastic.

iv) Pseudo plastic flow

Most polymer solution of moderate concentrations exhibits this type of flow. In this case, viscosity decreases with increasing shear rate. Ethylhydroxyethyl cellulose, CMC, alginate etc. demonstrates pseudo-plasticity.

1.4. Advantages of pigment printing

- 1) Pigment printing is the most economical printing process and allows maximum output of goods because of the elimination of washing - off, quick sampling and high printing speeds.
- 2) Properly produced pigment prints, using selected products, have an unsurpassed fastness to light and good general fastness properties.
- 3) Pigment printing can be applied to all substrates which are of interest to the printer, including glass fibers, PVC and imitation lather, subject to some limitations in color depth. It is extremely well suited for color resist effects, for example, under azoic and reactive dyes.
- 4) Pigment printing presents the fewest problems for the printer of all the coloration processes, with regard to labor costs, equipment, and reliability of production. Mistakes in printing can be recognized quickly.
- 5) From the ecological point of view, pigment printing, using pastes free from white spirit, IS more acceptable than any other system, excepting only transfer printing methods.

1.5. Disadvantages of pigment printing

- 1)The fastness levels of medium or dark colored prints on materials made from polyester fibers are at best only suitable for articles that will not be subjected to a great deal of wear. Dark-colored prints on woven and knitted goods of synthe-tic fiber blends are especially susceptible to abrasive wear, as well as to reduction in color strength by use or washing.
- 2)The handle of the printed goods is often unduly hard because of the large amounts of external cross linking agents, and this necessitates after treatment of the prints on breaking machines to produce some improvement.
- 3)Pigments are sensitive to crushing during roller, particularly where bulky materials and deep engravings are concerned. Pigment printing needs shallow engravings, and bulky textiles should be printed on screen printing machines.
- 4)The original surface of the textile material is covered by the binder film. This is occasionally aesthetically effective, but usually undesirable.
- 5)No pigment print is completely fast to dry cleaning. Depending upon the pigment and binder (which must be characterized as "fast to solvents") the prints can show rub- marks and / or a loss in color depth.

1.6. Fastness

When the dye or pigment is imported on the fabric it is expected to have certain properties, thus the colored fabric is exposed to sunlight during its use, and the dye should not fade or change its color. During the exposure of colored fabric to crock or sunlight in the presence of air (oxygen or moisture).The color absorbs some portion of sunlight [11].

1.6.1. Fading

Fading is seen as a color loss by the dyed or printed textile material. It is the result of some change in the structure of the dye molecule due to absorption of light, reaction with air pollutants, laundering, dry cleaning and /or other agency

1.6.2. The Light Fastness

The fading of dyed or printed colors in light. It is suggested that fading may be due to some kind of breakdown in the light energy absorption capacity of the electrons of the chromospheres or a breakdown in the structure of the dye molecule. When sunlight energy is absorbed ,the loosely held electrons of the chromophores are raised to a higher energy level; that is ,they become more active .It is known that ultraviolet component of sunlight will in time initiate chemical reactions. Such chemical reactions will be accelerated under moist conditions .Fading in sunlight is due to partly to ultraviolet radiation that initiate chemical degradation of loosely held electrons of chromophores. Fading of dyed or printed textile materials does not occur so readily in artificial light, mainly incandescent and fluorescent light, as there light sources don't emit significant quantities of ultraviolet radiation [11].

1.6.3. Crocking Fastness

Crocking is the transfer of color from a colored textile to another fabric surface through the rubbing process. The extent of rubbing may be influence by the moisture, as many textiles transfers more color when wet. The test requires a crock meter & color transfer is then evaluated using the standard chromatic transference scale or gray scale for staining [11].

1.7 Aims and objectives of the study

The study has been subjected that the rubbing fastness and light fastness of pigment printed cloth is directly affected by the nature of binders used and also depends upon the use of certain chemicals used in paste, such as liquor ammonia and ammonium sulphate. The objectives of the study were;

- To observe an effect of using different Binders on Light fastness and Rubbing fastness.
- To observe an effect of using different viscosities by varying the thickening agent's quantity on the Light fastness and Rubbing fastness.

