

A Study on Synthetic Thickeners as
Kerosene Substitute in Pigment Printing

BY

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A THESIS SUBMITTED TO THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE
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MASTER OF SCIENCE IN TEXTILES AND CLOTHING

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Dedicated To My

**Parents,
Brothers and
Sister**

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SYNTHETIC THICKENERS AS KEROSENE SUBSTITUTE IN PIGMENT PRINTING

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Introduction

I. INTRODUCTION

Pigment printing came into vogue in the '50s when there was a need for printing which was very much easier for the application compared to the dyes in use at that time like naphthols / bases / salts / vats / rapidogens / rapidfasts etc.,. The versatility, ease of application and the possibility of seeing the near final print at the printing stage itself was a boon to the printers. Hence the style of printing done with pigments world wide is in a majority, when compared to other styles, even though other styles do have their own plus points over pigment printing.

When pigment printing was first attempted in the 1930s the thickeners available at that time were used. These were of a high molecular weight, water soluble and based on natural or modified starches. The results were poor with respect to colour depth and fastness. The properties of pigment printing established themselves as a result of the introduction of emulsion thickening.

Conventional pigment printing is carried out using kerosene-water-emulsion as the thickener, containing 70% - 80% kerosene. The printing process is very popular due to its

- * simplicity in application
- * flexibility of printing on various types of fibers and blends
- * elimination of washing-off process after printing

- * adequate overall fastness, properties and reasonable brilliance

The main drawbacks of the pigment printing with the use of kerosene emulsion, in spite of the advantages are ;

- * after printing, kerosene vapour is discharged into the atmosphere during the process of drying and curing, resulting in environmental pollution
- * there is also the risk of explosion, of dryness due to the accumulation of kerosene vapour. More over, on evaporation it produces a carcinogen (cancer causing) which causes health hazards.

There is also no effluent treatment for removal of kerosene which in turn pollutes the surroundings.

It has been estimated that in pigment printing, Indian textile industry consumes over 100,000,000 liters of kerosene annually. In our country, in addition to the above mentioned problems, kerosene is in short supply. Moreover it is extensively used as a cooking fuel and for domestic lighting by a large segment of the population. The rapidly increasing cost of kerosene also influences a lot.

Way back in the 1950s a great deal of interest was evoked in Germany, whereby major manufacturers of pigment printing composition for textiles had to face the problem that the use of white spirit emulsions, to increase the print paste viscosity was facing legal restraint. Through the years several other countries

like U.S.A. and Japan have banned the use of kerosene in printing.

Due to the shortage of all petroleum products, Indian administrators have always insisted on cutting down the use of kerosene in the textile industry to a minimum. The present uncertainty in the Gulf War has again resulted in the worsening of the position there by making the availability of kerosene more acute than ever. More over there are days of awareness regarding the pollution caused to ecology and the health of human beings in every field of activity.

Recently, a few synthetic thickeners have been introduced in the market by indigenous manufacturers. These are claimed to substitute kerosene, either partly or fully.

Keeping the above factors in view, the investigator has undertaken this study to analyse how far these kerosene substitute products i.e. synthetic thickeners can replace kerosene usage to a minimum.

The objectives of the study are to

- * analyse how far the synthetic thickeners may replace kerosene effectively viz; 100%, 15% and 50%
- * test the effectiveness of the synthetic thickeners with respect to fastness properties
- * test whether the synthetic thickener produces any variation in the performance qualities
- * and mainly the colour strength acquired by the prints due to the synthetic thickeners

Review of Literature

II. REVIEW OF LITERATURE

Review of literature is summarized under the following categories

- A. Importance of pigment printing
- B. Pigment printing technique
- C. Components of the pigment printing recipe
- D. Effect of components in the recipe
- E. Advantages of kerosene emulsion
- F. Limitations of kerosene emulsion
- G. Need for kerosene replacement
- H. Advantages of the synthetic thickener
- I. Limitations of the synthetic thickener

A. IMPORTANCE OF PIGMENT PRINTING :

Iyer (1991) opines that pigment printing came into vogue in the '50s when there was a need for printing which was very much easier for the application compared to the dyes in use at that time like naphthols / bases / salts / vats / rapidogens / rapidfasts etc.,. The versatility, ease of application and the possibility of seeing the near final print at the printing stage itself was a boon to the printers. Hence this style of printing has come to dominate the printing arena for a long time.

Varghese et al (1989) stressed that the printing technique had been popular all over the world in view of the fact that the shade matching is easy, the prints obtained are brilliant and

sharp and they do not need an after wash.

According to BTRA (1985) pigment printing is very much in vogue in India and else where. It is also in a strong position because it provides a better fastness than the respective dye stuffs. Further, pigment printing can be carried out on all textile substrates and the washing off process can be eliminated.

Shenai (1985) is of the opinion that pigment printing exhibits good fastness to light, washing, fading, chlorine, alkalis, peroxides, perspiration, solvents and especially to abrasion. The cost is favorable. It satisfies particular colour requirements which are very brilliant.

Humphries et al (1985) stressed that pigment printing is theoretically simple, low cost and is a high production system with no subsequent wash off and is obviously attractive particularly as the process is always the same on all fabrics.

Varghese et al (1984) says that pigment printing of textiles is highly popular due to various reasons. The most prominent among these are its versatility i.e. applicability to almost all textile fibres, simplicity of the technique and the comparatively high fastness of pigment print especially to light.

Basu et al (1983) explains that from as early as about 400 B.C. in China and Egypt, the colouring of textiles with pigments applied by a simple brush or wooden block has developed into todays complex array of technological systems of pigment printing of textiles fabrics.

Varghese et al (1982) expresses that the printing has been popular all over the world in view of the fact that shade matching is easy, the prints obtained are brilliant and sharp and they do not need an after wash.

Colourage (1981) adds to the importance as follows : Today the largest share in the printing market is still pigment printing. Pigment printing is the simplest and most economical way to print a multitude of substrates and blends. The economic advantages are a result of low production costs due to the elimination of fixation and washing.

B. PIGMENT PRINTING TECHNIQUE :

Gulrajani (1993) specifies that pigment prints must be cured at 140° C to 150° C for optimum fastness and brilliance of colour. While Shenai (1991) views that in pigment printing pigments with the help of binders and fixers are converted into a homogenous or dispersed phase. The binder then undergoes polymerization or crosslink when subjected at an elevated temperature at 140° C to 150° C for three to five minutes.

To quote Lyle (1988) pigment printing is a method of printing in which the insoluble pigment is mixed with a resin binder, the thickener, to form a printing paste. The printed fabric is then treated at high temperature to cure the resin binder.

Wigger (1988) states that pigment printing is a technique in which binding agents are used to fix patterns with no affinity

for the textile fibres and fabrics. Humphries et al (1985) adds to the point that pigments have no groups which can react with fibres and show no substantivity for the fibres. Fixation is achieved by using a binder which secures them in a film at the fiber surface.

Basu et al (1983) postulates that after printing a drying prints are cured usually at 150^o C for three to five minutes. The pigment in itself has no affinity for the fibres but is mechanically held to the fiber by the binder which forms a transparent film entrapping the pigment paste.

Tortora (1982) puts forward the fact that the pigment colours are attached to the surface of the fabric by a resin and when the resin is cured or permanently fixed to the fabric, the dye is also fixed at the fabric surface. Navarathi (1982) is of the opinion that in pigment printing the process after printing is curing or steaming.

C. COMPONENTS OF PIGMENT PRINTING RECIPE :

Iyer (1991) states that the essential ingredients of a printing paste are : (1) Synthetic binder (2) Kerosene oil-in-water emulsion (3) Non-ionic emulsifier (4) Body building agents or a film former (5) A catalyst or acid donor.

Shenai's (1991) view is that pigment printing pastes contains the pigment emulsion, binder, kerosene emulsion in water and an aqueous solution of the catalyst. To quote Varghese et al (1989) conventional pigment printing of textiles involves the use of kerosene oil emulsion as the thickener for printing. The

pigment dye along with the binder on the textile substrates.

According to Gharia et al (1989) in a textile printing recipe, a dye in the dissolved or dispersed form is mixed with a viscous thickener paste. These two ingredients therefore govern the cost of the printing recipes. Other ingredients are added with specific purposes to play some special roles. In pigment printing, kerosene emulsion has been the thickener of choice.

Basu et al (1983) formulates the theory that in printing with insoluble pigments the inorganic or organic chemical is mixed with a binder, catalyst and thickener, usually oil-in-water emulsion to form a printing paste.

ATIRA Technical Digest (1981) Gutjabr (1981) are of the opinion that basic pigment print pastes consist of pigments, binders and thickeners.

D. EFFECT OF COMPONENTS IN A RECIPE :

ATIRA Technical Digest (1981) and Gutjabr (1981) are of the opinion that pigments supply coloration, the binder holds the pigment onto the fabric and produces good fastness property and that the thickener is necessary to keep the binder and the pigment in place where the paste is deposited.

1. Pigments :

Corbman (1985) reports that pigment colours are not true dyes but are of the utmost importance in printing. These colours are fixed to the fiber by means of a resin that is very resistant to laundering and dry cleaning.

Humphries et al (1985) opines that pigments are molecular aggregates which are insoluble in the media from which they are applied during both the application and the subsequent useful life of the coloured material. They show no substantivity to the fibre.

Tortora (1982) states that pigments are not true dyes but that these colours produce a permanent and fast colour. They are attached to the surface of the fabric by a resin. Varghese et al (1982) defines pigment dyes as insoluble molecular aggregates with hardly any substantivity towards the substrate to which they are applied.

2. Binders :

Galrajani (1993) stresses that fastness property of the pigment print is dependent on the fastness property of the binder film which in turn depends on the curing efficiency.

Humphries et al (1985) expresses the view that in pigment printing fixation is delivered by using a binder which secures them in a film at the fibre surface. International dyer (1982) explains that the task of the binder system is to form an elastic film in which the pigment is embedded and which adheres to the fibre thereby securing the pigment to it. In general the binder is responsible for the colour yield, the fastness to dry rubbing and soft handle.

3. Setting Agents :

International dyer (1982) views that the job of the setting agent on the other hand is to harden the high molecular weight binder film during curing.

4. Thickener :

Gharîa et al (1990) felt that for pigment printing polymers are not very useful; as with such products the residue left behind after drying causes dullness and stiffness. The oil-in-water types emulsion gives best results as the constituents vaporize leaving no residue.

Director BTRA (1985) states that white spirit emulsions are used in the pigment printing to increase the viscosity of the print paste. International dyer (1982) opines that emulsion thickener is the spelt success for pigment printing and effect the brilliance, depth of shade and handle.

To quote, Krishnan (1982) the functions and requirements of a ideal thickener are to act as a vehicle for carrying the colour to the cloth and secondly as a perceptive against its spreading by attractions beyond the limits of its allotted space in the design.

According to Thomas (1981) expresses the major functions of a thickening agent in textile printing is to prevent dye migration during printing, drying and steaming of the fabric. The thickener should keep the dye within the printed area and must not break during any process.

E. Advantages of Kerosene Emulsion :

Sinha and Gharía (1993) list the advantages as

1. Simplicity as no after-treatment is required
2. Flexibility of printing on various type of fibres and blends
3. Adequate overall fastness properties and reasonable brilliance

Gharía et al (1989) postulate that oil-in-water emulsions give best results in pigment printing as the constituents vaporize giving no residue. According to Varghese and Gore (1984) the use of kerosene oil-in-water emulsion has got its own advantage viz; very low solid content which leads to brighter prints with better feel and handle of the printed fabrics.

To quote, Varghese (1984) kerosene emulsion has high solvent system and offers four advantages namely softhandle, brilliant prints, better fastness characteristics and higher drying speeds.

Basu et al (1983) summarize the advantages due to kerosene emulsion usage as

1. Low cost
2. Ease of colouration
3. Good overall fastness
4. No problem of compatibility of colours
5. Applicability to all textile fibres
6. Clear brilliant shades with high colour yield
7. Fidelity of reproduction

8. Final colours are seen as soon as the cloth leave the machine permitting quick detection of defects
9. Left over colours stand with out decomposition
10. Elimination of soap-off and reuse

Colourage (1981) states that natural thickness are relatively constant in viscosity generally unaffected by shearing action. While Narkar (1980) formulates the advantages of oil-in-water emulsion as follows.

1. Desired viscosity can be obtained with low solids
2. Better penetration and more colour yield
3. Quick drying due to low solids and volatile nature of solvents.
4. Prints with emulsion thickening are soft and less liable to cracking
5. Removal of thickening is easy.

F. LIMITATIONS OF KEROSENE EMULSION :

According to Iyer (1991) the vaporized kerosene oil can cause health problems. Moreover the kerosene oil vapors are a source of carcinogen (cancer). Gharia et al (1989) says that kerosene emulsion causes two major problems, namely, pollution and fire hazard, and Textile Dyer and printer (1991) supports the point.

Varghese and Gore (1984) point out that white spirit or kerosene oil is too valuable and too expensive to use it for preparing print paste and then evaporate it into the air or wash it away into the water.

Basu et al (1983) specifies that kerosene has become more expensive and scarce. Narkar (1980) lists the disadvantages as fire hazards, air pollution and cost and availability of the turpentine.

G. NEED FOR KEROSENE REPLACEMENT :

Textile Dyer and Printer (1991) expresses that the availability of kerosene has always been a problem of the textile industry in our country. Due to the shortage of all petroleum products the administration has always insisted on cutting down the use of kerosene in textile industry to a minimum possible limit. The present uncertainty in the Gulf region and the possible threat of the eruption of war again resulted in worsening of the position and making the availability of kerosene more acute than ever.

Teri (1991) lists the factors that have compelled the search for a replacement of kerosene as

1. The present oil crisis both in terms of cost and availability makes it imperative to minimize kerosene
2. When printed fabrics are dried and cured in ovens kerosene is expelled in to the atmosphere. The number of total accidents caused by explosion in curing oven proves that this system is highly risky
3. The emulsion of a high important of hydrocarbons through the curing exhaust is considered to be posing a very serious pollution problem

To quote, Gharia et al (1989) apart from the problems of fire hazard and pollution it is a wasteful use of kerosene which is imported and more over it is used as a domestic fuel. A rough estimate indicates that the organized sector of Indian textile industry alone uses millions of liters of kerosene per year, all of which is drawn into the atmosphere during the drying operation.

Colourage (1985) views as follows

1. Risk of Explosion in the Drier : It is recommended that the proportion of hydrocarbon in the drier should not exceed 0.6% and in some instances government regulations quote 0.3% because of this, manufacturers could be reluctant to use an emulsion system or may be prevented from doing so by legislation.
2. Environmental Pollution : In many other countries or in many parts of many countries, strict regulations now in force to limit or ban completely the disposal of white spirit into the atmosphere or white spirit has escalated in the past decade.

Varghese and Gore (1984) express that with the ever increasing price-rise of kerosene oil and restricted availability, its use in textile printing is reviewed. Further, use of kerosene pollutes the atmosphere. Moreover at times, accidental explosion may also occur, all of which have attributed to the development of synthetic thickener.

H. ADVANTAGES OF SYNTHETIC THICKENER :

Teri (1991) lays down the advantages of synthetic thickener over the natural thickeners as

1. Synthetic thickeners are pseudoplastic. This special property of these thickeners enables the use of extremely fine screen gauges and roller engravings to give finer designs.
2. The lower solid content of the synthetic thickener leads to a higher degree of fixation and a greater depth of colour is obtained.
3. With a complete fixation, washing problems are reduced which is economically beneficial.
4. Suitable thickeners enable a greater surface loading and thus prints of greater depth of colour can be obtained.
5. Very high quality pigment prints can be produced using synthetic thickener without using kerosene.
6. Synthetic thickeners are free from hardening and browning problems unlike natural thickeners during high temperature fixation.

Varghese and Gore (1984) view the use of all aqueous system enable one to have less stringent safety precautions in the print work. Also it leads to less clogging of the screen. Mehta (1981) discusses the advantages as :

1. No requirement of kerosene or minerals spirit which is always in short supply and getting costlier day by day.
2. Possibility of explosions are totally eliminated.
3. No pollution in the atmosphere.
4. Large storage facility for kerosene not required.

