Analysis of Major Constituents Present in Web Press (Offset) Ink in Sri Lankan Market.

By

Kudagama S.A.S.N.

04/AS/059

A Research Report Submitted in partial Fulfillment of the Requirement for the General Degree of Bachelor of Science (Applied Sciences)

Department of Physical Science & Technology

Faculty of Applied sciences

Sabaragamuwa University of Sri Lanka

Belihuloya

March 2009

DECLERATION

The project described in this thesis was carried out at the Marketing Department of Union Development Co. (Pvt) Ltd,. Under the supervision of Dr.(Mrs.)M.N.Wickramaratne and Mr. Mohan Athugala. A report on this has not been to any other university for another degree.

Research Student

S.A.S.N. Kudagama
Department of Physical Science & Technology,
Faculty of Applied sciences,
Sabaragamuwa University of Sri Lanka,
Belihuloya.

.....
Signature

20/04/2009
Date

Certified by

Internal Supervisor

Dr. M.N.Wickramaratne
Department of Physical Science & Technology,
Faculty of Applied sciences,
Sabaragamuwa University of Sri Lanka,
Belihuloya.

.....
Signature

27/04/2009
Date

External Supervisor

Mr. Mohan Athugala,
General Manager,
Union Development Co. (Pvt) Ltd,
104/11, Grandpass Road,
Colombo 10.

.....
Signature

18/04/2009
Date

Dr. C.P.Udawatte,
Head of Department of Physical Science & Technology,
Faculty of Applied sciences,
Sabaragamuwa University of Sri Lanka.
Belihuloya.

.....
Signature

2009.04.27
Date

AFFECTIONALY DEDICATED TO

MY PARENTS

AND

TEACHERS

ACKNOWLEDGEMENT

I wish to express my deepest gratitude to my internal supervisor Dr. (Mrs.) M. Nirmalee Wickraratne. Senior Lecture, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka. Belihuloaya. For her assistance, encouragement, guidance and her valuable time to make this study a success.

I am grateful to Mr. Mohan Athugala, General Manager,Union Development Co.(Pvt) Ltd, for the encouragement, guidance, and support extended to me at all times during my work at Union Development Co.(Pvt) Ltd.

I would like to thank to all the executives of the Marketing Department of Union Development Co.(Pvt) Ltd for their kind cooperation extend me at all times.

I would like to express my sincere thanks to Dr. C.P.Udawatte, Head, Department of Physical Science & Technology, Faculty of Applied sciences, Sabaragamuwa University of Sri Lanka. Belihuloya for the tremendous encouragement and highly inspiring guidance and help to make this study as success.

Abstract

The Sri Lankan web press ink manufacturing industry is small but perhaps no industry uses a wider range of import raw materials and to better advantage since every small area of printed matter is subject to scrutiny. The Sri Lankan web press ink industry underwent a rapid expansion after 1977. The world usage of web press ink increases day by day. As well as most of the ink manufacturers face the same problem due to the lack of international standards for web press ink. Hence a comparative analysis of web press ink with worldwide accepted quality product is important in marketing products to the international community.

The objective of this study was to analyze the major constituents present in the web press ink profiles offered by two major competitors to make suggestions, about difference percentage of major constituents in the web press ink of Christal ink and key competitors' ink and improvement of quality of Christal ink. In this regard, major constituents of web press ink performance such as ash, pigment, volatile matter and varnish have been analyzed for comparison.

For the purpose of comparative analysis, databases were prepared using the chemical analysis of similar range of Christal ink product and key competitors' product. From this comparative analysis, the difference between percentages of major constitutes in Christal ink and key competitors' ink was identified. The improvements required for the current range was identified.

CONTENT

CHAPTER 3

Methodology

CHAPTER 4

Results and Discussion

CHAPTER 5

Conclusion and Recommendation

List of Abbreviations

mm	- mille meters
^{0}C	- Celsius
^{0}F	- Fahrenheit
min.	- minutes
etc.	– etcetera
C.W.	- Crucible Weight
W.P.I.W.	–Web Press Ink Weight
F.W.	- Final Weight
G.W.	- Glass screw-top jar Weight
C.T.W	- Centrifuged Tube Weight
P.W	- Pigment Weight
J.W.	– Jar Weight
V.W.	- Varnish Weight
%V.M.	- Percentage of Volatile Matter
%Ash	- Percentage of ash content
%pig.	- Percentage of pigment content
%var.	- Percentage of varnish content

List of Figures

Fig. no. **Page no.**

List of Tables

CHAPTER 01

INTRODUCTION

1.1 Background

The world range of web press ink increases day by day. As well as most of ink manufactures face the problems due to the lack of international standards for the web press ink. Therefore, comparison of Christol ink with the competitors on selected major constituents could give an edge its marketing quality, specially when selling web press ink into the industrial market segment. To cope with the demands Christol Ink Company has decided to carry out a research on worldwide accepted competitive ink manufactures' product and find out the differences of the percentage of major web press ink constituents. Therefore major constituents of web press ink such as ash, pigment, volatile matter and varnish were chosen for the comparative studies.

This information is important for the further development of Christol ink as appropriate for the international market.

In addition to those analytical information of web press ink, about how to choose the quality web press ink also have prominent place. For this purpose information of qualities of web press ink such as working qualities and optical qualities would need to be research and gathered. This would Christol ink to identify proper working qualities that they are already in compliance with and those which are essential to be in compliance with.

1.2 Overall objective

To analysis and compare major constituents present in web press ink.

1.3 Specific objectives

a) Analysis of ash percentage in web press ink.

b) Analysis of pigment percentage in web press ink.

c) Analysis of volatile matter percentage in web press ink.

d) Estimation of varnish percentage in web press ink.

e) Studying and searching the qualities of web press ink in the global market

CHAPTER 2

LITERATURE SURVEY

2.1 The web press ink industry

Introduction

News paper web presses are generally called "perfecting" presses since they print both sides of the stock at one time or "perfect" the jobs.