2. Material, Machines, Methodology

2.1. Introduction

In this chapter the major portion of work is performed at Clariant Scientific Laboratory and the test are conducted at wet-processing laboratory. The preparation of fabric, printing procedure, machines used for the printing and testing techniques are discussed in this chapter.

2.2. Material

The material used this project includes fabric, pigments and auxiliaries. The detail IS given as follow;

2.2.1. Fabric

In pigment printing, the vast variety of fabric can be printed. This is the main advantage of pigment printing. In the project we have used 100% cotton (Bleached). Fabric specification is given in the Table 2.1. It is supposed to use bleached cotton fabric.

2.2.2. Pigments

There are various manufactures of this product in the project we have used the product of Clariant named (Printofix-H) the detail of pigments used in the project is given in the (Table 2.2)

2.2.3. Auxiliaries

The auxiliaries are used according to the specification are recommendation of the manufactures the details of auxiliaries is given in the (Table 2.3).

Table 2.1: Fabric specification

Parameters	Values
Fabric	100% cotton
Weave design	Plain
Construction	20x20/108x58
pH	7
Absorbency	33
Nature	Bleached

Table 2.2: Pigments used in research work

Name of the manufacturer	Pigments
Clariant	Printofix-H Red 3BD
	Printofix-H Orange G80
	Printofix-H Flavine RNC

Table 2.3: Printing auxiliaries used in research work

Chemicals	Source
Thickener	Clariant
Binder	Clariant
Liquor ammonia	Laboratory
Ammonium Sulphate	Laboratory
Caustic soda	Laboratory

2.3. Machines

There are various machines used for printing, and are used according to their use. Which are brief discussed as under;

2.3.1. Viscometer

The Viscometer is used for reading the viscosity of printing paste. And its unit is poise, centipoises or kilo Pascal. It has six spindles to measure the viscosity and is used according to thickness of viscosity. The maximum speed of spindle rotation is 100 rpm.

2.3.2. Crock meter /Rubbing fastness tester (IS0105)

Crock meter /Rubbing fastness tester is used to determine the color fastness of textile material to dry or wet rubbing, provided with a crocking finger of 16 mm diameter with a down ward force of 9 Newton and the facility for mounting standard crocking fabric. A pinned acrylic sample holder ensures rapid sample mounting and repeatability of results.

2.3.3. Hand printing screen

The printing process consists of forcing a viscous print paste through the open areas of the screen with a flexible, synthetic rubber, squeegee. The rubber blade, which is contained in a wooden or metal support, is drawn steadily across the screen at a constant angle and pressure. If the screen is too wide to allow one operator to reach all the way across it, two operators may work together, one on either side of the table. The pressures exerted by the two must be as similar as possible.

The amount of print paste passing through the screen can be controlled in several ways. Factors affecting this are:

1. The 'mesh' (thread per inch) or 'raster' (threads per cm) of the screen fabric; generally a coarse mesh allows more paste to pass through than a fine one.
2. The fraction of open area in the screen fabric, this depends not only on the mesh but also on the yarn diameter and the effect of subsequent treatments, such as calendaring.
3. The hardness and cross section of the squeegee blade, a hard rubber squeegee with a sharp cross - section is suitable for outlines, whereas a soft, rounded blade applied more paste and is suitable for blotches.
4. The hardness of the printing table, if the top of the table is firm a soft squeegee is probably necessary; whereas with a resilient table surface a harder squeegee is preferable.
5. The viscosity of the print paste; the constraint of the for good definition, the viscosity can be varied, thinner pastes passing through the screen pores more readily than viscous ones.
6. The squeegee speed, angle and pressure.