5. No intermediate drying of the print.
6. No washing of the pigment print.

According to Colourage (1981) the advantages of this system respect to fixation are as follows :

1. Simplicity of use
2. Economics
3. No pH adjustments necessary
4. No oxidizing agents required
5. Little or no tendency to brown and harden
6. Single print paste formulation suitable for all fixation methods
7. No high temperature auxiliary required for polyester

1. LIMITATIONS OF SYNTHETIC THICKENER :

Iyer (1991) postulates that synthetic thickeners are very sensitive to electrolytes and hence the concentration of unnecessary inorganic chemicals will disturb the system. The paste will thin down and cause printing problem. Soft water is recommended for good results.

According to Colourage (1985) the limitations associated with the use of synthetic thickeners are ; Electrolyte sensitivity, Reduced brightness of the print and Lower production resulting from drying rates. International dyer (1982) reports that white spirit free printing pastes prepared with white spirit emulsions which is probably why they do not produce optimum results in respect of brilliance depth of shade and handle.

Mehta (1981) summarizes the limitations as follows :

1. Being all aqueous system, quality of water affects the brightness of the print.
2. These thickeners based on fatty alcohol, ethylene oxide condensates are not only affected in terms of shade but in solubility property also.
3. Quality of the binder is important as not all the binders can work satisfactorily.
4. pH of the paste needs careful control.
5. Colour value depending upon the pigment colour used is less varying from 10% - 20%
6. Wet crocking fastness is less depending upon which thickener is used.
7. Slightly rough handle is imparted to the prints.
8. Printing production is likely to be affected in blotch design.
9. Thinning down of the print paste during printing operation.
10. Chemical cost is high.
11. Wicking property affects the sharpness of the prints.

Experimental Procedure

III. EXPERIMENTAL PROCEDURE

The experimental procedure consists of the following aspects :

- A. Selection of the material
- B. Selection of synthetic thickener
- C. Selection of the dyes
- D. Selection of the method
- E. Selection of recipes
 - 1. Oil-in-water system
 - 2. 100% aqueous system
 - 3. 75% aqueous system
 - 4. 50% aqueous system
- F. Nomenclature of the recipes
- G. Preparation of stock solution
 - 1. Recipes
 - 2. Method of preparation
 - 3. Stock solution of thickener
 - 4. Duration of the preparation and its appearance
- H. Preparation of printing paste
 - 1. Recipes
 - 2. Method of preparation
- I. Printing technique
 - 1. Preparation of the table
 - 2. Preparation of the material
 - 3. The printing operation

J. After treatments

1. Drying

2. Curing

K. Nomenclature of the printed samples

L. Evaluation of the printed samples

1. Visual inspection

a. General appearance

b. Brightness of the print

c. Clarity - outlines of the print

d. Texture of the print

e. Lustre of the print

2. Performance tests

a. Fabric weight

b. Fabric stiffness

c. Fabric thickness

3. Color fastness tests

a. Fastness to washing

b. Fastness to crocking - wet and dry

c. Fastness to sunlight

d. Fastness to perspiration - acid and alkali

4. Computer analysis

a. Color analysis

A. SELECTION OF THE MATERIAL :

The selection of material is of pure cotton. The cotton material has already been subjected to basic finishes like Desizing, Scouring, Bleaching and Mercerising in order to produce a satisfactory print over it.

B. SELECTION OF SYNTHETIC THICKENER :

The usage of synthetic thickener in the printing units is in the initial stage. The technology is new. The following were the synthetic thickeners selected because of their local availability and easy procurement. The manufacturers name has also been listed.

1. SM Alcoprint 'P' system - SM Dyechem Ltd.
2. Thicknol - Associated Chemicals
3. Novaprint CL - C.D. Corporation
4. RAN - 5000 - RSA Polymers

C. SELECTION OF THE DYES :

The pigment particles vary in size widely and are in various dispersion ranges. For full-fledged analysis of various pigments in dispersions, almost the complete range has been tried to be covered along with their respective trade names;

Red	- Impron Red KCGR
Blue	- Impron Blue KCG
Yellow	- Impron Yellow KCRM
Turquoic Blue	- Impron Turquoic Blue KCBN
Black	- Impron Black KCG

D. SELECTION OF THE METHOD :

The pigment printing was done by hand screen printing, since the quantum of printed samples was low. The screen was made of nylon.

E. SELECTION OF RECIPE :

The recipe variations were made mainly based on the amount of kerosene and water in a particular system.

Generally, the instructions given by the manufacturers were followed. But for the binders, SLN binder was used for all recipes in spite of the special binders prescribed by them. And for the aqueous system instead of water, hard water was used in order to reduce the cost. Four different recipes were formed. They were :

1. Oil - In - Water Aqueous System :

This is the conventional pigment printing recipe. This recipe formed, helps us to evaluate the performance of synthetic thickeners and hence, serves as the standard recipe.

2. 100% Aqueous System :

This recipe does not involve any use of kerosene. The dispersion medium is water only. Hence this recipe replaces the usage of kerosene by 100%.

3. 75% Aqueous System :

This recipe involves the synthetic thickeners and an added 25% kerosene and hence the replacement of kerosene was 75%.

4. 50% Aqueous System :

This recipe uses the synthetic thickeners and the kerosene in equal parts, there by, 50% replacement of kerosene.

The recipe 2, 3 and 4 are applicable to all synthetic thickeners.

F. NOMENCLATURE OF RECIPES :

The recipes were named according to the type of synthetic thickeners and the volume of kerosene used in the printing process.

The standard recipe of oil in water emulsion was named K 100. While the other recipes are as follows :

Systems ----- Thickeners	100% Aqueous System	75% Aqueous System	50% Aqueous System
SM Alcoprint 'P' System	A 100	AK 25	AK 50
Thicknol	T 100	TK 25	-
Novaprint CL	N 100	NK 25	NK 50
RAN - 5000	R 100	RK 25	RK 50

G. PREPARATION OF STOCK SOLUTION :

1. Recipes :

The different proportion of ingredients used in different recipes are tabulated as follows :

DIFFERENT PROPORTIONS OF INGREDIENTS IN A RECIPE (In Percentages)

Title of Recipes	K 100	T 100	A 100	N 100	R 100	TK 25	AK 25	NK 25	RK 25	AK 50	NK 50	RK 50
SLN Binder	15.0	10.0	15.0	15.0	15.0	10.0	15.0	15.0	15.0	15.0	15.0	15.0
Liquor Ammonia	-	*	0.5	0.5	0.5	*	0.5	0.5	0.5	0.5	0.5	0.5
Urea	-	5.0	-	-	1.0	5.0	-	-	1.0	-	-	1.0
Emulsifier	1.0	0.5	-	-	-	0.5	-	-	-	-	-	-
DAF	1.0	-	-	-	-	-	-	-	-	-	-	-
Synthetic Thickener	-	*	1.5	1.8	4.0	*	1.5	1.8	4.0	1.5	1.8	4.0
Kerosene	82.0	-	-	-	-	25.0	25.0	25.0	25.0	50.0	50.0	50.0
Water	-	-	82.0	81.7	80.0	-	57.0	56.7	55.0	32.0	31.7	30.0
Fixer ccl	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
'S' *	-	84.5	-	-	-	59.5	-	-	-	-	-	-

* Footnote : 'S' is 150 gm of Thickenol + 2 liters of Water + Liquor Ammonia

The usage of DAP and other like electrolyte were found to adversely affect the viscosity of the synthetic thickener and so were avoided in the recipes where synthetic thickener was implemented.

2. Method of Preparation :

Except for thicknol - TK 25 and T 100 all the other recipes follow the same method of preparation namely ;

The ingredients except fixer ccl are weighed accurately and converted into a homogenous mixture. The mixture was then thoroughly stored in a high speed stirrer (plate - I) continuously till the desired consistency was obtained.

Fixer ccl was added on to the printing paste just before printing.

3. Stock Solution for Thicknol :

The method of preparation of stock solution for thicknol differs completely from other chemicals. To 150 gm of thicknol 2 liters of water was added. Liquor ammonia was added in small quantities till the pH of the solution was brought between 8 and 8.5. The solution was then kept undisturbed for a minimum period of 12 hours (the solution was kept over night) for swelling.

With this solution 100%, 75% and 50% aqueous system recipes were prepared. It was noted that in the case of partial aqueous system no homogenous mixture did form and therefore the particular recipe was not analyzed experimentally.

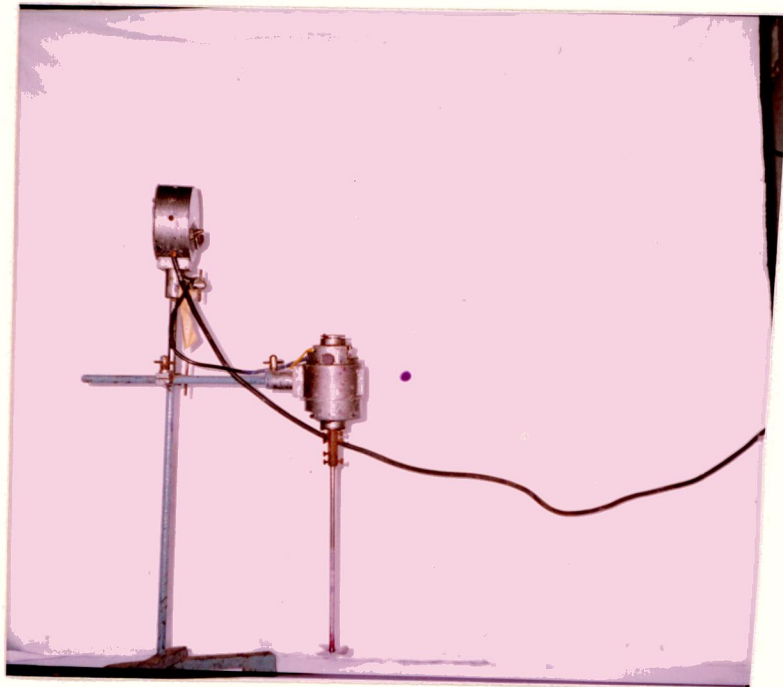


PLATE-I
HIGH SPEED STIRRER

4. Duration of the Preparation and its Appearance :

The time taken for the preparation of the stock solution and the appearance were as follows.

	Oil-in-water emulsion	100% aqueous system	75% aqueous system	50% aqueous system
Time taken	3 - 5 minutes	10 - 15 minutes	5 - 10 minutes	3 - 5 minutes
Appearance	High viscous paste	Liquid with low viscosity	Low viscous Paste	High viscous paste

H. PREPARATION OF PRINTING PASTE :

1. Recipe :

The recipe used for the printing paste was :

1. Stock solution 94%
2. Pigment 6%

The above mentioned recipe was the same for all colors. Usually the percentage of the pigment varies according to the depth of the shade desired. The composition of the printing paste is always maintained at 100% between the stock solution and the pigment, minor variations being allowed in both.

For an added depth 6% pigment was used and the percentage was maintained through out for easier testing and analysis.

2. Method of Preparation :

The pigment and the stock solution was weighed accurately. Fixer ccl in measured quantities was added just before printing and mixed thoroughly. The paste thus made was ready for printing.



PLATE - II
HAND SCREEN WITH SQUEE^GEE

J. AFTER TREATMENT :

After treatment was given to the fabric so that any unfixed matters such as dyes, chemicals and pastes used in the printing operation were entirely removed from the printed fabric to obtain a desired level of fastness. After treatment for pigment printing involves two operations namely,

1. Drying :

After printing the material was dried in a hanger to remove the moisture from the print paste. This drying operation is essential in order to retain a good printed mark and to prevent the printing being heavily marked from handling and subsequent processing. The drying was done for 24 hours.

2. Curing :

After the fabric was printed and dried it was then put through a process of curing. Curing makes the needed cross-linkages between the fabric and the print to ensure good fastness. Thus curing is a polymerization process in a curing chamber (plate - III). The actual operation of curing involves the material to be put in a curing chamber maintained at a temperature of 160° C for five minutes. During curing the thickener evaporates.

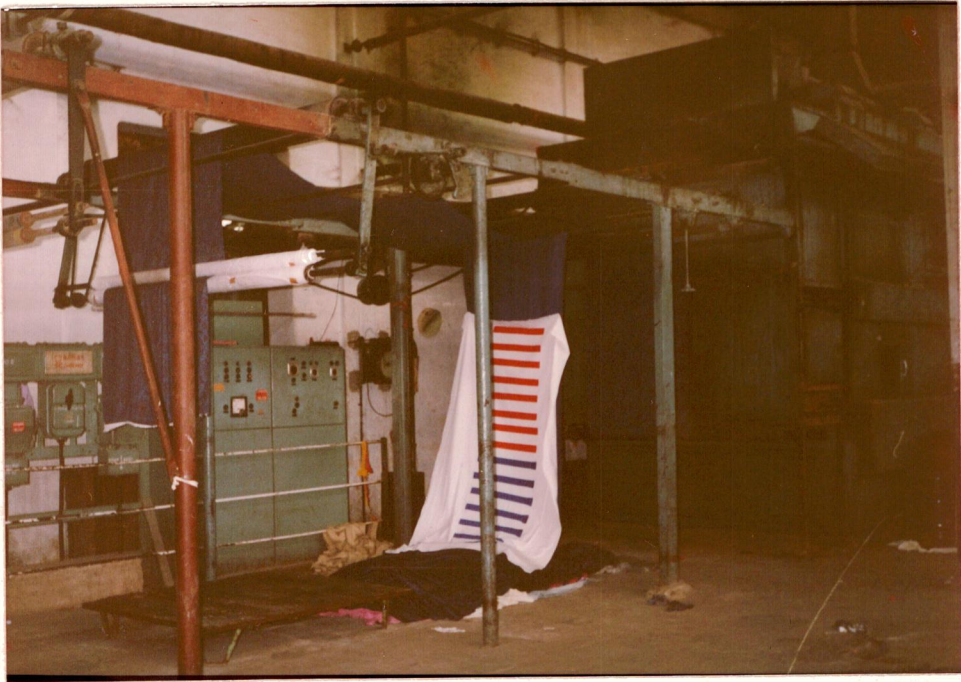


PLATE-III
CURING CHAMBER

K. NOMENCLATURE OF PRINTED SAMPLES :

Following the nomenclature of the recipe the printed samples of all the different were named as per the table :

Colors	Red	Yellow	Blue	Turquoise Blue	Black
Title of recipe					
Oil-in-water emulsion					
K100	K100 Re	K100 Ye	K100 Be	K100 TB	K100 BK
100% Aqueous system					
A100	A100 Re	A100 Ye	A100 Be	A100 TB	A100 BK
T100	T100 Re	T100 Ye	T100 Be	T100 TB	T100 BK
N100	N100 Re	N100 Ye	N100 Be	N100 TB	N100 BK
R100	R100 Re	R100 Ye	R100 Be	R100 TB	R100 BK
75% Aqueous system					
AK25	AK25 Re	AK25 Ye	AK25 Be	AK25 TB	AK25 BK
TK25	TK25 Re	TK25 Ye	TK25 Be	TK25 TB	TK25 BK
NK25	NK25 Re	NK25 Ye	NK25 Be	NK25 TB	NK25 BK
RK25	RK25 Re	RK25 Ye	RK25 Be	RK25 TB	RK25 BK
50% Aqueous system					
AK50	AK50 Re	AK50 Ye	AK50 Be	AK25 TB	AK25 BK
NK50	NK50 Re	NK50 Ye	NK50 Be	NK50 TB	NK50 BK
RK50	RK50 Re	RK50 Ye	RK50 Be	RK50 TB	RK50 BK

L. EVALUATION OF PRINTED SAMPLES :

The printed samples were evaluated as follows :

1. Visual Inspection :

A proforma was evolved to evaluate the samples visually for the following quantities.

- a. General appearance
- b. Brightness of the print
- c. Clarity - outline of the print
- d. Texture of the print
- e. Lustre of the print

The samples were evaluated by 30 judges who belonged to the textile field. The results were carefully recorded and consolidated.