The inks for use on web presses must of necessity be quite fluid and as a general rule the higher the press speed the thinner must be the consistency of the ink. The tack of the ink is also dependent upon the press speed and upon the weight of the stock being run, as the ink must have sufficient tack to distribute well and yet not so much as to pick or tear the fast moving stock. If the consistency or viscosity of the ink is too thin there is the possibility that the ink will "fly". This is an odd complaint, and one which is practically confined to web press inks, wherein affine spray or mist of the ink is thrown off by the fast moving rollers. This spray generally coats everything in the vicinity of the press with a sticky layer of ink, much to the dismay of the pressroom workers, and to the detriment of production. (NIIR Board, 2003)

Web press inks are made in number of consistencies or viscosities to accommodate the various types of presses and press speeds. Inks designed for use on very high speed presses and those with "overshot" fountain rollers are very fluid and consist almost entirely of mixtures of mineral oils and carbon black, with the possible admixture of a small percentage of an oil-soluble toner dye like indulines base to overcome the brownish undertones of the carbon black and the mineral oil. In the better grades of web press inks, designed for use on slower moving presses the vehicle generally consists of either gum or wood rosin dissolved in mineral oil to which has also been an added varying amount of resin oil, gilsonite varnish, pitch varnish or linseed varnish. Larger percentages of soluble blue dyes, with the possible addition of small amounts of iron blue or reflex blue, are used to tone the better grades of web press inks. (NIIR Board, 2003)

2.1.1 Major printing ink categories in printing ink industry

Printing ink is essentially intimate mixture of pigments, oils, varnishes, driers, waxy or greasy compounds. Like most general statements this definition requires considerable amplification to be of practical value. The ink must possess sufficient cohesion and adhesion to make it work well on the printing press and adhere properly to the paper, or other printing surface. It must have satisfactory color and drying properties so that the printed sheets may be handled in a reasonable time without causing the ink to offset or smudge. In addition to these general properties the ink must also print a sufficient number of impressions per pound. (NIIR Board, 2003)

Printing inks are divided in to three main classes, typographic, plano graphic and intaglio corresponding to the three major divisions of printing. Each of these three classes of ink must be essentially different in character and properties from the other two. (NIIR Board, 2003)

Typographic ink used to print from raised surface such as ordinary type, and line and halftone cuts, as are used by every printer for his general run of work. These inks consist of soft pigments ground in a vehicle composed essentially of heat-bodied linseed oil varnishes, and as the paper they are generally used on is more or less non-absorbent, they must dry mainly by oxidation of the vehicle. Typographic inks are generally rather "long" in nature. That is to say they may be drawn out to a long thread between the fingers before the thread breaks. They also possess considerable tack, or adhesion, so that they will distribute evenly on the various presses and transfer from the type to the paper.

Planographic inks are used to print from plain surfaces, as in the lithographic and offset processes. These inks are generally considerably heavier and "shorter" than the typographic inks, that is, they posses considerable tack, or adhesion, when pressed between the fingers. but break with rather a short thread when drawn out. The pigments and varnishes used in these inks must not be affected by water, since this process depends upon the fact that when a design is drawn upon a smooth limestone slab, or upon a specially prepared metal surface. With a greasy crayon, lithographic inks will adhere crayon, lithographic inks will adhere to the design, but not to the design, but not to the

remainder of the plate, providing it be kept moist. The vehicle portion of these inks consists of "lithographic varnish", which is pure linseed oil that has been brought to a fairly heavy consistency by cooking it at about 550 Fahr. for several hours. (NIIR Board, 2003)

Intaglio inks, originally called steel or copper plate inks, are used to print from ergaved surfaces. The character of the ink depends upon the kind of plate and speed of operation, thus hand printing of fine engravings requires an ink which will dry by oxidation, and which possesses a short, buttery nature. At the same it must be quite greaseless so that the excess ink may be wiped off the face of the plate without disturbing the ink in the lines, and so the ink will readily lift from the lines of the engraving when the paper is pressed against it. Since the paper used in the class of work is generally dampened before use, the inks must also exhibit no tendency to bleed, or dissolve, in water. At the other extreme are the initaglio inks which are used to print from engraved copper rolls at high speed. Here the drying is mainly by absorption and evaporation and the inks must be very thin and consist of very low gravity pigments thoroughly suspended in a highly fluid vehicle which contains little, or no, drying oil. (NIIR Board, 2003)

2.1.2 Choosing the quality web press ink

Qualities of web press inks

Those printing inks, which are suitable according to the working process of web press printing machines, are called web press inks. All the ink manufactures print "web press inks "on the label stuck on the ink tins. (NIIR Board, 2003)

The general quality of web press ink is that the ink should not dry onto the rollers, plate and blanket. Maximum ink of the plate should be transferred on to the blanket, and the printing substrate (paper), which should be free from all the defects. (NIIR Board, 2003)

According to the above description, the quality of ink can be judged during the process of working, which should be correct in optical sense and defect free after printing. Therefore different qualities of web press inks are being described in the following lines. (NIIR Board, 2003)

2.1.2.1 Working qualities

1. Quality of drying:

Web press ink should have sufficient drying power, so that set-off the defect doesn't occur in the printed sheets. In general, all the printing inks have drying materials mixed in it. It is the duty of the printer that he should mix suitable drier in the ink according to the requirement of the paper surface. Mostly art papers having glazed surface, need extra drier to be mixed. The quantity of drier is decided according to the nature of job and requirement of the paper surface. (NIIR Board, 2003)

2. Quality of moisture resistance:

Principally the water and the ink both are applied on the surface of the plate. In such condition, the pigment particles should not be mixed with the water. Otherwise the non image areas will also catch ink and print on the paper at the same time. In this way the quality of printing shall reduce. The sticking of the ink in the non image areas causes scumming.

There should be some moisture in the ink. Various printing defects occur when pigment particles dilute in the water. The moisture resistance in the ink is increased by using highly pigmentation and viscosity in it. (NIIR Board, 2003)

3. Tackiness:

The web press inks require sufficient tack. Because due to this quality, the web press inks set quickly on the surface of paper. The travel of ink from ink duct to the substrate via inking rollers and image surface because of the lack quality in the ink. The ink layer printed by offset process is very thin in comparison to the letterpress process. Therefore it is necessary to have more tackiness in the web press inks.

There is no specific measurement of tackiness in the ink for different nature of jobs. Skill of operator and his experience is the only correct measurement; the operator has to prepare the ink in suitable tack according to the nature of the job and the surface of the

paper by mixing reducer in the ink. Excess tack in the ink may cause picking and plucking defect in printing.