2.4. Plan of the work

It was planned that 27 samples were printed by three different binders at three different viscosities. Nine samples were printed with the Binder F, nine samples were printed with the Binder FT, nine samples were printed with the Binder 77 with three different colors with three different viscosities.

- a) Three shades were printed with different viscosities with Binder F.

- b) Three shades were printed with different viscosities with Binder FT.
 - c) Three shades were printed with different viscosities with Binder 77.
 - d) Rubbing fastness is tested by the Crock meter.
 - e) Light fastness is tested by the light fastness tester
- Recipes and procedures of all shades is given in Table (2.4 - 2.7) **Table 2.**

Recipe of shade for binder F

Table 2.5: Recipe of shades for binder F.T

Sr.No.	Shade	g/Kg
1	Printofix-H Red 3BD	30
2	Printofix-H Orange G80	40
3	Printofix-H Flavine RNC	30

Table 2.6: Recipe of shades for binder 77

Sr. No.	Shade	g/Kg
1	Printofix-H Red 3BD	30
2	Printofix-H Orange G80	40
3	Printofix-H Flavine RNC	30

Table 2.7: Recipe of printing auxiliaries

Sr.	Shade	g/Kg
1	Printofix-H Red 3BD	30
2	Printofix-H Orange G80	40
3	Printofix-H Flavine RNC	30

2.5. Procedure

First of all make the recipe and stir handsomely until reach at the desire viscosity of the paste and then put it on the screen and sweep it with doctor blade or wiper and get the sample and quickly dry it in oven at the temperature of 1200C and after dry it will be fixed by the Thermosol machine at the temperature of 250-260oC for 2-5minutes.

Auxiliaries	Range Of Viscosity	Range of Viscosity	Range of Viscosity
	6000 cpi	8000 cpi	9000 cpi
Stock Thickener (gm)	174	174	174
Binder	(g/Kg Pigment x 2.5)+25	(g/Kg Pigment x 2.5)+25	(g/Kg Pigment x 2.5)+25
Liqour ammonia	2 ml/lit	2 ml/lit	2 ml/lit
Ammonium Sal	Optional	Optional	Optional
Anti-foaming	Optional	Optional	Optional

2.5.1. Printing Route

Printing Drying Fixation

2.5.2 Printing

There are various s machines used for printing which are briefly discussed above. At the lab scale the fabric had been printed by hand and it is called Hand screen printing. In very first make the printing paste and maintain its viscosity

and put the paste on the screen and wipe it with doctor blade with accurate pressure and get the printed cloth for drying and fixation.

2.5.3. Drying

After printing the specimen is brought for drying. For drying oven is used. Set the temperature of oven at 120°C and set for 2-5 minutes and send the sample for fixation.

2.5.4. Fixation The dried samples were then ready for fixation of the pigments. Because the pigments are not soluble in water and does not fix. For fixation we use thermo fix machine at 250-260 DC and fix the sample

2.6. Light fastness test

The outdoor exposure option requires the good light fastness this fastness test IS performed at the mercury bulb at the standard of ISO 105 (B02).

2.6.1. Test Procedure

The test procedure along with ISO Light Fastness Blue Scale (1-8 Blue Wool Reference) were exposed to the Mercury bulb in light fastness test until the fourth wool reference became equal to the fourth scale in grey scale of change of shade .The color fastness was then assessed by the change in color of the specimens with that of the scale used.

This procedure is commonly considered as an equivalent procedure for the ISO-I05 (B02) Light Fastness Test.

2.7. Crocking fastness

The rubbing fastness test of the printed cloth is very poor. For improving the rubbing fastness of pigment printing, the accurate selection of binders is very necessary. The rubbing fastness is assessed by two parameters which are dry and wet

Dry: Rub the rubbing fabric with crock meter under pressure of 9N (400 p/cm²) (To and Fro) on the test sample of sized 10x 1" inch for ten times

Wet: Rub the rubbing fabric soaked with demineralized water (100% pick up) with the crock meter under a pressure of 9N (To and Fro) on the test sample of 10 x 1 inch for ten times.