2. Performance Tests :

a. **Fabric Weight** : Weight is an important fabric property. It is an indicator of quality says Dorothy (1977). According to Skinkle (1972) and ISI (1982) the fabric weight is determined by two methods, "Weight per unit area" and "Weight per unit length"

The investigator had followed the method of weight per unit length where samples of length and breadth (9.75 inches X 1 inch) were cut and weighed in an electronic plate (plate - IV) for accuracy. The mean of the values was calculated from the tabulated values.

b. **Fabric Stiffness** : The fabric printed with pigment colors is usually stiff. The variations if any found among the samples were

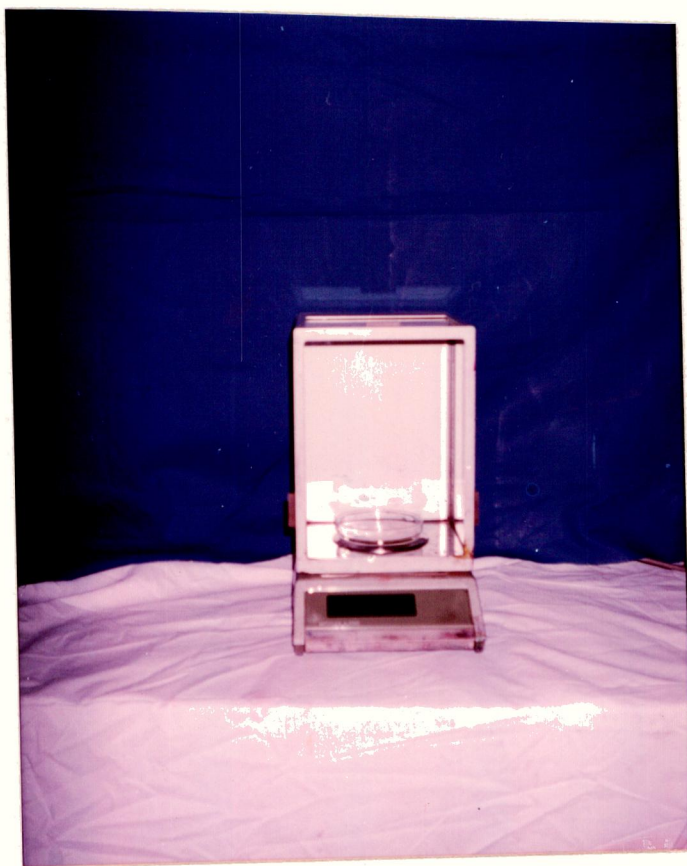


PLATE - IV
ELECTRONIC BALANCE

found through the stiffness tester. Shirley's stiffness tester (plate - V) was used to determine the stiffness in bending length, using a scale of 6 inches length and 1 inch wide which form the template. Samples were cut accordingly. Each sample along with fabric was mounted on the platform which was horizontal and the template was moved along with the fabric slowly until the fabric fell to the edge of the platform and the tip of the fabric coincides with the index line which was viewed in the mirror. The bending length was read from the scale mark opposite to the zero line on the side of the platform. Four reading for each sample was taken and the mean calculated.

c. **Fabric Thickness** : According to Booth (1970) and ASTM Standards (1975) thickness of a textile material is the distance between two parallel surfaces while exerting a specified pressure on the material. Ayle (1977) expresses the fact that the fabric thickener is the distance between the upper and lower surface of the material measured under specified pressure.

The thickness tester (plate -V) has a broad anvil upon which a presser foot is pressed by a spring. The original sample was placed on the anvil without any tension or crease and presser foot is lowered on to the sample by releasing the raising lever slowly. This is then allowed to rest upon the sample for 30 seconds at 2 Kg pressure. Each division of the dial reads 0.01 mm. The dial reading indicates the thickness of the material in 1000's of an inch between the anvil and the presser foot. The dial reading was recorded. 10 reading were taken from different



PLATE - \bar{v}
SHIRLEY'S STIFFNESS TESTER

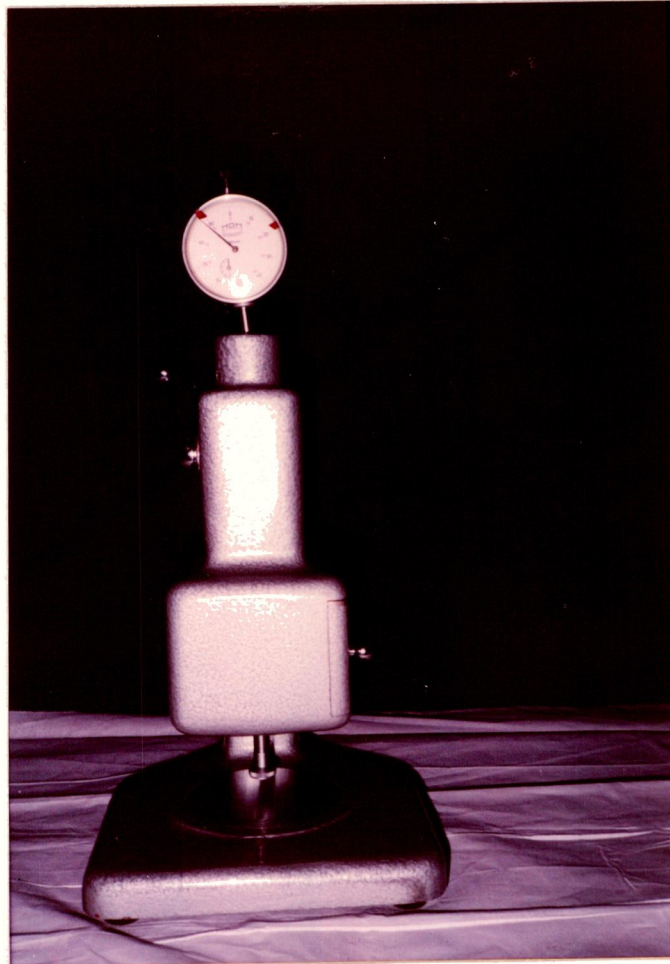


PLATE-VI
THICKNESS TESTER

parts of the same material. The mean value of the ten readings were calculated and recorded.

3. Color Fastness Tests :

Colours are generally fast when they resist the deteriorating influences to which they are subjected. The outstanding property of the dyed / printed material is the fastness of its shade, declares Trotman (1984). When a dye is present on a fabric it is expected to have certain fastness properties adds Shenai (1983). The following color fastness tests were conducted to determine the color fastness of the printed sample.

- a. Fastness to washing
- b. Fastness to crocking - wet and dry
- c. Fastness to sunlight
- d. Fastness to perspiration - acid and alkalis

a. Fastness to Washing :

Samples of different prints were cut and sewed on to one end of the same size of the white material. Wash wheel equipment (plate - VII) was used for the study. The procedure for the test is given below. For every liter of water 5 gm of soap and 3 gm of soda ash was taken and mixed well.

The beakers were filled with soap solution and the sample was kept immersed in it. It was then loaded in the conditioned and operated at a temperature of 100°C for a period of 30 minutes after which the samples were dried. After drying the samples were graded according to the amount of staining on the white material saved.

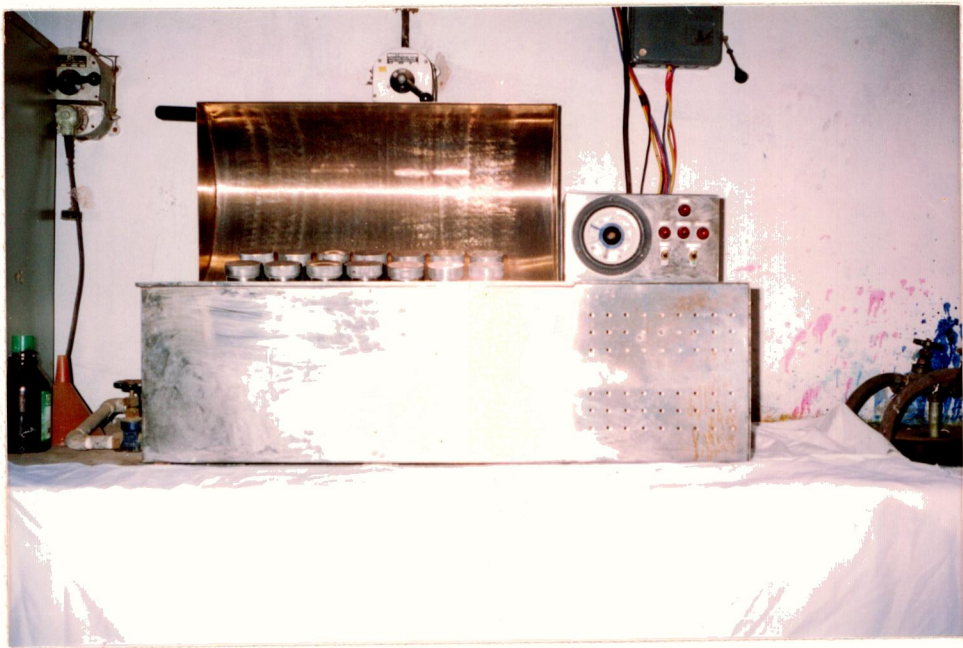


PLATE - VII
WASH WHEEL

b. Fastness to Crocking - Wet and Dry :

Crocking is defined as the color change or the transfer from one colored textile to other by rubbing wingate (1984). A sample was cut according to the ISI standards of dimension 14 cms x 5 cms was placed in the "SASMIRA" crockmeter (plate - VIII) which has two metal blocks. The base is stationary while the upper block has arrangements to move to and fro on the stationary lower block with a mechanical device. The upper block has a rubbing finger attached to one end through which the number of rubs can be standardized.

Dry Crocking : The test specimen was fixed to the lower block. A dry square of the same but unprinted material was fixed at the tip of the rubbing finger of the upper block. The test piece was rubbed 10 times in 10 seconds and the white square piece was then graded for its staining.

Wet Crocking : A fresh test specimen was fixed to the rubbing device. A fresh piece of unprinted cloth was soaked in distilled water and squeezed so that it contains its own weight of water and fixed to the rubbing finger. The rubbing was done as above and then graded. The test was repeated for all the printed samples.

c. Fastness to Sunlight :

According to Mary Scheuck (1951) the sample is cut and divided into equal parts and one part was placed between thick black papers and stapled to prevent that part from direct sunlight. The other portion was exposed to direct sunlight for a

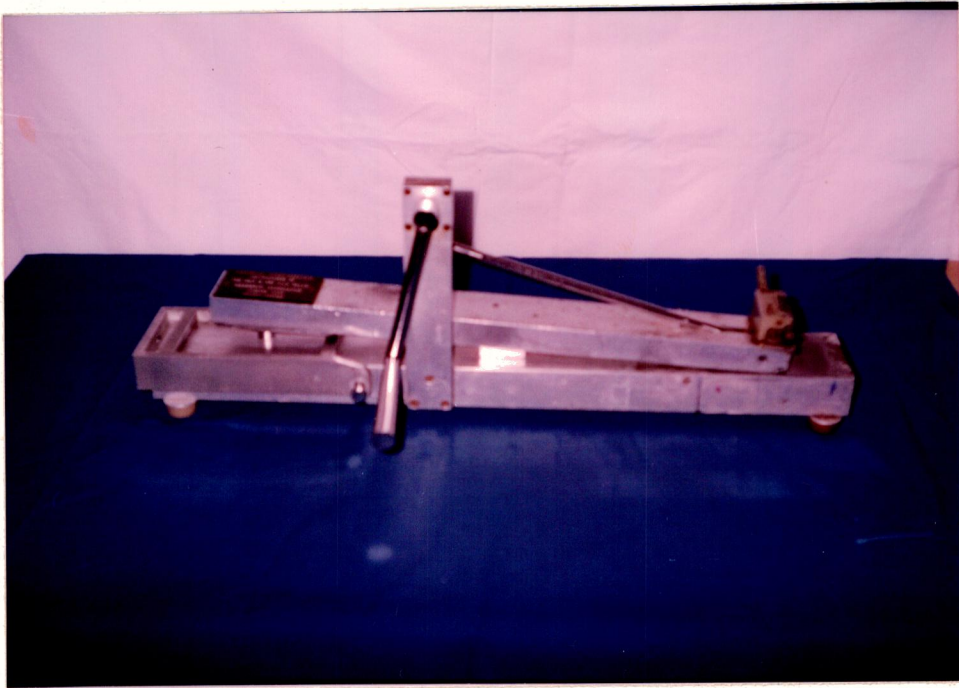


PLATE - VIII
SASMIRA CROCKMETER

week. The investigator had exposed during the day time hours of 9 AM to 5 P.M. not considering the other hours as full day time, the exposed part of the sample and the unexposed part was compared and graded.

d. Fastness to Perspiration - Alkali and Acidic :

According to Wingale (1983) apparel fabrics should be fast to perspiration. Fastness to perspiration was tested on the "SASMIRA" perspirometer (plate - IX). The perspirometer consists of stainless steel plates separated by a spring arrangement. Slides could be placed between the plates and pressed which can be adjusted by means of a 10 Kg weight.

Preparation of Samples : Two swatches of 5 cm x 4 cm were cut from each sample according to ISI (1984), one for alkali and one for acidic perspiration. Each sample was then placed between a white material and stitched on three sides.

Preparation of Alkali Solution : Three gram per liter of sodium was taken and the pH was maintained with sodium carbonate at 7.2.

Preparation of Acidic Solution : 2.65 gm per liter of sodium chloride and 0.75 gm of urea were added to the water. The pH was maintained at 5.6 with the addition of acetic acid. One set of samples were immersed in alkali solution for 30 minutes after which was taken, squeezed and placed between the slides so that its weight presses the sample. The perspirometer was then transferred to a desk oven and the temperature was maintained at 40 degrees C for four hours. The dried samples were then examined



PLATE - IX
SASMIRA PERSPIROMETER
AND
DESK OVEN

for change in color and graded. Other set of samples were immersed in acidic solution and the test was repeated following the same procedure as in the case of alkali perspiration.

4. Computer Analysis :

The computer analysis for the color strength was done in the ACS color computer (plate - X). The printed samples were fed into the computer individually and the results were tabulated via the printer.

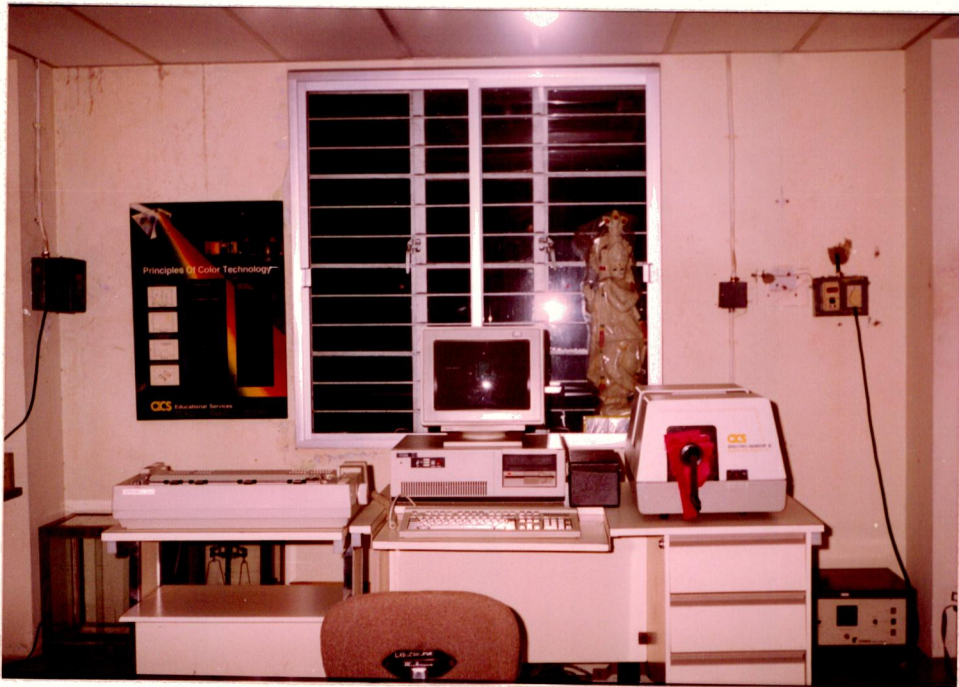


PLATE - \bar{x}
ACS COLOUR COMPUTER

Results and Discussion

IV. RESULTS AND DISCUSSION

The results obtained in the study are discussed under the following heads ;

1. Visual Inspection

- a. General appearance
- b. Brightness of the print
- c. Clarity - outlines of the print
- d. Texture of the print
- e. Lustre of the print

2. Performance Qualities

- a. Fabric weight
- b. Fabric stiffness
- c. Fabric thickness

3. Colour fastness of the prints

- a. Fastness to washing
- b. Fastness to crocking - wet and dry
- c. Fastness to sunlight
- d. Fastness to perspiration - acid and alkali

4. Colour strength of the prints

1. Visual Inspection :

The results obtained in the visual inspection are discussed irrespective of the color in the following order,

- * Comparison among the systems
- * Comparison within the systems
- * Best synthetic thickener irrespective of system
- * Comparing the efficiency of the system by picking out the outstanding synthetic thickener from each system

All the above comparison is made with respect to kerosene emulsion (K 100).

a. General Appearance :

The general appearance of printed samples as evaluated by the judges is given in table I.