At the time of deciding the tack in the ink, the machine room temperature, number of rollers fitted in the machine for the distribution of the ink, quality of the ink, surface of the paper and the tackiness of the printed ink layer etc.

In the first unit of the inking system of multicolor sheet-fed and web-fed offset machines, should have a little more tack and a little less tack gradually in the other units. By the gradual reduction of tack in the different units, the trapping of ink is each color becomes easier. (NIIR Board, 2003)

The tackiness of ink may also be tested by ink knife or finger tips. The ink is mixed properly and a long thread has to be made by the end of the knife or by tip of the finger. When the thread more than 15 cm that is called long ink. The long ink is suitable for rough paper. (NIIR Board, 2003)

When the thread is less than 10 cm that is called short ink. The short ink is suitable for halftone jobs and on art paper.

By this testing, it is estimated that shorter the ink tackiness shall be more. Similarly longer the ink will have less tackiness. The halftone dots require more tacky ink as it. Doesn't need more coverage of ink. In the heavy solids or posters of large typed, require more coverage of ink and therefore need less tack or long ink. (NIIR Board, 2003)

Though the testing of tackiness in the printing inks by the fingers is very easy but there are no calculations in it. Hence the result doesn't come satisfactory. Due to it, equipment named "Inkometer" is available for correct testing for the tack of ink. (NIIR Board, 2003)

4. Sufficient flow in the ink:

The meaning of flow of ink is related with the length of the ink. The length of the ink is related with the tack of it. Similarly, the flow of ink also depends on the quality of the pigments. Therefore along thread in the tacky ink and short thread in the ink can also be made.

The sufficient flow of ink depends on the wet ability of the vehicle to the pigment particles. As much as the pigment particles are made wet, similarly the ink flow becomes more. Some of the mineral inks do not have sufficient flow. The inks of such quality can only be used for letterpress treadle (platen) and label top small offset machines.

Only due to the quality of sufficient flow in the ink, it travels through the inking system, i.e. from ink duct, vibrator, distributor, oscillator, forme rollers, plate cylinder, blanket cylinder and arrives sufficiently at the end up to the paper.

The property of flow in any material is a science of its own, which is called "Rehology". The flow of ink can be studies through it. There are some equipments available for measuring the measuring the flow of ink but not very successful. The process of testing or measuring of the flow of ink by ink knife or operator's finger is only accepted successful procedure.

The flow of ink is controlled and maintained according to the general qualities of different solids and liquids. The general quality of solid and liquids have flow in it through the use of force. The revolution of different size of roller in the inking system of printing machine creates force to flow the ink from ink duct to the printing paper or any surface.

Due to this principle, most of the web press inks are made by mixing synthetic oils and therefore the quality of flow of these inks become similar to the plastic materials. Accordingly the flow of web press inks should have to be controlled and maintained. (NIIR Board, 2003)

5. Thixotropy :

The quality of sufficient fluidity on the printing machine rollers and quick solidification of the ink on the printing surface is called thixotropy. When the cover of the ink tin is cover of the ink tin is opened and turned down the ink does not come down. It means the ink seems to be a solid state.

Hence a little ink is taken out from the tin and kept on the ink slab. After that it is mixed by ink knife and then the ink becomes sufficiently fluid. This quality of fluidity should be present in a good web press ink.

The sufficient quality of thixotropy in a web press ink minimizes the possibility of set-off. Generally all the tacky inks have more thixotropic quality and the inks having less tack, don't have sufficient thixotropic quality. Besides having more thixotropic quality in the ink it also becomes more moisture resistant. This is mostly required quality of an web press ink. (NIIR Board, 2003)

2.1.2.1 Optical qualities

Each printing ink has some color. And we feel the presence of color by the reflection of light rays from our retina. Therefore it is necessary for each ink to look suitable and pleasant too. For it printing ink must have some of the following characteristics.

1. Opacity

The full coverage of a printed ink layer is the quality layer should set in a solid from. Only then the color of printed ink looks very good. Specially when printing solid job.

When printing multi color jobs, every subsequent color should fully trap the previous color. This quality in the ink will only be there when the ink has sufficient opacity.

Though there are some inks which have transparent quality. Transparent inks are good for printing single color jobs. It is necessary to print transparent inks first and then opaque inks in multicolor jobs. The characteristics of transparency and opacity in the printing ink depend on the properties of pigments. Some of the pigments are opaque in nature and others are transparent. (NIIR Board, 2003)

2. Effect of color

The effect of the printed ink color should be the same, which is its original hue. The color of some of the inks looks correct when testing before printing. But after printing it looks faded or light in color. The pigments of such inks are defective and not good for printing quality jobs.

Actually that is the only original color which looks after printing on the paper. For this the color and surface of the paper should be considered when testing of ink is done. Because some of pigments and the printed ink layer have differences in the wave length when reflected from the surface of the printed layer. (NIIR Board, 2003)

3. Strength in the color

Expect the colors which have light affect other should have sufficient strength in the printed ink layer. Generally the strength of a color depends on the quantity and quality of the pigments in the ink.

The strength of any ink can be reduced by adding white ink. For example the strength of fast red can be reduced by mixing white ink and required effect of the color may be obtained. When the inks are being selected for printing by web press process, the application of water and thin layer of ink should necessarily be considered. Brightness and strength of the color is usually reduced by the use thin layer of ink and effect of water. (NIIR Board, 2003)

2.1.3 Major constituents used in ink manufacturing

In order to write down the ideas of the mind, the relationship in the paper, pen and ink has been known from ancient times. But the pen is not sufficient to quench the education thirst of the modern period. Therefore printing becomes more popular instead writing work. For printing any book inks and papers and used. (Fisk, 1976)

In order that the impression of the printing surface may be visible on the paper, it is necessary to apply ink on the upper surface of it. When the paper is fed in the machine

and it comes in contact with the inked surface, the ink is transferred on the paper. Then the required image is dearly visible on the paper. (Fisk, 1976)

In the beginning of the printing age, only black ink made from coal was used for printing. But with the progress and development of this art the printing ink began to be made from several materials by mechanical and chemical methods. There is a great contribution of chemistry as well as physics in the production of modern printing inks.