3. Results and Discussion

3.1. Result of Light Fastness of Pigment Printed samples

It is studied that the light fastness of pigment printed is appreciable. There were three Binders (F, F.T and 77) used in at different viscosities .the light fastness of all three Binders is compared with each other as shown in Table (3.1)

Table 3.1.1: Shows the light fastness rating of all three Binders at different viscosities

Viscosity	Binder F			Binder F.T			Binder 77		
	Red	Orange	Flavine	Red	Orange	Flavine	Red	Orange	Flavine
6000	6	5	6	5	6	5	5	5	6
8000	6	7	6	5	7	6	6	6	6
9000	5	7	6	6	7	5	7	6	7

3.1.2. Comparison of light fastness of printed cloth at the viscosity of 6000 cpi

Figure (3.4) shows the light fastness of the cloth graphically. The blue scale rating of Binder F in the Figure (3.1) is higher than the others and the light fastness of Binder F.T and Binder 77 is same at 6000 viscosity. The reason of low fastness is the Binder's chemistry. The bonding of Binder F and Binder 77 act as weaker bonding in moist conditions.

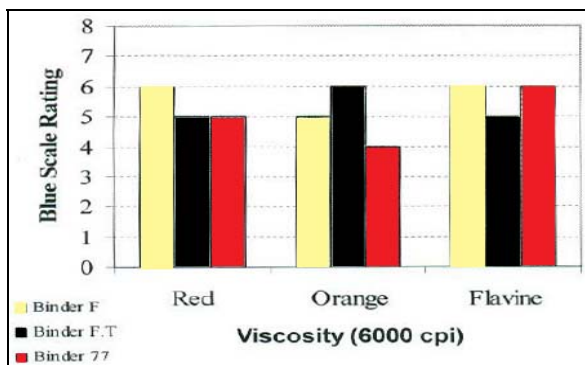


Figure 3.4: Comparison of light fastness of printed cloth printed at the viscosity of 6000 cpi

3.1.3. Comparison of light fastness of printed cloth at the viscosity of 8000 cpi

Figure (3.5) shows the blue scale rating of printed samples at the viscosity of 8000 cpi. At this viscosity the result of Binder F.T is higher than the other Binders and the rating of binder F.T at 8000 cpi is higher than the rating at 6000 cpi. The reason of low fastness is the Binder's chemistry. The bonding of Binder F and Binder 77 act as weaker in moist conditions.

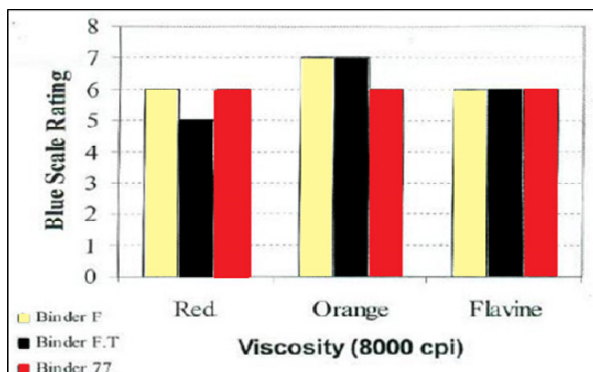


Figure 3.5: Comparison of light fastness of printed cloth printed at the viscosity of 8000 cpi

3.1.4. Comparison of light fastness of printed cloth at the viscosity of 9000 cpi

Figure (3.6) shows the blue scale rating of at all viscosities of all Binders. The light fastness of all shades of binders

varies to each other at this viscosity. All Binders at the viscosity have low substantivity.