Table - I

General Appearance of the Printed Samples (In Percentage) K 100 = 100%

Sl. No.	Color → Title of Recipe	Red			Yellow			T. Blue			Blue			Black		
		Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
1.	A 100	86.67	10.00	3.33	96.66	3.33	0	83.33	10.33	6.34	93.33	3.33	3.34	86.67	10.00	3.33
2.	R 100	56.17	33.33	10.13	86.66	10.33	3.33	60.00	30.00	10.00	80.00	10.00	10.00	73.33	13.33	13.33
3.	T 100	49.99	46.67	3.33	63.33	33.33	3.33	49.99	40.01	10.00	56.17	26.63	20.33	49.99	20.00	10.00
4.	N 100	76.67	10.00	13.33	90.00	10.00	0	73.33	16.67	10.00	90.00	10.00	0	83.33	13.33	3.33
5.	AK 25	83.33	16.67	0	93.33	6.67	0	73.33	26.67	0	96.66	3.34	0	90.00	10.00	0
6.	RK 25	83.33	16.67	0	93.33	6.67	0	80.00	20.00	0	100.00	0	0	90.00	10.00	0
7.	TK 25	73.33	26.67	0	83.33	16.67	0	73.33	26.67	0	83.33	16.67	0	80.00	20.00	0
8.	NK 25	86.67	13.33	0	90.00	10.00	0	80.00	20.00	0	96.66	3.34	0	90.00	10.00	0
9.	AK 50	86.67	13.33	0	90.00	10.00	0	86.67	13.33	0	100.00	0	0	93.33	6.67	0
10.	RK 50	86.67	13.33	0	93.33	6.67	0	83.33	16.67	0	100.00	0	0	96.67	3.33	0
11.	NK 50	83.33	16.67	0	90.00	10.00	0	83.33	16.67	0	100.00	0	0	86.67	13.33	0

From the above table, it is clear that 50% aqueous system and 75% aqueous system are as good as kerosene where as in the 100% aqueous system only alcoprint ranks equivalent to them.

The ranking done by judges can be summarized as follows ;

	100% Aqueous System	75% Aqueous System	50% Aqueous System
I	Alcoprint (89.33%)	RAN-5000 (89.32%)	RAN-5000 (92%)
II	Novaprint (82.66%)	Novaprint(88.67%)	Alcoprint(91.33%)
III	RAN-5000 (71.22%)	Alcoprint(87.32%)	Novaprint(88.66%)

From the above summarization it could be stated that alcoprint and Novaprint are best suited for all the aqueous systems. RAN-5000 is found to give good results in 75% and 50% aqueous systems rather than in 100% aqueous system.

Taking into account the best ranking in all the systems it is clear that kerosene can be replaced completely as the synthetic thickeners are found to equal the kerosene emulsion thickener which is in practice.

b. Brightness of the Prints :

The brightness of the prints as rated by the judges are listed in the table II.

Table - II

Brightness of the Prints (In Percentage)

K 100 = 100%

Sl. No.	Color -> Title of Recipe	Red			Yellow			T. Blue			Blue			Black		
		Bright	Medium	Dull	Bright	Medium	Dull	Bright	Medium	Dull	Bright	Medium	Dull	Bright	Medium	Dull
1.	A 100	86.67	10.00	3.33	76.67	10.00	3.33	76.67	13.33	10.00	73.33	23.33	3.33	73.33	23.33	3.33
2.	R 100	56.67	30.00	3.33	66.67	10.00	23.33	43.33	46.37	10.00	73.33	16.67	10.00	63.33	20.33	13.33
3.	T 100	46.67	26.67	6.67	50.00	40.00	10.00	33.33	30.33	30.33	56.67	33.33	10.00	56.67	40.33	10.00
4.	N 100	56.67	20.00	3.33	66.67	20.00	13.33	66.67	20.00	10.33	66.67	30.00	3.33	63.33	23.33	13.33
5.	AK 25	80.00	20.00	0	83.33	16.67	0	70.00	30.00	0	70.00	30.00	0	76.67	23.33	0
6.	RK 25	76.67	23.33	0	86.67	13.33	0	76.67	23.33	0	80.00	20.00	0	96.67	3.33	0
7.	TK 25	80.00	20.00	0	73.33	26.67	0	73.33	26.67	0	66.67	33.33	0	80.00	10.00	0
8.	NK 25	76.67	23.33	0	76.67	23.33	0	70.00	30.00	0	63.33	36.67	0	80.00	20.00	0
9.	AK 50	83.33	16.67	0	93.33	7.33	0	80.00	20.00	0	76.67	23.33	0	80.00	20.00	0
10.	RK 50	83.33	16.67	0	90.00	10.00	0	83.33	16.67	0	80.00	20.00	0	90.00	10.00	0
11.	NK 50	83.33	16.67	0	93.33	7.37	0	80.00	20.00	0	80.00	20.00	0	86.67	13.33	0

With regard to the brightness of the print 50% aqueous system stands out followed by 75% aqueous system. The 100% aqueous system are judged to be less brighter than K 100 (Standard).

From the above table, ranking can be done as follows

	100% Aqueous System	75% Aqueous System	50% Aqueous System
I	Alcoprint (77.3%)	RAN-5000 (83.34%)	All are equally good (90.00%)
II	Novaprint (64.01%)	Novaprint (76.00%)	
III	RAN-5000 (60.66%)	Thicknol (74.67%)	

Hence it is evident that 50% kerosene substitution is good in brightness. In 75% aqueous RAN-5000 proves result equivalent to 100% aqueous system not as good as 75% and 50% kerosene substitution.

Among the synthetic thickeners, alcoprint is found to be the best followed by RAN-5000 and Novaprint.

Taking into account the best ranking in all the systems, 50% and 75% kerosene substitution are found to equalize the brightness of K 100.

c. Clarity - Outlines of the Print :

The results obtained regarding the clarity of the prints are listed in table III.

Table - III

Clarity - Outlines of the Prints (In Percentage) K 100 = 100%

Sl. No.	Color -> Title of Recipe	Red			Yellow			T. Blue			Blue			Black		
		Even	Mod. Even	Uneven	Even	Mod. Even	Uneven	Even	Mod. Even	Uneven	Even	Mod. Even	Uneven	Even	Mod. Even	Uneven
1.	A 100	93.33	3.33	3.33	80.00	20.00	0	76.67	20.00	3.33	70.00	17.67	3.33	83.33	16.67	0
2.	R 100	66.66	20.00	10.33	83.33	10.33	10.33	76.67	20.00	3.33	73.33	20.00	6.67	76.67	20.00	3.33
3.	T 100	50.00	40.00	10.00	70.00	20.00	10.00	60.00	30.00	10.00	50.00	40.00	10.00	43.33	43.33	10.33
4.	N 100	70.00	20.00	10.00	86.67	10.00	3.33	86.67	10.00	3.33	86.67	10.00	3.33	53.33	40.00	6.67
5.	AK 25	90.00	10.00	0	83.33	16.67	0	90.00	10.00	0	80.00	20.00	0	86.67	13.33	0
6.	RK 25	83.33	16.67	0	86.87	13.33	0	86.67	13.33	0	90.00	10.00	0	80.00	10.00	0
7.	TK 25	80.00	20.00	0	83.33	16.67	0	70.00	30.00	0	80.00	20.00	0	90.00	10.00	0
8.	NK 25	86.67	13.33	0	83.33	16.67	0	86.67	13.33	0	86.67	13.33	0	83.33	16.67	0
9.	AK 50	86.67	13.33	0	86.67	13.33	0	90.00	10.00	0	93.33	6.67	0	86.67	13.33	0
10.	RK 50	90.00	10.00	0	86.67	13.33	0	86.67	13.33	0	83.33	16.67	0	83.33	16.67	0
11.	NK 50	93.34	6.63	0	86.67	13.33	0	86.67	13.33	0	86.67	13.33	0	86.67	13.33	0

As per the table, clarity of the prints in 50% aqueous system and 75% aqueous system are very good. While in 100% aqueous system, the clarity seem to be reduced a little.

From the above table, the ranking can be summarized as ;

	100% Aqueous System	75% Aqueous System	50% Aqueous System
I	Alcoprint (80.76%)	Alcoprint(86.00%)	All are equally good (88.00%)
II	Novaprint (76.67%)	Novaprint(85.33%)	
III	RAN-5000 (75.33%)	RAN-5000 (85.33%)	

Thus, it could be said that 75% substitution and 50% substitution of kerosene give good results. In 100% kerosene substitution alcoprint can be considered equivalent with K 100.

Among the synthetic thickeners alcoprint, Novaprint and RAN-5000 produce results equivalent to K 100 irrespective of the systems.

In general (considering the best in all systems) 75% and 50% kerosene substitutes produce outlines as clear as K 100 while in 100% substitution it is nearly good.

d. Texture of the Prints :

The results obtained regarding the texture of the print are tabulated in table IV.

Table - IV

Texture of the Prints (In Percentage)

K 100 = 100%

Sl. No.	Color -> Title of Recipe	Red			Yellow			T. Blue			Blue			Black		
		Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
1.	A 100	86.67	13.33	0	83.33	13.33	3.33	90.00	6.67	3.33	90.00	6.67	0	83.33	10.00	6.67
2.	R 100	76.67	20.00	3.33	80.00	20.00	10.00	73.33	20.00	6.67	86.67	3.33	10.00	80.00	20.00	10.00
3.	T 100	73.33	20.00	6.67	73.33	20.00	6.67	76.67	20.00	3.33	93.33	6.67	0	76.67	20.00	3.33
4.	N 100	80.00	20.00	0	70.00	20.00	10.00	86.67	10.00	3.33	10.00	6.67	3.33	80.00	20.00	10.00
5.	AK 25	80.00	20.00	0	86.67	13.33	0	86.67	16.67	0	93.33	6.67	0	90.00	10.00	0
6.	RK 25	93.33	6.67	0	90.00	10.00	0	90.00	10.00	0	90.00	10.00	0	93.33	6.67	0
7.	TK 25	86.67	13.33	0	86.67	13.33	0	93.33	6.67	0	86.67	3.33	0	80.00	20.00	0
8.	NK 25	86.67	13.33	0	93.33	6.67	0	90.00	10.00	0	80.00	20.00	0	83.33	16.67	0
9.	AK 50	86.67	13.33	0	93.33	6.67	0	90.00	10.00	0	86.67	3.33	0	86.67	13.33	0
10.	RK 50	96.67	13.33	0	96.67	3.33	0	93.33	6.67	0	90.00	10.00	0	86.67	13.33	0
11.	NK 50	80.00	20.00	0	90.00	10.00	0	96.66	3.33	0	96.67	3.33	0	90.00	10.00	0

From the above table, it can be said that 50% aqueous system and 75% aqueous system produce texture equivalent to K 100 which is followed by 100% aqueous system.

From the above table, the ranking can be done as follows ;

	100% Aqueous System	75% Aqueous System	50% Aqueous System
I	Alcoprint (86.00%)	RAN-5000 (91.33%)	RAN-5000 (91.33%)
II	Novaprint (81.33%)	Novaprint(90.67%)	Alcoprint(87.33%)
III	RAN-5000 (79.34%)	Alcoprint(88.67%)	Novaprint(86.67%)

Thus, 50% and 75% kerosene substitution show no textural variations with K 100 while the difference is bit displayed in case of 100% kerosene substitution.

When synthetic thickeners are taken into account, RAN-5000, Alcoprint and Novaprint are equally good irrespective of the system, while thicknol is good only in 75% kerosene substitution.

When the first ranks are taken into consideration, it could be said that there is no textural variation in 100% kerosene substitution which is negligible.

e. Lustre of the Print :

The lustre of the print as evaluated by the judges are given in table V.

Table - V

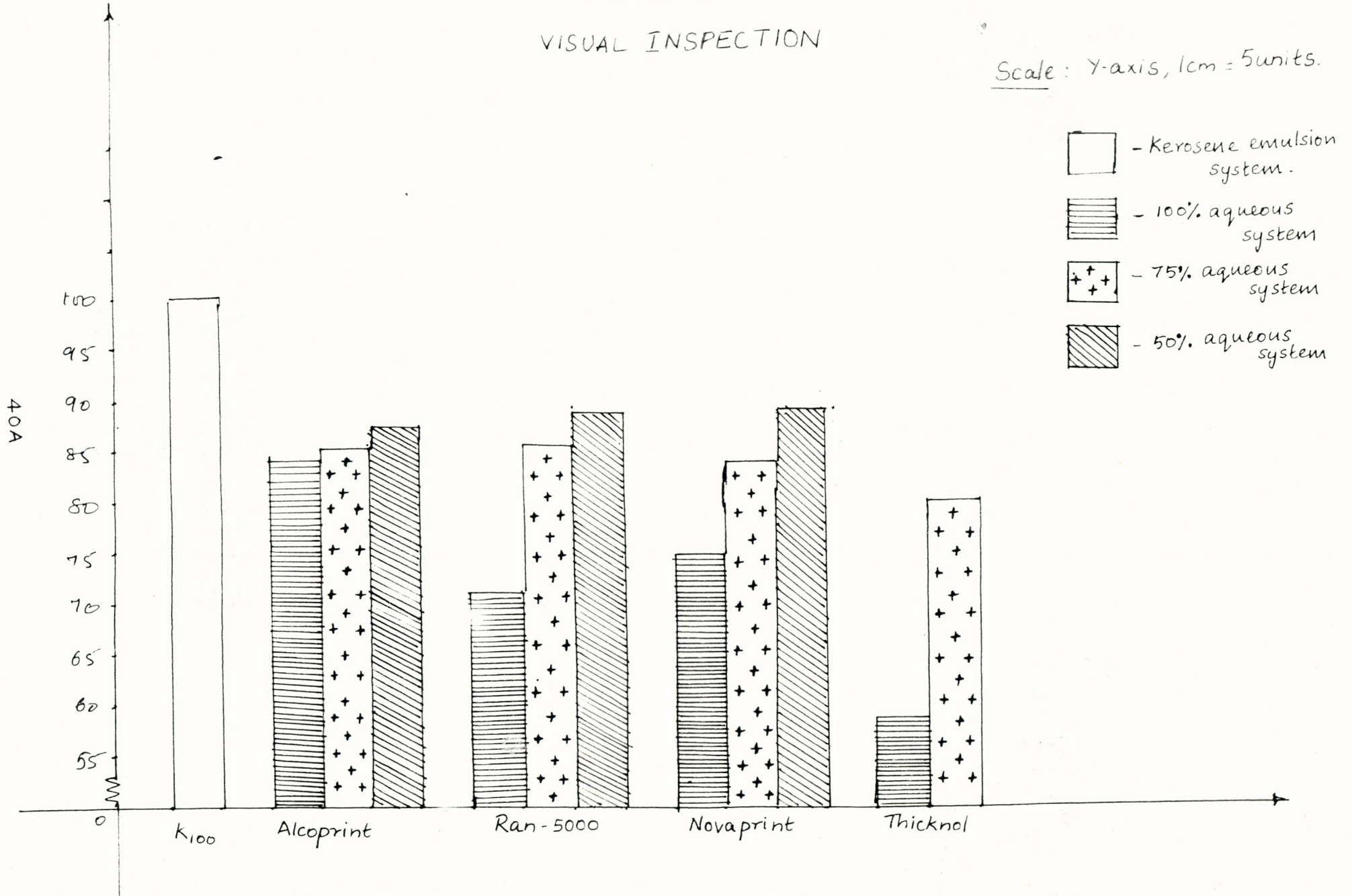
Lustre of the Prints (In Percentage)

K 100 = 100%

Sl. No.	Color -> Title of Recipe	Red			Yellow			T. Blue			Blue			Black		
		Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
1.	A 100	86.00	10.33	3.67	93.33	3.33	3.33	86.67	10.00	3.33	80.00	10.00	10.00	83.33	10.33	6.67
2.	R 100	76.67	20.00	3.33	80.00	10.00	10.00	66.67	20.00	13.33	66.67	20.00	10.33	66.67	23.33	3.33
3.	T 100	53.33	20.33	13.33	66.67	20.00	13.33	70.00	20.00	10.00	56.67	30.00	6.67	56.67	30.00	3.33
4.	N 100	60.00	20.00	10.00	73.33	20.00	6.67	76.67	20.00	3.33	76.67	20.00	6.67	76.67	20.00	3.33
5.	AK 25	90.00	10.00	0	86.67	13.33	0	93.33	7.67	0	93.33	6.67	0	86.67	13.33	0
6.	RK 25	86.66	13.34	0	83.33	16.67	0	80.00	20.00	0	86.67	13.33	0	83.33	16.67	0
7.	TK 25	80.00	20.00	0	90.00	10.00	0	86.67	13.33	0	80.00	20.00	0	83.33	16.67	0
8.	NK 25	90.00	10.00	0	93.33	7.67	0	86.67	13.33	0	83.33	16.67	0	76.67	24.67	0
9.	AK 50	93.33	6.67	0	80.00	20.00	0	86.67	13.33	0	86.67	3.33	0	90.00	10.00	0
10.	RK 50	86.67	13.33	0	93.33	6.67	0	90.00	10.00	0	90.00	10.00	0	83.33	16.67	0
11.	NK 50	86.67	13.33	0	90.00	10.00	0	93.33	7.67	0	90.00	10.00	0	80.00	20.00	0

FIGURE - I
VISUAL INSPECTION

Scale: Y-axis, 1cm = 5 units.