The ink has to be prepared according to the requirement of the different printing processes. The different ingredients used in the different printing processes. The chief ingredients used in the manufacture of printing ink are; pigment, varnishes, volatile matter, reducer and extenders. (Fisk, 1976)

2.1.3.1 Pigment

Pigment is the main element for producing color. Actually pigment is only the main coloring agent of any ink. When any color has to be prepared, first of all it has to be collected in the form of powder of that pigment. The preparation of pigments and their vehicles are kept secret every ink manufacture. (Fisk, 1976)

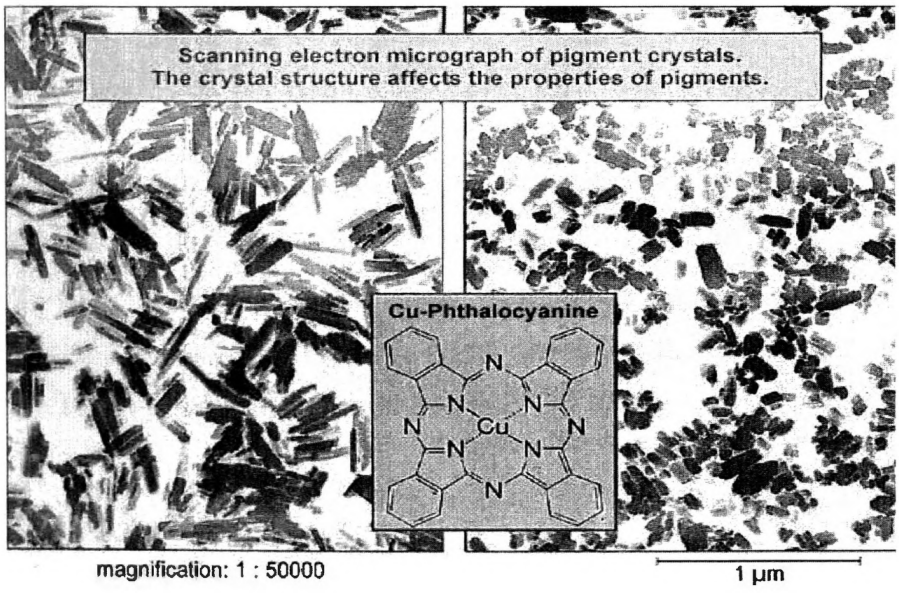

Fig 2.01 Crystals of Cu phthalocyanine pigments

(Source: http://www.hdm-stuttgart.de/projekte/printing-inks/p_gercom.htm)

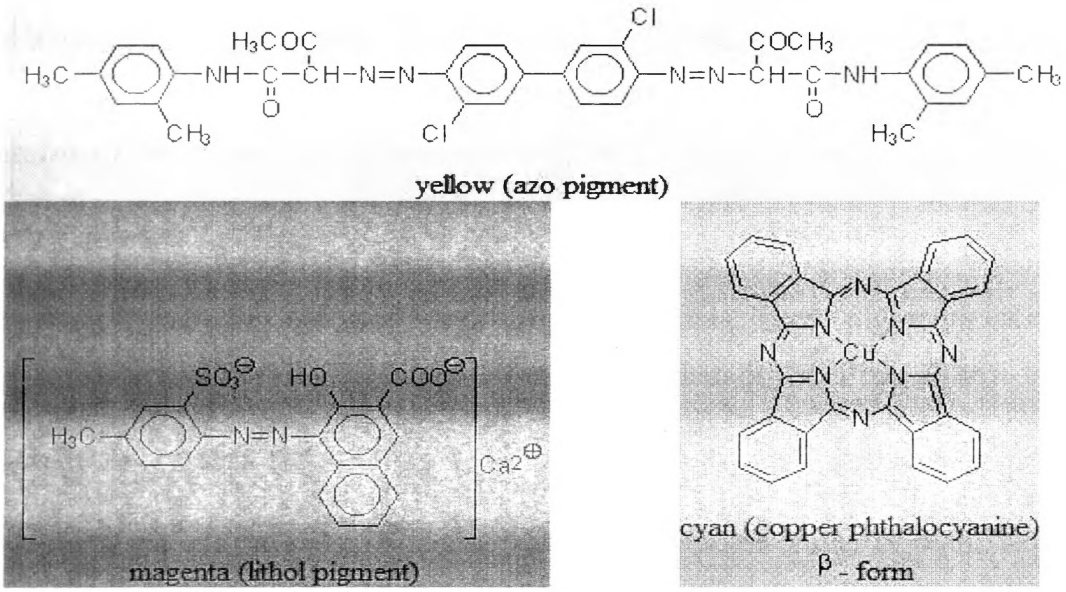

Fig 2.02 Pigments for colored printing inks

(Source: http://www.hdm-stuttgart.de/projekte/printing-inks/p_gercom.htm)

Nature

Some pigments are found in nature and called natural pigments. The inks prepared from them are of light color and they appear to be pale. Because those pigments can't be grinded properly. They take more time in drying on the paper. These inks do not have sufficient flow and they are cheaper. Therefore these inks dry very slowly. The defect of set-off may appear in these inks very often. (Fisk, 1976)

Minerals

Some pigments are prepared through the chemical reactions made on some minerals. These have good shining effect and the inks made from these sources are also of good quality. But these pigments are heavy; hence more quantity of vehicle is use. The printability of these inks is less than others. (Fisk, 1976)

Carbonic sources

Some carbonic materials are used for preparing pigments. These pigments take too much time in spreading and drying. This type of ink is less than other. (Fisk, 1976)

Botanical

Most of the pigments are prepared from different flower and leaves of plant. E.g. the Neel tree is used for preparing blue pigment. Green pigment is prepared from the leaves of some plants. The leaves and flowers are dried-up arid then powdered. After that these pigments are prepared through some chemical reaction and then different types of inks are made. (Fisk, 1976)

From animals

The bone and fat of animals are also used for some pigments. Some pigments are also prepared from ivory.

Thus it is clear that the color of a special thing is due to the pigment in it. Therefore it has to be prepared of the best quality pigments. They have different names and qualities for different inks. Only one pigment is used for preparing any primary color, but one color can also be obtained from different pigments. Some important pigments made through the different materials and uses in the printing inks are mentioned as follows. (Fisk, 1976)

Black pigments

The black pigment is made from many type of materials as follows :

Lamp black

Mineral oils are burnt in a closed chamber and the coal produced in it is collected. This is mixed in varnish completely and black ink is prepared. This coal is softer and lighter than carbon. The ink prepared from it has a brownish color. Although this colour is cheap and has a solid effect but its effect after printing appears to be pale. Therefore it is not used generally. (Fisk, 1976)

Coal can be prepared by burning wood, oil and sprit. This method is similar to the method of preparing 'kajal' for the eyes.