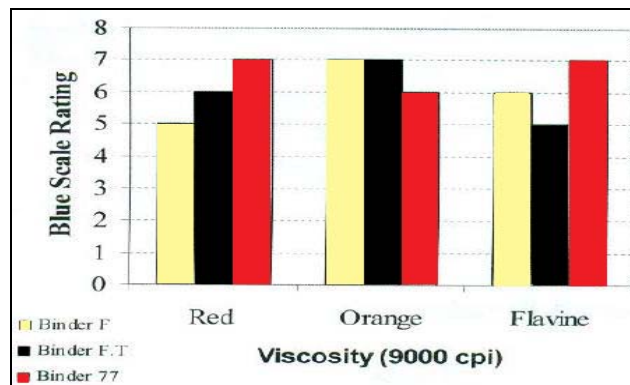


Figure 3.6.: Comparison of light fastness of printed cloth printed at the viscosity of 9000 cpi

3.2. Result of Rubbing Fastness of Pigment Printed samples

It has been studied the rubbing fastness of printed fabrics has immense importance. There were three Binders (F, F.T and 77) used in the project at different viscosities. The Crocking fastness of all three Binders is compared with each other. And is mentioned in Table (3.2 and 3.3) and in Figures (3.7-3.9)

Table 3.2.1: Shows the rating of dry rubbing fastness of Binders (F, F.T and 77)

Viscosity	Binder F			Binder F.T			Binder 77		
	Red	Orange	Flavine	Red	Orange	Flavine	Red	Orange	Flavine
6000	2	2/3	2	3	2/3	2	2	3	3
8000	3	3/4	2	2/3	4	4	4	3/4	4
9000	2	2/3	2/3	2	2	2/3	3	3	2/3

Table 3.2.2: Shows the rating of Wet rubbing fastness of Binders (F, F.T and 77)

Viscosity	Binder F			Binder F.T			Binder 77		
	Red	Orange	Flavine	Red	Orange	Flavine	Red	Orange	Flavine
6000	3	2/3	2	3	2/3	2	3	3	2/3
8000	3	3/4	3	3/4	4	4	4	3/4	3
9000	2	3	2/3	3	2	4	3	2/3	4

3.2.3. Comparison of rubbing fastness of printed cloth at the viscosity of 6000 cpi.

Figure (3.7) shows the Grey scale rating of at all viscosities of all Binders. The Crocking fastness of all shades of Binder 77 is same and higher than other Binders at dry and wet rating of crock meter at this viscosity. The reason of low fastness is the Binder's chemistry. The bonding of Binder F.T and Binder F act as weaker in moist conditions.

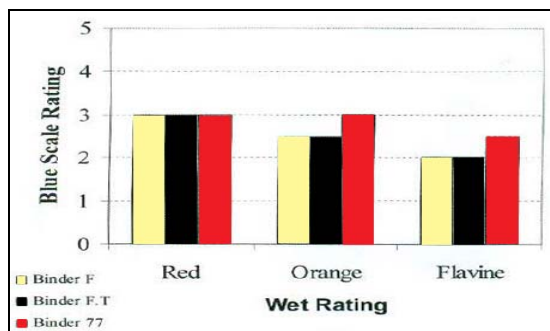
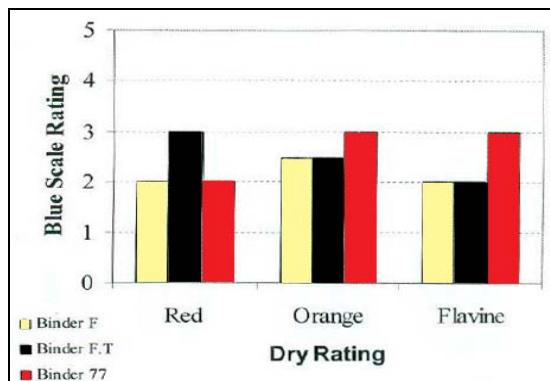


Figure 3.7.: Comparison of Crocking fastness of printed cloth printed at the viscosity of 6000 cpi

3.2.4. Comparison of rubbing fastness of printed cloth at the viscosity of 8000 cpi

Figure (3.8) shows the Grey scale rating of at all viscosities of all Binders. The Crocking fastness of all shades of Binder F. T is same and higher than other Binders at dry and wet rating of crock meter at this viscosity. The reason of low fastness is the Binder's chemistry. The bonding of Binder F.T and Binder 77 act as weaker in moist conditions.