As far as the visual inspection is concerned, Alcoprint is found to suit all the aqueous systems while RAN-5000 and Novaprint give good results in 100% aqueous system. The above fact is depicted in Figure I.

2. Performance Qualities :

As pointed out earlier, the performance qualities are discussed with regard to the weight of the printed sample the stiffness acquired after printing and ultimately the thickness of the printed sample. The performance qualities are analyzed irrespective of the color since there exists not much difference.

a. Fabric Weight :

The fabric weight of the printed samples are listed in Table VI.

TABLE VI

	Red	Yellow	T. Blue	Blue	Black	Mean
K 100	0.7908	0.8025	0.8240	0.8194	0.8004	0.8075
A 100	0.8189	0.8107	0.7938	0.8106	0.7902	0.8050
T 100	0.8330	0.8277	0.8254	0.8582	0.8442	0.8377
R 100	0.8342	0.8554	0.8506	0.8346	0.8742	0.8500
N 100	0.8180	0.8052	0.8233	0.7900	0.8411	0.8155
AK 25	0.8109	0.8225	0.8305	0.8098	0.8104	0.8169
TK 25	0.8200	0.8112	0.8113	0.8062	0.8363	0.8170
RK 25	0.8319	0.8094	0.8198	0.7917	0.8245	0.8120
NK 25	0.8082	0.8019	0.7985	0.8250	0.8235	0.8114
AK 50	0.8058	0.8173	0.8008	0.8040	0.8038	0.8065
RK 50	0.8314	0.8102	0.8256	0.8086	0.8167	0.8185
NK 50	0.8106	0.8043	0.7955	0.7973	0.7846	0.7984

From the above table, it is clear that the fabric weight has increased in all the systems except in a few cases (A100, AK50

and NK50). Among the synthetic thickeners Alcoprint and Novaprint equals almost the weight of the standard (K100). To find out whether there is any significant difference in weight within system and among systems, analysis of variance was done.

The same fact is depicted in Figure II. The results of the analysis of variable (within system) are given in the following tables.

TABLE VI-a
ANOVA for 100% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	4	0.007808	0.001952	8.3359*	2.87
Error	20	0.004683	0.000234		
Total	24	0.012491			

* Significant at 5% level

TABLE VI-b
ANOVA for 75% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	4	0.000341	0.000085	0.52598 ^{NS}	2.87
Error	20	0.003247	0.000162		
Total	24	0.003588			

NS = Not Significant

FIGURE - II

FABRIC WEIGHT

SCALE = Y-axis, 1cm = 0.005 unit

- Kerosene emulsion system
- 100% aqueous system
- 75% aqueous system
- 50% aqueous system

0.8550
0.8500
0.8450
0.8400
0.8350
0.8300
0.8250
0.8200
0.8150
0.8100
0.8050
0.8000
0.7950

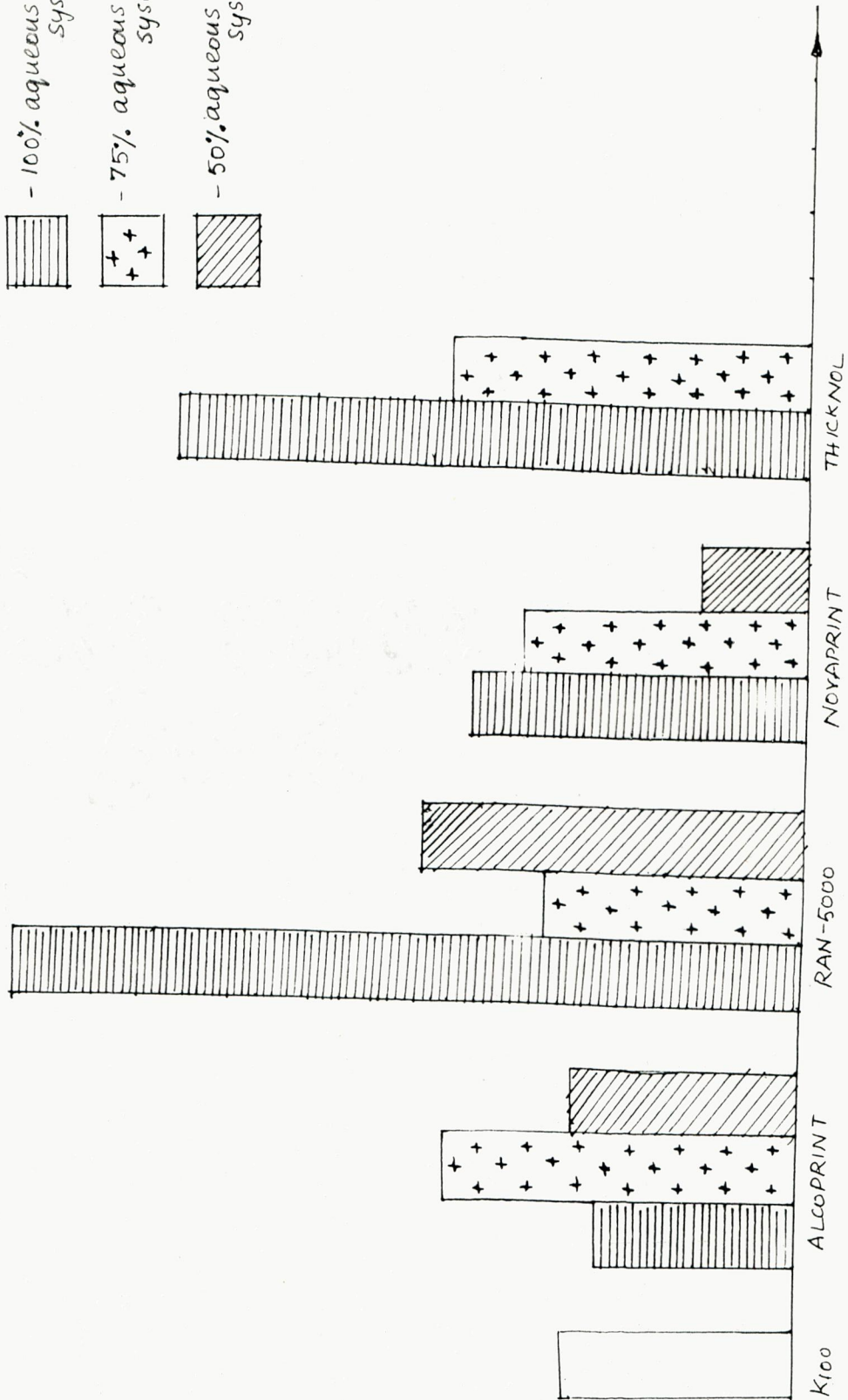


TABLE VI-c
ANOVA for 50% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	3	0.001019	0.000339	3.195715 ^{NS}	3.24
Error	16	0.001701	0.00106		
Total	19	0.002721			

NS = Not significant

The above analysis proves that there is significant difference in weight in 100% aqueous system. Duncan's Multiple Range test was done to find out which thickener influences the difference in weight. The results of the multiple range test is given in the Table VI-d.

TABLE VI-d
Duncan's Multiple Range Test for 100% Aqueous System

S.E. of sample means = 0.006843

	2	3	4	5
P(5%)	2.95	3.04	3.12	3.20
RP(5%)	0.02	0.02	0.02	0.20

Recipe	Mean	Difference			
A 100	0.8048				
K 100	0.8074	0.0026			
M 100	0.8155	0.0107	0.0081		
T 100	0.8377	0.3329	0.0303	0.0222	
R 100	0.8498	0.045	0.0424	0.0343	0.0121

The above analysis proves that there is significant difference in weight due to T 100, R 100 and N 100.

The results of analysis of variance done among the systems taking the best rankings in all the systems proved that there is no significant difference in weight among the systems. The result is shown in Table VI-e

TABLE VI-e
ANOVA - Among System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	3	0.016	0.0053	0.5520	3.24
Error	16	0.154			
Total	19	0.17			

NS = Not significant

b. Fabric Stiffness :

The stiffness or bending length of the printed material is tabulated in the Table VII

TABLE VII

Fabric Stiffness (In Centimeters)

	Red	Yellow	T. Blue	Blue	Black	Mean
K 100	2.525	2.55	2.55	2.55	2.5	2.535
A 100	2.925	3.05	2.8	2.775	2.875	2.885
T 100	2.95	3.075	2.775	3.25	3.25	3.060
R 100	2.725	2.75	2.9	2.85	2.625	2.770
N 100	2.575	2.775	2.75	2.475	2.775	2.670
AK 25	2.45	2.575	2.725	2.525	2.45	2.545
TK 25	2.575	2.6	2.5	2.575	2.525	2.555
RK 25	2.5	2.525	2.625	2.625	2.5	2.235
NK 25	2.625	2.475	2.575	2.525	2.6	2.560
AK 50	2.45	2.475	2.4	2.625	2.55	2.500
RK 50	2.225	2.375	2.325	2.4	2.4	2.345
NK 50	2.45	2.575	2.55	2.475	2.375	4.485

From the above table, it is clear that all the aqueous systems show an increase in stiffness, except Novaprint, irrespective of the synthetic thickness/color. Novaprint shows a reduction of stiffness when compared with K 100 and 75% aqueous system.

The above fact is depicted in figure III. To find out whether there is any significant difference in stiffness within system and among systems, analysis of kerosene was done and the results (within systems) are tabulated in Table VII-a.

FIGURE - III

FABRIC STIFFNESS

SCALE = Y-axis, 1cm = 0.0010 unit

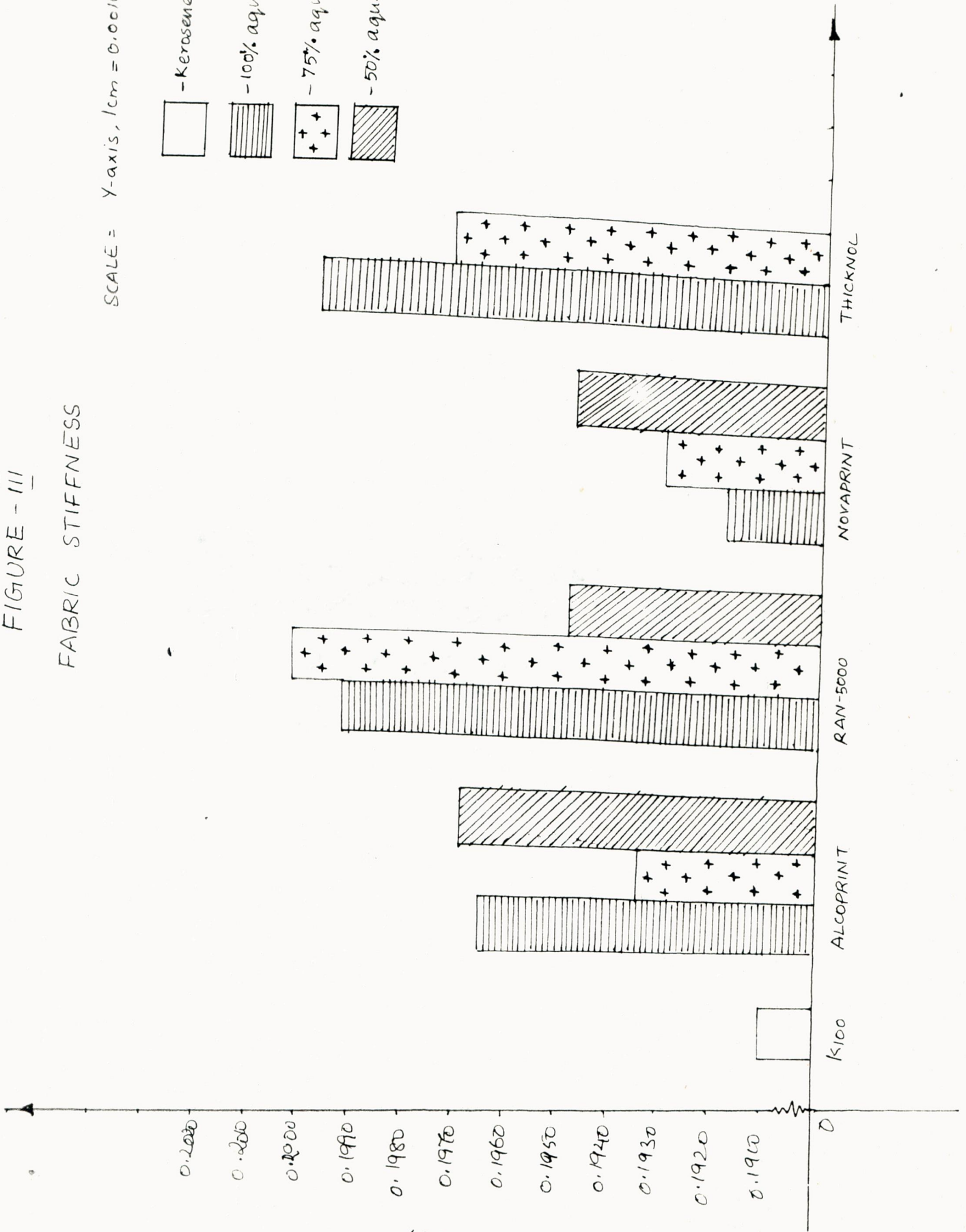
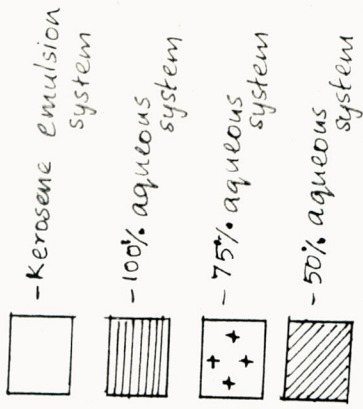


TABLE VII-a

ANOVA for 100% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	4	0.80785	0.201196	11.9416	2.87
Error	20	0.33825	0.01691		
Total	24	1.1461			

* Significant at 5% level

TABLE VII-b

ANOVA for 75% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	4	0.0026	0.00065	0.151603	2.87
Error	20	0.08575	0.004287		
Total	24	0.08835			

NS = Significant at 5% level

TABLE VII-c

ANOVA for 50% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	3	0.103	0.034333	6.97561	3.24
Error	16	0.07875	0.004921		
Total	19	0.18175			

* Significant at 5% level

The above analysis proves that there is significant difference in stiffness due to 100% and 50% aqueous system.