Russian black

It is prepared from the coal obtained by burning wood and resin etc. the ink prepared by this method is volatile but this is very suitable pigment. Though it take much time in mixing with varnish but good quality of ink can be prepared from it. (Fisk, 1976)

Coal or gas

The pigment prepared from coal can be mixed properly in varnish. It has high printability good flow and length in the ink prepared from it. The pigments are made into very fine particles. The pigment made by this source is very light. Therefore the color prepared from it, appear to be shining. Generally, reducers or driers have to be mixed before printing can also be prepared from the different gases obtained from the earth. (Fisk, 1976)

Wooden coal

The color of this pigment is like the pigment of the coal. It can only be prepared from charcoal. Its grinding takes much time for the preparation of pigments. (Fisk, 1976)

Ivory coal

The tooth of an elephant is called ivory. The large tooth of an elephant can also be burnt in order to obtain to coal for pigment. But it is not available in the large quantities and is also very costly. Therefore very little pigment is prepared from it. (Fisk, 1976)

Bones

The bones of animals are collected and burnt to ashes. After this, the coal prepared is grinded properly and mixed in varnish. (Fisk, 1976)

Parish black

The pigment is prepared from some specials bones. It can be prepared from very small pieces of bones only. (Fisk, 1976)

Lead and graphite

Lea and Graphite is also used for black pigment. The ink prepared from this pigment has a brownish color. If white color is mixed in it, a good brown tint can be obtained from it. Therefore it is regarded to be better than other black inks. It is also used as a drier. (Fisk, 1976)

Composition black

Animal's materials are kept in a iron vessel and it is heated. Potassium carbonate is mixed in the vessel for reaction. Finally some residue is obtained and collected for preparing the pigment. This residue is called composition black and used as pigment to prepare the black ink. (Fisk, 1976)

All these pigments are used for preparing different inks. All the inks prepared from various pigments, have different qualities in effect. Therefore they are used for preparing different inks, according to the requirement of the job to be printed. (Fisk, 1976)

Yellow pigments

When multicolor printing is done, generally the yellow color is printed first, because it is the most transparent color. The yellow color is one of the primary colors. When mixed with other primary color, the colors of the 2nd or 3rd order are obtained. Therefore it is essential that the pigment materials of all the colors should be such that there is a balance and adjustment in the mixture of all colors. Yellow pigments are of the following types:

Chrome yellow

It is not a very good color. It is the most commonly used pigment for the preparation of ink because it is can be prepared easily and converted to ink. Its chief quality is that it can be grinded easily and can be easily mixed in varnish. It is the most transparent pigment and a soft material prepared from lead. It is easily crushed if prepared with the hand and is very useful for preparing green ink. (Fisk, 1976)

Cadmium yellow

Its chemical name is Cadmium Sulphide. It is costly but very useful pigment. This pigment can be used for preparing orange colour. It forms a green colour when mixed with a blue pigment. It should not be used to lighter other colours. (Fisk, 1976)

Ochre's yellow

It is type of soil of an orange colour. Varnish is mixed in it after grinding. It is found in few parts of India and England. After washing it is dried and grinded. After that it is mixed in varnish to prepare ink. One properly about this pigment is that even if it is very much grinded the ink has granuls all time. (Fisk, 1976)

Gummy material

This is a material which sticks like gum but it is not actual gum. It is a secretion of some trees found in Ceylon and other countries. Besides this, it is also prepared from the fat like materials in the intestine of animals. This ink has a properly of sticking. Good shining yellow ink can also be prepared from it. (Fisk, 1976)

Minerals

Yellow pigments called Orpine, Orpiment; Realger etc. come in this group. All pigments are very useful. They are the best pigments for preparing yellow ink. But there are some defects in them, because they are poisonous. They dissolve in metallic ink. It makes the colour defective if mixed with a light colour. The pigments Kings and Chinese are also of this type Other yellow pigments can also be prepared from minerals. (Fisk ,1976)

Red pigments

This is also a primary color. Its visual effect is hot. Purple colors made when mixed with blue and become orange when mixed with yellow coiour. The pigment used for preparing red color is as follows:

Vermillion s

It is found in the form of small pieces. The other name for it is Mercuric Sulphide and in chemistry, it is also called Bi-Sulphurate of mercury. Mercury and Sulphate have to be mixed in the ratio 25:4 for preparing this pigment. It is found in large quantity in China and India.

Full solid red ink can be prepared from Vermillion. The ink prepared from it has a high printability. Transparent white pigment is mixed in it to increase the density and shining of this color. The usual effect of this ink is very hot and shining. A lighter shade of this color seems to be very nice. (Fisk, 1976)

Carmine

This is a very beautiful but expensive pigment. Previously, it was prepared from the bodies of dead animals. But now it is prepared from a salt layer prepared from a salt layer prepared by vaporization. Its effect can be made permanent by mixing white color in it. It is necessary to keep this pigment in light for some time after preparing it. Some ink manufacturers use gelatin and albumen of egg for it. But those inks are not good for

offset printing. Because these materials are soluble in water and water has to be used in offset printing. (Fisk, 1976)

Lac

It is obtain from trees and found in large quantity in the branches of Peepal tree. It is mostly used for preparing red pigment. The durability of some other inks can be increased if it is mixed in them. It is a dry materials found in small pieces. Lac is found in Indian in large quantity similar to the raisin. (Fisk, 1976)

Lake pigment

The word lake is used for beautiful color. This pigment easily gets fixed on cloth and other surfaces. It is prepared from a mixture of alum and alkali. (Fisk, 1976)

Kothenial Lake

Its properly are similar to alum. It can be used successfully only if it is not affected by light. It is a beautiful and useful pigment and also used as drier in the inks. But the ink prepared from it should not be kept for long time. Good light colors are not formed when white colors are mixed in it. (Fisk, 1976)

Madar

This is a good pigment for preparing pink color. It is also called the Rubia tree. It is a suitable color for preparing rose pink color. It can be used as a drier. Because the ability of quick drying is absent in this pigment a powder of lead is mixed in it. The ink prepared from this pigment has to be prescribed like color of the flesh and blood of the body. It is a very sift ink and it become permanent after printing. (Fisk, 1976)

Blue pigment

This is third primary color. When yellow is mixed in it green color is formed and purple color is obtain by mixing red with it. It is an opaque pigment. The pigment used for preparing this color is asunder.