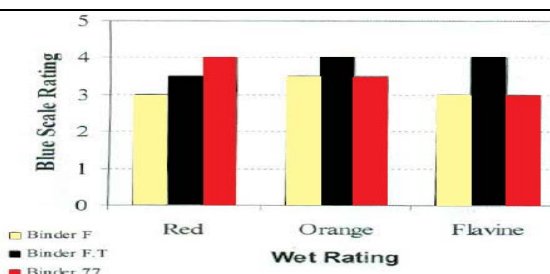
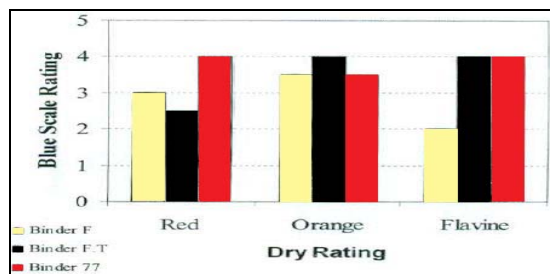


Figure 3.8: Comparison of Crocking fastness of printed cloth printed at the viscosity of 8000 cpi

3.2.5. Comparison of rubbing fastness of printed cloth at the viscosity of 9000 cpi

Figure (3.9) shows the Grey scale rating of at all viscosities of all Binders. The Crocking fastness of all shades of Binder F is less than all Binders and Binder 77 is higher than other

Binders at dry and wet rating of crock meter at this viscosity. The reason of low fastness is the Binder's chemistry. The bonding of Binder F and Binder F.T act as weaker in moist conditions

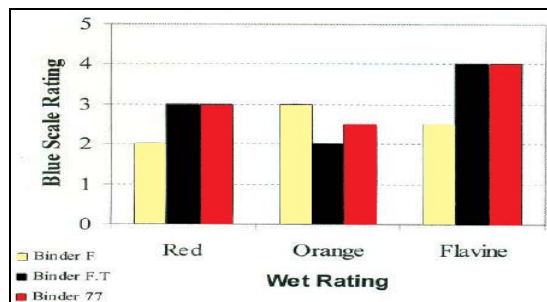
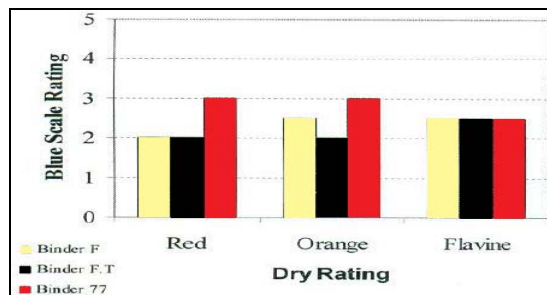


Figure 3.9: Comparison of Crocking fastness of printed cloth printed at the viscosity of 9000 cpi

4. Conclusion

Following conclusions are revealed from the results. It is observed that the light fastness and crocking fastness of pigment printed fabric can be improved by the appropriate selection of Binder. However the viscosity acts an immense role in binding of pigments with cloth.

- If binder F is used at a viscosity of 8000 CPI. The Crocking fastness decrees by half rating of gray scale.
- And also if Binder FT is used at a viscosity of 9000 CPI. The light fastness decrees by one a half rating a blue scale.
- Due to low viscosity the flushing problems were occurred to control the viscosity the temperature has to be maintained for individual and also control the factors which effect on viscosity.
- Appropriate selection of Binder must be followed for getting the accurate results.
 - ✓ Binder F give best results at 6000 CPI
 - ✓ Binder FT gives best results at 8000 CPI.
- After application of paste, the fixation time and temperature has significant role.

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