Duncan's multiple range test was done to find out which thickener influences the difference in stiffness. The result is given in Table VII-d and Table VII-e.

TABLE VII-d

Duncan's Multiple Range Test for 100% Aqueous System

S.E. of sample means = 0.05815

	2	3	4	5
P(5%)	2.95	3.04	3.12	3.20
RP(5%)	0.17	0.18	0.18	0.19

Recipe	Mean	Difference			
K 100	2.535				
M 100	2.670	0.135	0.10		
R 100	2.770	0.235	0.25	0.115	0.175
A 100	2.885	0.350	0.390	0.295	
T 100	3.060	0.525			

* Significant 5% level

TABLE VII-e

Duncan's Multiple Range Test for 50% Aqueous System

S.E. of sample means = 0.031374

	2	3	4
P(5%)	3.00	3.15	3.23
RP(5%)	0.094	0.99	0.10

Recipe	Mean	Difference		
RK 50	2.345	0.14		
MK 50	2.485	0.15	0.01	0.04
AK 50	2.495	0.19	0.05	
K 100	2.535			

* significant 5% level

From the above test it is noted that the difference in stiffness was due to M 100 and A 100 in 100% aqueous system and in the 50% aqueous system was due to RK 50.

The analysis of variance among systems was done best ranking in all the systems and tabulated in Table VII-f.

TABLE VII-f
ANOVA - Among Systems

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	3	0.2673	0.08927	12.994	3.24
Error	16	0.1100	0.00687		
Total	19				

* Significant at 5% level

From the above analysis it is proved that there is significant difference in stiffness due to the 50% aqueous system.

c. Fabric Thickness :

The thickness of the printed samples are tabulated in the Table VIII

TABLE VIII
Fabric Thickness (In mm)

	Red	Yellow	T. Blue	Blue	Black	Mean
K 100	0.19	0.195	0.185	0.195	0.19	0.191
A 100	0.202	0.20	0.19	0.19	0.20	0.196
T 100	0.207	0.20	0.197	0.20	0.195	0.20
R 100	0.20	0.207	0.20	0.192	0.197	0.199
N 100	0.19	0.192	0.19	0.20	0.187	0.192
AK 25	0.20	0.20	0.192	0.175	0.20	0.193
TK 25	0.20	0.207	0.202	0.185	0.19	0.197
RK 25	0.20	0.20	0.205	0.197	0.20	0.200
NK 25	0.20	0.195	0.20	0.19	0.19	0.195
AK 50	0.20	0.20	0.20	0.192	0.192	0.197
RK 50	0.20	0.202	0.20	0.18525	0.19	0.195
NK 50	0.20	0.195	0.20	0.187	0.192	0.195

From the above table it could be said that 75% and 50% aqueous systems (except Ran-5000) shades equivalent the lines when compared with the standard (K 100). In the 100% aqueous system the thickness of the fabric is increased a little. The same fact is depicted in Figure IV.

Statistical analysis was done to find out whether there is any significant difference within systems and among systems irrespective of the color.

Tables VIII-a, VIII-b and VIII-c showed the results of analysis of variance for within systems.

FIGURE - IV

FABRIC THICKNESS

SCALE = Yaxis; 1cm = 0.1 unit

- Kerosene emulsion system
- 100% aqueous system
- 75% aqueous system
- 50% aqueous system

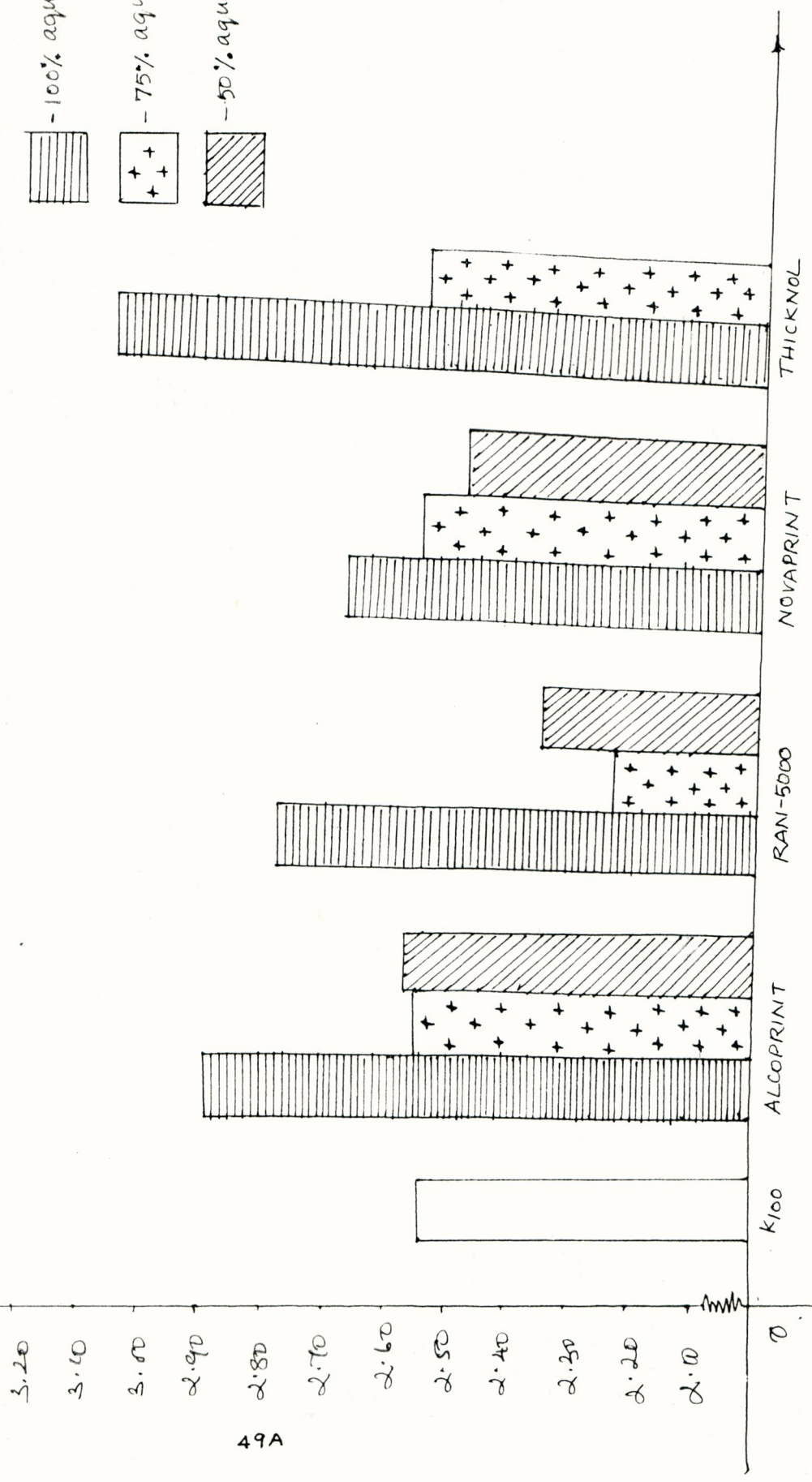


TABLE VIII-a
ANOVA for 100% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	4	0.000334	0.000083	3.29156	2.87
Error	20	0.000507	0.000025		
Total	24	0.000841			

* Significant at 5% level

TABLE VIII-b
ANOVA for 100% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	4	0.000258	0.000064	1.272119	2.87
Error	20	0.001017	0.000050		
Total	24	0.001276			

* Significant at 5% level

TABLE VIII-c
ANOVA for 50% Aqueous System

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipes	3	0.000029	0.8598	3.24	
Error	16	0.000549	0.000034		
Total	19	0.000638			

NS = Not Significant

Thus from the above results it could be noted that there is significant difference due to 100% aqueous system.

The result of Duncan's multiple range test for 100% aqueous system is given as seen in table VIII-d.

TABLE VIII-d

Duncan's Multiple Range Test for 100% Aqueous System

S.E. of sample means = 0.005

	2	3	4	5
P(5%)	2.95	3.04	3.12	3.20
RP(5%)	0.01	0.01	0.01	0.01

Recipe	Mean	Difference			
K 100	0.191				
M 100	0.192	0.001			
R 100	0.196	0.005	0.004	0.002	
A 100	0.199	0.008	0.007	0.004	0.001
T 100	0.20	0.009	0.008		

* Significant at 5% level

The above test proves that the significant difference in thickness is due to thicknol.

To find out whether there is any difference in thickener among systems, the best rankings within the systems were taken. The results are given as seen in Table VIII-e

TABLE VIII-E
ANOVA - Among Systems

Source	D.F.	S.S.	M.S.S.	F. Value	F. 5%
Between recipis	3	0.3457	0.0290	0.7073	3.24
Error	16	0.6565	0.0410		
Total	19	0.32			

* Significant at 5% level

The above analysis clearly shows that there is no significant difference in thickness due to the systems.

3. Colour Fastness Tests :

a. Colour Fastness to Washing :

The grades obtained by the washed samples are given in Table IX .

TABLE IX

	Red	Yellow	T. Blue	Blue	Black
K 100	3-4	3-4	4	3-4	3-4
A 100	3	3-4	3-4	3-4	3
T 100	2	2	1-2	1-2	3
R 100	3-4	4	3-4	3	3-4
N 100	3	4	3-4	4	3-4
AK 25	3-4	3-4	3-4	4	3-4
RK 25	3-4	3	3	3	3
TK 25	2	2	1-2	1-2	3
NK 25	3	3	3-4	3-4	3-4
AK 50	3	3-4	3-4	3-4	4
RK 50	3-4	3-4	3-4	4	4
NK 50	3	3-4	3-4	3-4	4

Keynote : 4 Good; 3-4 Fair; 3 Moderate; 2 Poor; 1 Poor;

It is evident from Table IX, that all the synthetic thickeners show equivalent grades with kerosene irrespective of color/systems thus making the 100% kerosene substitution a success.

b. Fastness to Crocking - Wet & Dry :

The grades obtained by dry crocking and wet crocking are depicted in Table X and Table XI respectively.

TABLE X
Fastness to Dry Crocking

	Red	Yellow	T. Blue	Blue	Black
K 100	1-2	2-3	1-2	2-3	3
A 100	2-3	3	2	2	2-3
R 100	2	3	1-2	2-3	2
T 100	1-2	3	3	2-3	1-2
N 100	2-3	3	2-3	3	2
AK 25	1-2	2-3	2	1-2	3
RK 25	3	3	1-2	3-4	2-3
TK 25	1-2	2-3	2-3	2	1
NK 25	2	3	2	2-3	2
AK 50	1-2	2	2-3	2-3	3
RK 50	1	2-3	1-2	1-2	1-2
NK 50	2-3	3-4	2-3	3-4	2-3

Keynote : 4 Good; 3-4 Fair; 3 Moderate; 2 Poor; 1 Poor;

TABLE X]

Fastness to Wet Crocking

	Red	Yellow	T. Blue	Blue	Black
K 100	1	2-3	1	2	1
A 100	1	1-2	1	1	1
R 100	1	1-2	1	1	1
T 100	1	1	1	1	1
N 100	1	2-3	1-2	1	1
AK 25	1	1-2	1	1	1
RK 25	1	1-2	1	1	1
TK 25	1	1	1	1	1
NK 25	1	1-2	1	1-2	1
AK 50	1-2	1-2	1	2	1
RK 50	1	2	1	1	1
NK 50	1	2	2-3	1	1

Keynote : 4 Good; 3-4 Fair; 3 Moderate; 2 Poor; 1 Poor;

From Table X and Table XI it is noted that the grades of the samples printed with synthetic thickeners irrespective of the color/system show equivalent grades with the standard (K100). Thus it could be stated that as far as the fastness to crocking - wet and dry, 100% replacement may be effective. (The lower grades may be due to usage of increased pigment percentage).

c. Fastness to Sunlight :

The grades obtained by the individual samples for its fastness to sunlight are tabulated in Table XII.

TABLE XII
Fastness to Sunlight

	Red	Yellow	T. Blue	Blue	Black
K 100	7	7	7	7	7
T 100	7	7	7	7	7
A 100	7	8	7	7	8
R 100	8	7	7	7	8
N 100	7	7	7	7	8
AK 25	7	7	7	7	8
RK 25	8	7	8	8	8
TK 25	7	7	8	8	8
NK 25	7	7	8	7	7
AK 50	8	7	8	7	8
RK 50	8	8	8	8	8
NK 50	8	7	7	7	8

Keynote : 7 Excellent; 8 Outstanding

The above table clearly indicates that almost all the samples show outstanding results irrespective of the systems/colors/ synthetic thickeners regarding the fastness to sunlight. Hence it could be stated that 100% kerosene replacement may be effective in pigment printing.

d. Colour Fastness to Perspiration - Acid and Alkali :

The printed samples were tested for fastness to alkali perspiration and acid perspiration and the grades are tabulated in Table XIII and Table XIV respectively.

TABLE XIII

Fastness to Alkali Perspiration

	Red	Yellow	T. Blue	Blue	Black
K 100	4-5	4-5	4-5	4	4
A 100	4	4-5	3-4	4	3-4
R 100	4-5	4-5	4	4	3-4
T 100	4-5	4-5	4	4	4
N 100	4	4-5	3-4	4-5	4-5
AK 25	4-5	4	3-4	4	4
RK 25	4	4	3-4	4-5	3-4
TK 25	4	4-5	4-5	4	4
NK 25	4	4-5	4-5	4	4
AK 50	4-5	4	4	4-5	4
RK 50	4-5	4-5	4-5	4	4-5
NK 50	4-5	4-5	4-5	4-5	4-5

Keynote : 5 Excellent or No Fading ; 4-5 Very Good;
4 Good ; 3-4 Fair

TABLE XIV

Fastness to Acid Perspiration

	Red	Yellow	T. Blue	Blue	Black
K 100	4-5	5	5	4-5	4
A 100	5	4	4-5	4	4-5
R 100	4-5	5	4	4-5	3-4
T 100	4-5	4-5	4	4-5	4-5
N 100	4-5	4-5	4	4-5	4
AK 25	4-5	3-4	3-4	4-5	4
RK 25	4	5	4-5	4	4
TK 25	4	4-5	3-4	3-4	4-5
NK 25	4	4-5	4-5	4	4
AK 50	4-5	4	4	4-5	4
RK 50	4-5	4-5	4-5	4	4-5
NK 50	4-5	4-5	4-5	4-5	4-5

Keynote : 5 Excellent or No Fading ; 4-5 Very Good;
4 Good ; 3-4 Fair

Table XIII and Table XIV clearly reveal that the grades of the samples printed with synthetic thickeners is equivalent to the standard K 100 irrespective of the system/color.

From the above discussion, it could be spelt that as far as the fastness property is concerned 100% kerosene replacement is a success.

4. Colour Strength of the Prints :

The colour strength or colour depth of the prints as visualized by the computer are tabulated in Table XV.

TABLE XV
Colour Strength of the Prints (In Percentage)

	Red	Yellow	T. Blue	Blue	Black	Mean
K 100	100.00	100.00	100.00	100.00	100.00	100.00
A 100	86.55	97.03	82.07	95.91	86.72	89.65
R 100	57.12	87.82	60.47	79.25	74.63	71.85
T 100	52.53	65.13	47.49	57.18	50.65	54.60
N 100	78.87	90.98	75.99	89.42	84.52	83.96
AK 25	83.99	94.69	75.81	97.64	91.80	89.79
RK 25	81.17	94.12	80.73	100.44	90.30	89.352
TK 25	76.43	85.04	73.40	82.29	91.07	81.646
NK 25	86.23	91.30	80.36	96.25	79.52	86.732
AK 50	86.81	91.95	85.76	101.14	90.17	91.66
RK 50	85.27	92.79	84.36	101.25	95.81	91.902
NK 50	85.84	90.20	83.44	100.17	87.66	89.46

From the above table it is evident that 50% aqueous systems show good colour strength followed by 75% aqueous system. In the 100% aqueous system one of the synthetic thickener (Alcoprint) is found to produce good results.

Among the synthetic thickeners Alcoprint ranks first in colour strength followed by RAN-5000 and Novaprint.