Prussian blue

It is a dense and solid pigment. Its effect is similar to the metallic inks. It is unaffected by light and has absorbing ability. It is prepared by mixing potash in a materials which appears like iron ore. It is the best pigment for offset printing. Some other pigments such as sky blue also mixed in it. Alkaline materials are used in it. Therefore alkaline materials should not be in it. Prussian blue pigment is also called Chinese blue and Paris blue. (Fisk, 1976)

Ultramarine blue

This color appears to be of a blue color like the sea. In the beginning this was prepared by grinding a very valuable stone. But because of very expensive it is prepared now from coal, alum and china clay. It is a permanent color of nature and have shining effect and totally transparent. This pigment is affected by alkaline materials. (Fisk, 1976)

Reflex blue

The effect of this pigment is like a reflection. It has shining effect but acidic materials may affect it. It is used to make black ink darker and lighter. Generally it becomes permanent if alkaline materials are mixed in it. (Fisk, 1976)

Oriental blue

Alum is the chief factor in it. It is a soft pigment and grinded easily. It is very much similar to the purple (violet) color. If other colors of its type are mixed in this pigment, a very nice mixed color can be obtained. It is also used for makin0g brown color. (Fisk, 1976)

Cobalt blue

Cobalt is a metal similar to Nicket. Arsenic phosphate is mixed in it and heated till red hot. Its use is best in water colors. Acidic and alkaline have no effect in it. When mixed in varnish, its color becomes greenish. (Fisk , 1976)

Indigo blue

It is also called Indian blue. This is obtained from the Renil plant. It is soluble in water and oil which become permanent in it. Flake white color should not be mixed in it. The quantities of it pigment are not found in any other materials. (Fisk, 1976)

The follows factors have been identified important to be a pigment suitable for printing

(1) Be a finely divided power.

(2) Have coloring or else hiding properties. The pigment may be transparent or opaque. The amount of transparency or opacity can be controlled by selecting pigments carefully; very transparency inks are required for three- or four-colour process printing, while very opaque inks are useful for printing on dingy stock or where blotting out properties are required.

(3) Form a homogeneous paste when ground into a vehicle.

(4) Have a good texture, grind easily and produce smooth working inks. A pigment with a soft texture does not cause much wear to printing plates, while most mineral pigments are too hard and gritty.

(5) Be wetted and dispersed easily.

(6) Be permanent to light heat, water and chemicals which may come into contact with the printed inks, e.g. soup, grease, alkalis, acids, solvents, and polluted atmospheres.

(7) Have adequate non-bleed properties. The pigment should not bleed in oils, solvents and wax. Further, when made into an ink and over-printed, bleeding should not occur.

(8) Reach a certain standard in shade and strength. A pigment with a high tinctorial strength is desirable but this can be nullified if it has a high oil adsorption and produces inks of poor flow.

(9) Have a satisfactory small particle size and preferably consist of spherical-shaped participles.

(10) Possess brilliance and cleanliness and produce shades which appeal to the eye. (Banke, 1981)

2.1.3.2 Varnishes

Many different varnishes are used by ink makers, but the principal ones are those prepared from resin and linseed oils respectively. The former is used for news and the commoner kinds of inks, the latter for the better sorts. (Flick, 1985)

The best oil is genuine, well matured, unadulterated, Russian Baltic linseed oil, costing a high price, and the worst are the rough, ill-matured Calcutta brands, which cost very much less, and which may be adulterated to any extent. An ill-matured oil is easily discovered when it is put into a varnish pot and heated, for it froths up and there are deposited what are technically known as "foots." The functions of all varnishes are two-fold:

1. To act as a vehicle or carrier of the color.
2. To act as a drying agent.

Without the vehicle it would be impossible to get the color conveyed to the formes and blocks, and without this drying agent, the printed matter would never be got into the customers' hands in the marvelously short time in which this is effected. Linseed oil, when subjected to prolonged boiling at a high temperature, is converted into a varnish which has an extraordinary affinity for oxygen. (Flick, 1985)

2.1.3.3 Volatile Matter

Volatile matter in web press ink refers to the components of ink, except for moisture, which are liberated at high temperature in the absence of air. This is usually a mixture of short and long chain high boiling hydrocarbon oils.Volatile organic compound content is the same as volatile content. (Henk, 2006)

The procedure of determining volatile content of web offset inks has some significance and use. This information is useful to the ink manufacturer and user and to environmental interests as part of the determination of the mass of volatile organic compounds emitted from the ink. (Henk, 2006)

2.2 Manufacturing process

The manufacture of printing ink may be considered as taking place in a series of closely related steps. The first step in the process is the preparation of the various pigments and dry colors from their respective raw materials. Since the manufacture of dry colors is a very technical operation and requires the installation and maintenance of elaborate equipment, it is the general practice for the printing ink manufacturer to purchase his dry colors from a reputable dry color manufacture, rather than to attempt to make them himself. Large manufacturers of printing ink may prepare a few special colors in their own plants, but this is the exception rather than the rule. (NIIR Board, 1998)

The next step in the manufacture of ink is the preparation of the various varnishes and oils which form the vehicles. As with the dry colors, unless the plant is very large, it is usual for the ink manufacturer to purchase his varnishes rather than to attempt to make them himself. (NIIR Board, 1998)

The various ingredients are weighed out in their proper order, according to formula, into either a change-can or dough-type of mixer in which they are thoroughly mixed and kneaded together. Thorough mixing and wetting out of the ingredients is essential in order to save valuable mill time and to produce a perfectly homogeneous ink.

2.2.1 Mixing operation

All the materials for manufacturing the ink i.e. pigment, vehicle and driers etc. have to be mixed with each other with each other. All the paste type inks used for letterpress and offset printing process are mixed with glass balls. The mixing operation is done in a closed drum of cylinder type machine. Due to the use of glass balls, these machines are called ball mixing machines. (NIIR Board, 1998)

There are no glass balls in mixing machines used for manufacturing the ink for flexography and gravure printing process. Only mixing of raw materials is done in this machine. The mixed material comes out from the machine in the shape of paste.