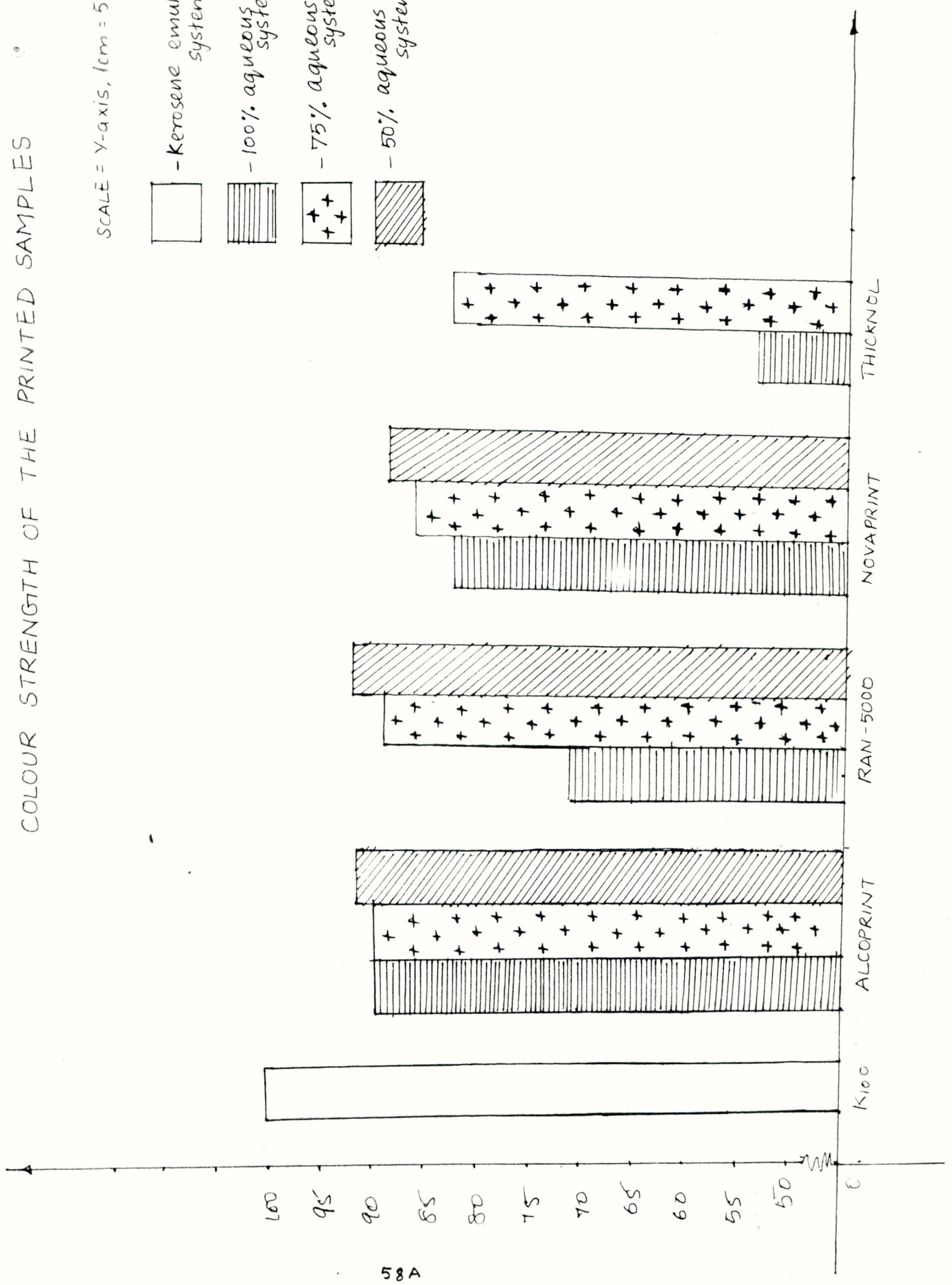
Hence it could be stated that with regard to colour strength 50% and 75% aqueous system show good results and Alcoprint ranks first followed by RAN-5000 and Novaprint.(FIGURE V)

FIGURE - V

COLOUR STRENGTH OF THE PRINTED SAMPLES

SCALE = Y-axis, 1cm = 5 units

- Kerosene emulsion system
- 100% aqueous system
- 75% aqueous system
- 50% aqueous system



Summary and Conclusion

V. SUMMARY AND CONCLUSION

Pigment printing is in vogue in India and elsewhere. Kerosene emulsion is the thickener of choice in pigment printing since it provides adequate overall fastness and reasonable brilliance. But the kerosene is expelled into the air during the process of drying and curing; thus causing environmental pollutions. Moreover the kerosene has no effluent treatment thus when it is washed off, it pollutes the surrounding water. In addition it leads to health hazards also.

The textile industry consumes over 100,000,000 liters of kerosene annually. In our country in addition to the above mentioned problems kerosene is in short supply and in addition it is implemented for domestic use in homes. This leads to the production of synthetic thickeners which has claimed to replace the kerosene completely or partially thus eradicating the pollution problems and thereby other above mentioned drawbacks. The objective of the study are to ;

1. Analyse how far the synthetic thickener plays the kerosene i.e. 100%, 75% and 50%
2. Test the effectiveness of synthetic thickeners with respect to its fastness properties
3. Test whether the synthetic thickener causes any variation in the printed samples with regard to its performance qualities.
4. Mainly the color strength acquired by the synthetic thickeners on the prints.

The experimental procedure of the study comprises of printing the samples with four recipes (oil-in-water system, 100% aqueous system, 75% aqueous and 50% aqueous system), four synthetic thickeners (Alcoprint 'P' system, Novaprint CL, RAN 5000 and Thicknol) and five colors (Red, Yellow, Blue, Black and Turquoise Blue). The recipe oil-in-water system was done on the basis of conventional pigment printing, hence it is taken as the standard.

Evaluation of the printed samples for its general appearance, brightness, clarity, texture and lustre are done by visual inspections. The variations if any, in weight, stiffness, thickness are found through the laboratory test. Color fastness tests were carried out for washing, crocking (wet and dry), sunlight, perspiration (acid and alkali). Color strength of the prints were visualized via the computer.

The findings of the study are as follows ;

- a. As far as the visual inspection is concerned 50% and 75% kerosene substitution may be suitable for pigment printing. Among synthetic thickeners, Alcoprint ranks first in all the aqueous system followed by RAN 5000 and Novaprint.
- b. The samples printed with 50% and 75% aqueous system show good results regarding the fabric weight. Alcoprint ranks first followed by Novaprint among the synthetic thickeners.

- c. The samples printed with 75% aqueous system show good results regarding stiffness followed by 50% aqueous system. Novaprint and RAN 5000 show equivalent results with the standard.
- d. 75% and 50% aqueous system show equivalent results when compared with the standard ; Novaprint ranks first followed by Alcoprint and RAN 5000.
- e. All the color fastness tests revealed the same results i.e. 100% kerosene substitution in pigment printing may be a success.
- f. Regarding the color strength of the printed samples 50% aqueous system show good results followed by 75% aqueous system. Among the synthetic thickeners Alcoprint ranks first followed by Novaprint and RAN 5000.

Conclusion

From the above findings it may be concluded that 100% kerosene substitution may be effective regarding the color fastness properties.

Recommendations

1. This study may be followed up by increasing the pigment percentage and bringing out variations in binder percentage to achieve the desired depth in shade 100% aqueous system
2. This trial study can be done in Rotary screen printing.

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Appendices

APPENDIX - I

LITERATURE OF THE SYNTHETIC THICKENERS USED

According to the literature produced from the respective manufactures, the details of the synthetic thickeners are summarized as follows :

1. SM Alcoprint 'P' System :

This synthetic thickener is produced by SM Dyechem Ltd.

Technical Properties

- a. Appearance - White pourable dispersion
- b. Ionogenicity - Anionic
- c. Solubility - Disperse readily in water and produces smooth paste
- d. pH of 1% paste - 5 to 6

Special Advantages

- a. 100% or partial replacement of kerosene or solvents used in pigment printing of textiles
- b. Ensures excellent color value, fastness properties and sharpness of prints
- c. Substantial savings in cost of pigment printing
- d. Suitable for roller, screen and rotary printing machines
- e. Ideal for hot and cold printing tables
- f. Non-hazardous and freely available

Precautions

- a. No acid liberating catalyst should be used
- b. If stored for longer time, binder free stocks are to be prepared to avoid the problem of skinning

2. Thicknol :

This synthetic thickener is manufactured by associated chemicals. Thicknol is a synthesis of judicious blend acrylic monomers which imparts a soft pliable tough and resistant film. This acrylic Co - polymer emulsion has the following features.

- a. Appearance - milky white thin emulsion
- b. pH - 3 to 3.5
- c. Active content - 28% +/- 2%
- d. Viscosity of 2% product at neutral pH 75 cps

Advantages :

1. There is no deleterious effect on fastness and brightness of the print with thicknol
2. Binders can be reduced to the extent of 2% for light and medium shades and 1% for deep shades
3. The partial replacement of kerosene with thicknol is suitable for different types of systems of printing like roller, flat bed and rotary
4. Thicknol minimizes fire and pollution hazard emanating from usage of solvent and consequent drying
5. Thicknol is cost effective without sacrificing the quality of print obtained

Precautions :

- a. Following catalyst effect the viscosity
 1. Sulfuric acid
 2. Para toluene sulphonic or its ammonium salt
- b. Addition of diammonium phosphate should be avoided

3. RAN - 5000 : From the House of RSA Polymer

RAN - 5000 is simple, highly cost effective and can be successfully substituted for emulsion printing.

Description of RAN 5000 :

- a. RAN - 5000 is available as a pourable liquid polymer
- b. RAN - 5000 easily disperses in water and forms a thick smooth paste
- c. pH of 2% paste is between 7 and 8
- d. RAN - 5000 is anionic in nature

Advantages :

- a. RAN - 5000 has several advantages over standard products today because of special mechanism utilized to give least free water content in the thickener paste.
- b. RAN - 5000 has a unique viscosity building mechanism which reduces flushing seen in other standard thickeners
- c. With reduced free water in printing paste it gives less back side penetration thus improving color yield by 10% at similar viscosity compared with conventional products
- d. RAN - 5000 can eliminate kerosene completely or partially depending on the needs of the printer

Storage :

- a. Keep RAN - 5000 carboys upside down during storage
- b. Shake RAN - 5000 for 5 to 10 minutes before sending to the user department
- c. Do not store above 45 degrees C or in direct sunlight
- d. Always keep the cap closed after each withdrawal of material

PROFORMA FOR VISUAL INSPECTION

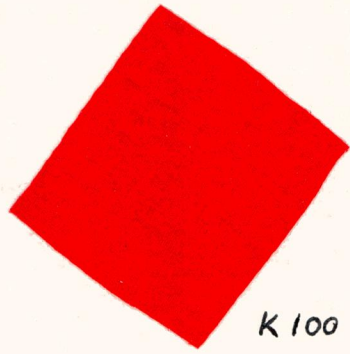
STANDARD - K100

Sl. No.	Title of Sample	General Appearance			Brightness of the print			Clarity - Outline of print			Texture of the print			Lustre of the print		
		Good	Fair	Poor	Bright	Medium	Dull	Even edged	Mod. Even	Uneven	Fine	Medium	Coarse	Good	Fair	Poor
1.	A100 - Re															
2.	R100 - Re															
3.	T100 - Re															
4.	N100 - Re															
5.	AK25 - Re															
6.	RK25 - Re															
7.	TK25 - Re															
8.	NK25 - Re															
9.	AK50 - Re															
10.	RK50 - Re															
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14.	T100 - Ye															
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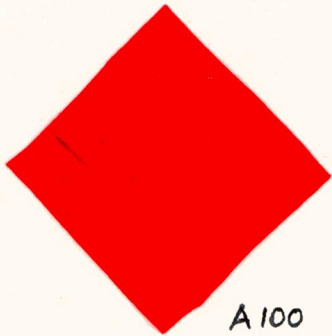
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APPENDIX-II

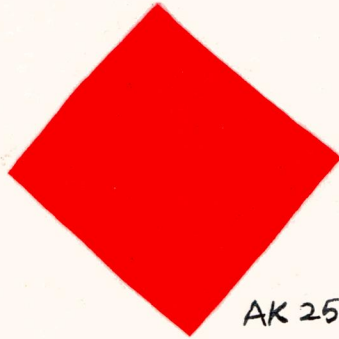
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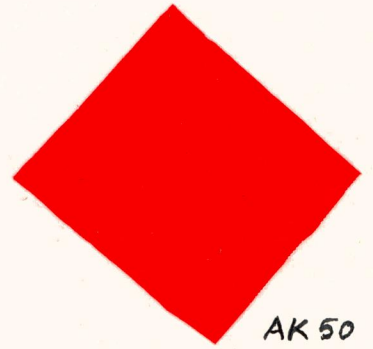
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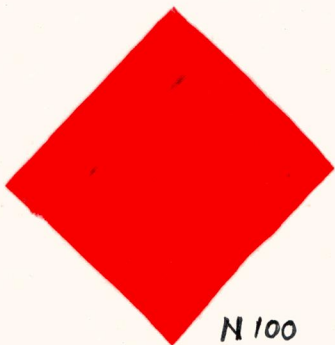
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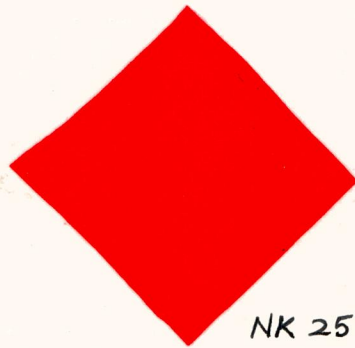
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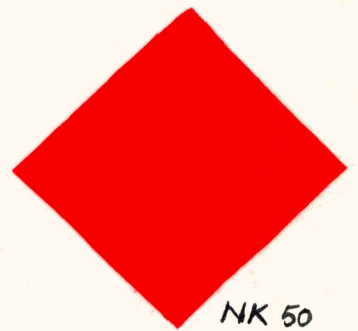
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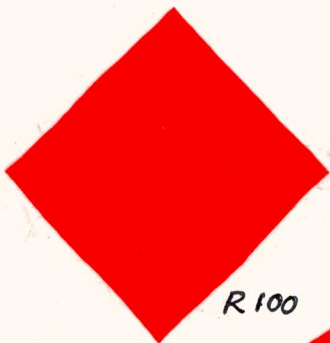
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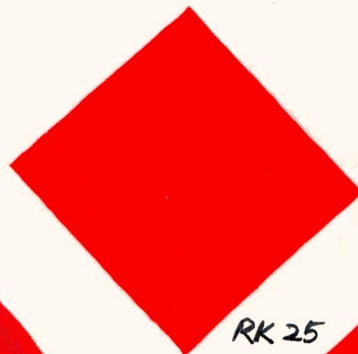
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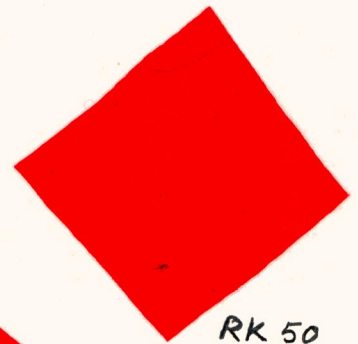
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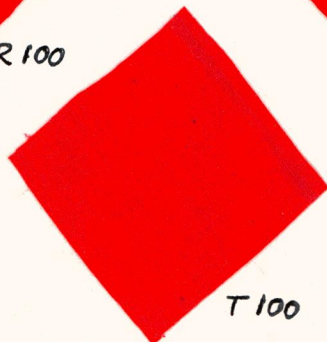
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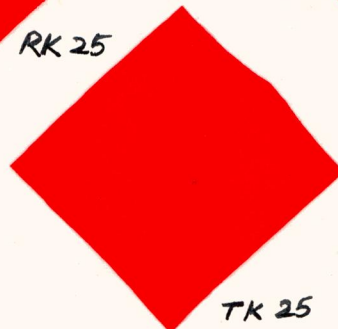
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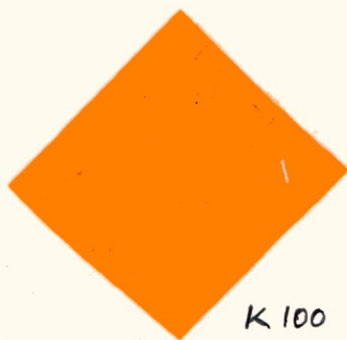


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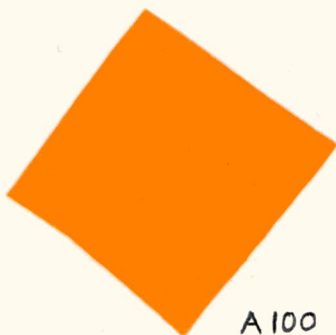


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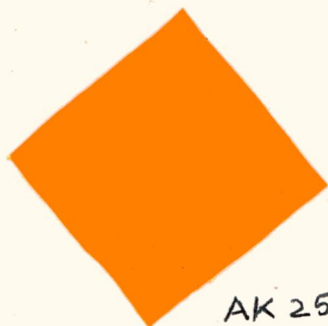
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K 100



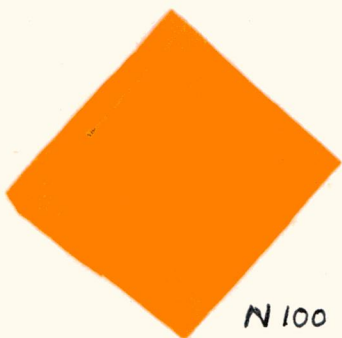
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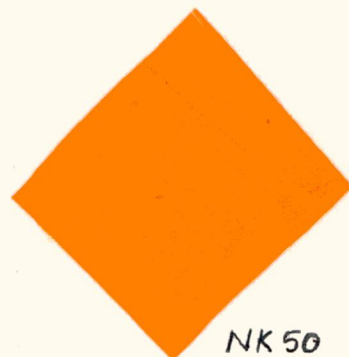
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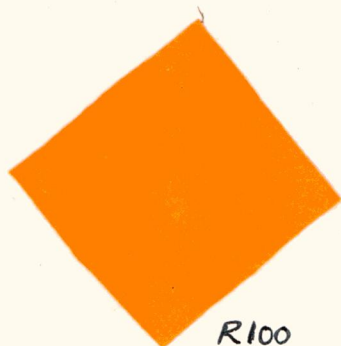
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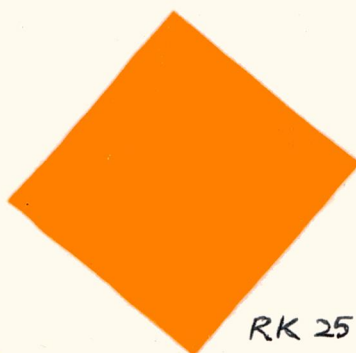
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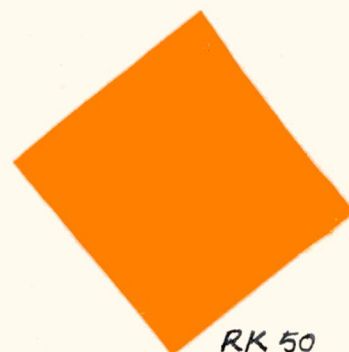
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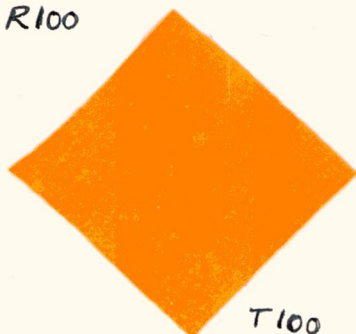
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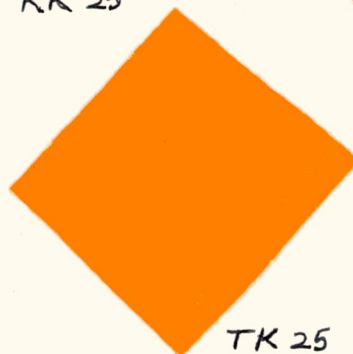
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RK 50

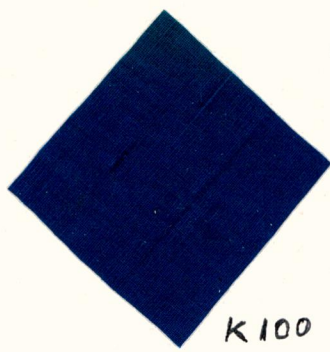


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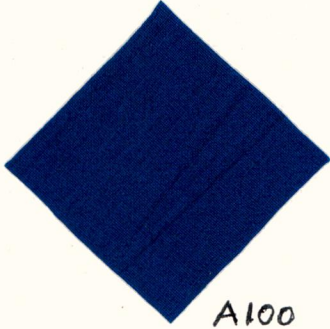


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IMPRON TURQOIC BLUE KCBN



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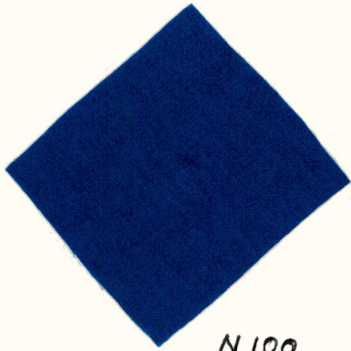
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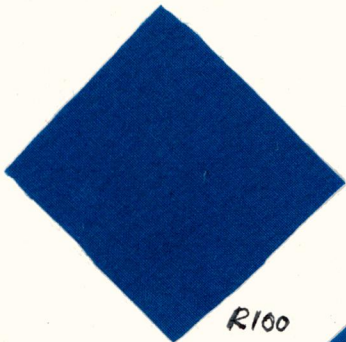
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NK 50



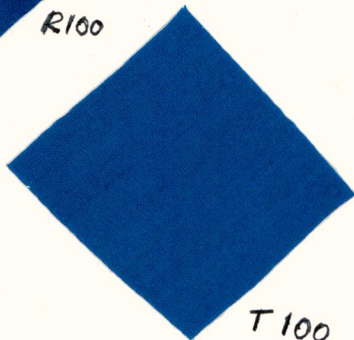
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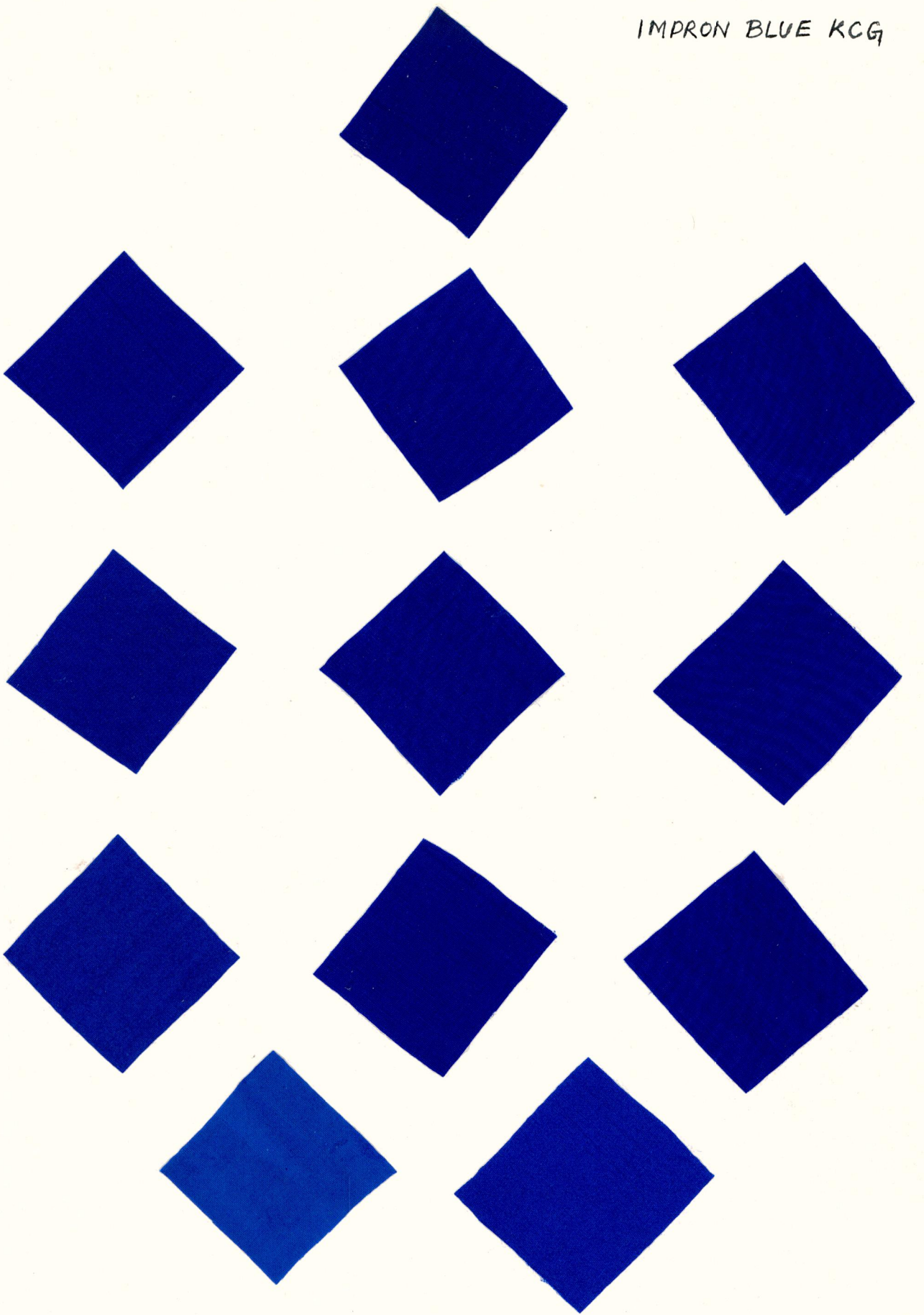


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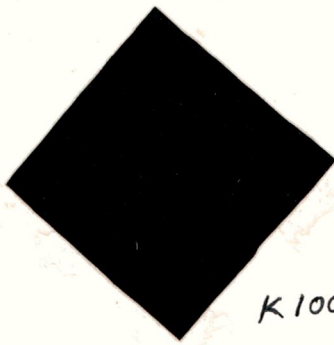


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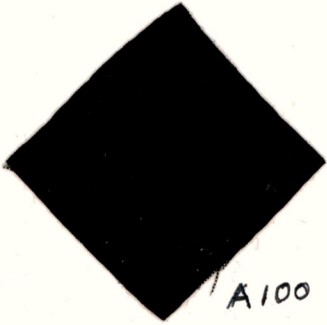
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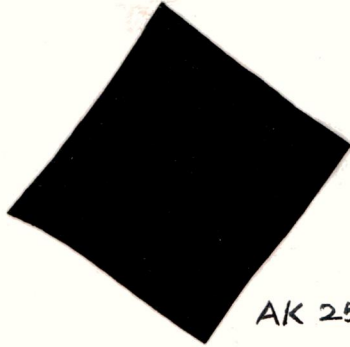
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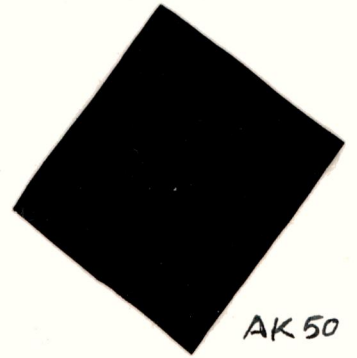
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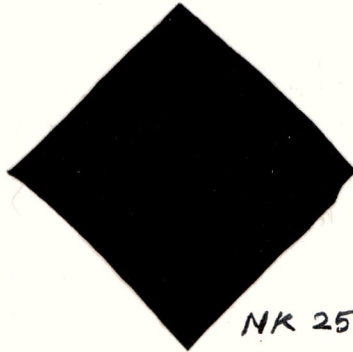
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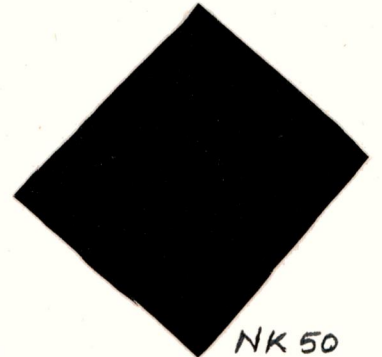
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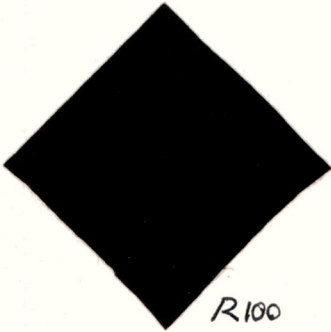
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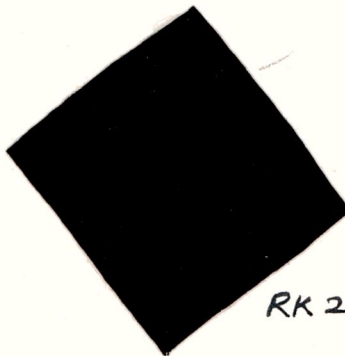
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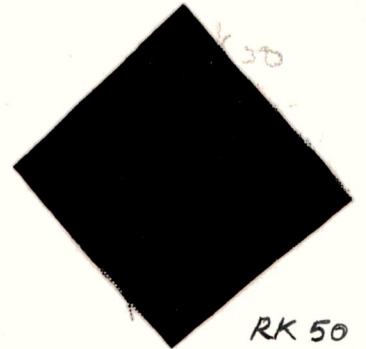
NK50



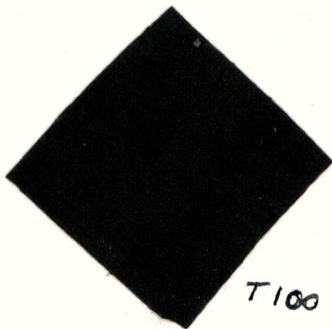
R100



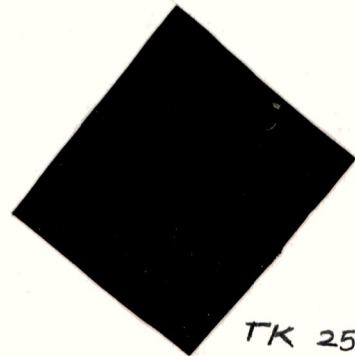
RK25



RK50



T100



TK25

APPENDIX - IV
STATISTICAL ANALYSIS

Analysis of Variance :

According to Gupta and Kapoor (1985) Fisher's Analysis of Variance (ANOVA) is the "separation of variance ascribable to one group of causes from the variance ascribable to other groups". If the calculated value of 'f' is greater than the table value, it is concluded that the difference in sample means is significant - On the other hand, if the calculated value of 'f' is less than the table value, the difference is not significant.

The analysis of variance table and the calculation for various components are shown below

ANOVA - ONE WAY CLASSIFICATION

Source of Variance	SS	df	MSS=SS/df	F. Value (observed)	F 5% (Fr)	Expected e
Between recipe	S^2	$a-1$	S^2_r	S^2_r/S^2_E		
Error	S^2_E	$a(K-1)$	S^2_E			
Total	S^2_T	$aK-1$				

SS = Sum of squares

df = Degrees of freedom

MSS = Mean sum of squares

v = 4 or 3 different recipes

Where

CF = Correction factor = G^2/N

G = Grand Total and N = 25

The sample means are arrayed for high to low and each is subtracted from above of the six differences, if only one exceeds D, the conclusion is that the item is different from other items but there are no defected differences among the characteristics of other items.

Here Duncan's Multiple Range Method is applied to the Fabric Stiffness.

$$S.E. = \frac{1.1461}{5} = 0.05815$$

P = F value at 5% level (from Duncan's Table)

RP (5%) = P x Shortest significant Range

S.E. of sample means = 0.05815

Shortest Significant Range	2	3	4	5
P(5%)	2.95	3.04	3.12	3.20
RP(5%)	0.17	0.18	0.18	0.19

Recipe	Mean	Difference			
K 100	2.535				
N 100	2.670	0.135	0.10		
R 100	2.770	0.235	0.215	0.115	0.175
A 100	2.885	0.350	0.390	0.29	
T 100	3.060	0.525			

Thus the test clearly reveals that there is significant difference among the samples.