The mix is next delivered to the mill-room where it immediately receives a thorough grinding on a chilled-iron roller mill. The ink is ground as soon after it is mixed as possible, as there are some pigments which undergo change if they are allowed to stand in the mixed condition for too long a time there are many types of roller mills in use today. (NIIR Board, 1998)

2.2.1.1 Mixing machines

Revolving drum or cylinder is the main part of the mixing machines. There are three different principles on which the cylinder revolves. First in horizontal position, second in vertical position and third in oscillation system. One another modernized mixer is named Turbine Mixer. There are blades inside the drum or cylinder. The mixing material does not stick inside the walls of the cylinder. The working of the turbine mixer is easier and the work becomes earlier than other. (NIIR Board, 1998)

The function of the ink mixing machine is very important. It takes more time and if the mixing is not perfect, further operations may be wrong. (NIIR Board, 1998)

2.2.2 Milling process

The process of mixing the ink is done after the raw materials are properly mixed. The purposes of milling the ink are addition of reducer and vehicle in the required quantity, mixing of driers, and distribution of pigment particles and to wet the pigment particles by the vehicle (liquid) in full quantity. (NIIR Board, 1998)

Because of last manufacturing operation of printing ink it has to be performed very carefully. Therefore different types of milling machines and their brief description are given as follows.

1. There cylinder mill
2. Two cylinder mill
3. One cylinder mill

(NIIR Board, 1998)

2.2.2.1 There cylinder mill

Large ink manufacturing units have three cylinder mills for milling the ink. This milling machine produces good quality of ink by the efficient milling operation of all the materials mixed in the ink. (NIIR Board, 1998)

This machine has three cylinders. Each cylinder revolves in opposite direction to each other in parallel position. One cylinder revolves in slow speed; second cylinder revolves faster than first. The third cylinder revolves faster than second cylinder. The proportion of the sizes of all three cylinder gears is made 1:4:11 or 1:2:4 obviously, there will be difference in the speed of the cylinders. Length and the periphery of each Cylinder are made even. (NIIR Board, 1998)

The surface of all the cylinders is made rough but even in its full size. Due to it, pasty ink sticks in more quantity on the surface of the cylinders and it helps in better milling of all the materials. (NIIR Board, 1998)

All the milling cylinders are made hollow from inside. Chilled water is circulated continuously through the hollow cylinders. By this, the temperature created due to the revolution and friction within the cylinders, become eve. Because the uneven temperature may cause uneven milling, and mixing of different materials used with the ink.

By all the above techniques, the pigment particles separate with each other and become wet property with the liquid of the vehicle. (NIIR Board, 1998)

2.2.2.2 Two Cylinder mill

These milling machines have two cylinders and one scrapper. Both the cylinders revolve in opposite direction to each other. The scrapper fitted with one cylinder forwards the paste of ink towards another cylinder. In this way the process of milling is done by both the cylinders. (NIIR Board, 1998)

In general, flexographic and gravure inks are processed by this milling machine. These inks are made in the shape of liquid. Silk screen inks used for printing on large size of cloths is made by this milling machine. This ink is also made in fluid state.

Though the use of two cylinder mill is only made for limited type of inks, but more useful for hard inks and high pigmented inks. This mill is also more useful and advantageous for small scale production. (NIIR Board, 1998)

2.2.2.3 One cylinder mill

This milling machine is also called unroll mill. This is an ordinary ink milling machine, which is used in the manufacturing of low viscosity inks. (NIIR Board, 1998)

The milling of inks used for rotary machines is done on one cylinder mill. There is a large tub filled with the ink and the cylinders filled in the center of the tub. When the cylinder revolves, liquid ink sticks with the periphery of the cylinder. (NIIR Board, 1998)

On one or two places, there are steel bars (rods) fitted in the full length of the cylinder. The flow of ink circulates between the rods and the periphery of the cylinder. Rods are set at 10^0 to 25^0 angles with the pressure on the surface of the cylinder, causes the milling function. (NIIR Board, 1998)

The pressure of the rods (bars) is adjusted and operated through a wheel, which reduces and increases the power of the hydraulic mechanism. There is a pump for the operation of hydraulic system and a pressure measuring watch, having two bars in the milling machine, produces better quality of ink than the one rod system. (NIIR Board, 1998)

Some of the ink manufactures call this machine as bar mill, due to the use of bars in the machine.

Most inks must be passed through the mill from three to five times, and some as many as nine times, before they are reduced to the required degree of fineness. The importance of thorough grinding and mixing cannot be over-estimated. It is the true ink making, and is fully as important as the selection of the proper ingredients. When it is considered that some typographic halftone plates contain over forty-thousand individual dots to every square inch of their surface, and that the success of the printing job depends upon each of

these dots printing sharp and clear, it is easily understood why grinding plays such an important role. (NIIR Board, 1998)

When it is judged that the ink has been sufficiently ground, it is returned to the mixing room and given a thorough mix to compensate for any unevenness in the grinding operation and to insure its being perfectly homogeneous. A sample is then sent to the laboratory for inspection. Here it is cooled down to room temperature and compared with the standard sample for fineness of grinding, hue, consistency, drying qualities, and any other tests that the prospective use of the ink indicates as necessary. (NIIR Board, 1998)

2.3 Storage and testing of raw materials

All the pigments, vehicles, driers and other raw materials used in the process of manufacturing the printing inks, are stocked in the store. All the raw materials are tested according to the use and process of printing. The properties, qualities and disqualifies of all the raw materials are tested in this department. (NIIR Board, 2002)

The raw materials in the form of powder are tested into microns and the liquid into poise. Generally the pigments from 0.8 microns to 2.5 microns are used for printing inks.

Very fine particles of the pigment don't wet earlier with the liquid of the vehicle. The pigment particles flew in the air during the manufacturing process and also when printing halftones or solid by any process. And thus, the printing machine becomes dirty and quantity of pigment in the ink is also reduced. In opposite to this, a bigger particle of pigment wets earlier by the vehicle and does not fly in the air. (NIIR Board, 2002)

There are different types of vehicles and driers used according to the printing machines, printing process and nature of jobs. All the materials are tested according to their suitability. It has various types of driers and vehicle in it. There for each and every necessary material should be kept in the store according to their quality and standard measurement. (NIIR Board, 2002)

When the ink maker, or chemist, has satisfied himself that the ink is up to standard and will meet the prescribed requirements in every respect, the batch is approved and the ink is filled into cans or kits and either placed in stock or prepared for shipment. (NIIR Board, 2002)

CHAPTER 03

MEHODOLOGY

3.1 Percentage of ash

A small quantity of ink is ashed in a crucible ignited strongly to a red heat.

Remove crucibles with cover which have been dried for at least 2 hr at 100^0C from oven, to desiccators. Cool and record weight of crucibles with cover to the nearest 0.1 mg.

Weigh 1.5 to 2.0 g of sample into the crucible, recording weight of crucible with cover and sample to the nearest 0.1 mg. and ash in furnace at 600^0C for 2 hr after the furnace reaches temperature.

Allow crucibles to cool in furnace to less than 200^0C and place crucibles with cover in desiccators with vented top. Cool and weigh crucible with cover and ash to the nearest 0.1 mg.

3.2 Percentage of volatile matter

This is determined by heating it weighed sample of the ink in an electric oven at 90^0C-105 ^{0}C., until no further loss of weight occurs. The result gives an indication of the percentage solvent present in the ink.

3.3 Percentage of pigment

A portion of ink, 10-15 g., is accurately weighed into a glass screw-top jar, and 10ml. ether, 10 ml of benzene, and 10 ml of acetone, plus a crystal of ferric chloride, are added. The ink is shaken until dissolved and is left to stand overnight. The pigment is centrifuged out, and the liquor is separated; the pigment is washed twice with the mixed organic solvents, dried in an electric oven at law temperature (about 70^0C) and weighed.

3.4 Estimation of varnish percentage in web press ink

The clear solution of vehicle after the pigments have been centrifuged out, is left exposed in air to lose most of the solvent. Final traces of solvent are removed by drying in an electric oven at 100^0C-120^0C for one hour.

The amount of varnish should be carefully weighed.

CHAPTER 04

RESULTS AND DISCUSSION

4.1 Ash content (see Appendix I)

4.1.1 Ash content in Christol web press ink

Web Press ink color	Sample No	C.W.	C.W.+ W.P.I.W.	W.P.I.W.	F.W.	%Ash	Average %Ash
Red	01	12.3127	13.7118	1.3991	12.6263	22.41	22.33
Red	02	9.5237	12.1748	2.6511	10.1136	22.25	
Yellow	01	9.4767	11.4245	1.9478	9.9853	26.11	26.29
Yellow	02	12.0174	14.7543	2.7369	12.7421	26.48	
Blue	01	11.0490	17.4396	6.3906	12.6252	24.66	24.64
Blue	02	9.7673	12.4972	2.7299	10.4391	24.61	
Black	01	11.6586	14.0491	2.3905	11.8717	8.91	9.29
Black	02	10.0635	14.1980	4.1345	10.4628	9.66	

Table 4.1.1 Experiment data of ash content for Christol ink

- Red color of Christol ink contains 22.33% of ash.
- Yellow color of Christol ink contains 26.29% of ash.
- Blue color of Christol ink contains 24.64% of ash.
- Black color of Christol ink contains 9.29% of ash.

4.1.2 Ash content in Toyo web press ink

Web Press ink color	Sample No	C.W.	C.W.+ W.P.I.W.	W.P.I.W	F.W.	%Ash	Average %Ash
Red	01	9.3925	12.1295	2.7370	9.82880	15.94	16.01
Red	02	9.5249	13.3397	3.8148	10.13801	16.07	
Yellow	01	12.0145	14.2049	2.1904	12.2749	11.89	11.57
Yellow	02	12.1918	14.3052	2.1134	12.4297	11.26	
Blue	01	11.7819	15.8392	4.0573	12.4807	17.22	17.59
Blue	02	9.9356	12.3650	2.4294	10.3721	17.97	
Black	01	9.5256	12.1301	2.6045	9.7598	8.99	9.20
Black	02	10.3012	12.2076	1.9064	10.4807	9.42	

Table 4.1.2 Experiment data of ash content for Toyo ink

- Red color of Toyo ink contains 16.01% of ash.
- Yellow color of Toyo ink contains 11.57% of ash.
- Blue color of Toyo ink contains 17.59% of ash.
- Black color of Toyo ink contains 9.20% of ash.

4.2 Volatile matter content (see Appendix II)

4.2.1 Volatile matter content in Christol web press ink

Web press ink color	Sample No	C.W.	C.W.+ W.P.I.W.	W.P.I.W.	F.W.	%V.M	Average % V.M .
Red	01	9.3996	11.8609	2.4613	11.8437	0.70	0.70
Red	02	11.7874	15.5935	3.8061	15.5669	0.70	
Yellow	01	9.3952	11.8995	2.5043	11.8787	0.83	0.83
Yellow	02	9.9490	11.9348	1.9858	11.9182	0.83	
Blue	01	9.5304	14.7964	5.266	14.7652	0.59	0.59
Blue	02	9.4853	11.2087	1.7234	11.1987	0.58	
Black	01	8.8127	10.1875	1.3748	10.1685	1.38	1.35
Black	02	10.3123	11.9448	1.6325	11.9232	1.32	

Table 4.1.1 Experiment data of volatile matter content for Toyo ink

- Red color of Christol ink contains 0.70% of volatile matter.
- Yellow color of Christol ink contains 0.83% of volatile matter.
- Blue color of Christol ink contains 0.59% of volatile matter.
- Black color of Christol ink contains 1.35% of volatile matter.

4.2.1 Volatile matter content in Toyo web press ink

Web press ink color	Sample No	C.W.	C.W.+ W.P.I.W.	W.P.I.W.	F.W.	%V.M	Average % V.M
Red	01	10.2782	13.2693	2.9911	13.237	1.08	1.08
Red	02	12.317	14.5238	2.2068	14.5001	1.08	
Yellow	01	11.7758	13.968	2.1922	13.9396	1.30	1.30
Yellow	02	12.0177	13.9884	1.9707	13.9628	1.30	
Blue	01	9.9387	12.6623	2.7236	12.6288	1.22	1.22
Blue	02	9.5341	11.7538	2.2197	11.7266	1.22	
Black	01	9.5513	12.3156	2.7643	12.2703	1.64	1.66
Black	02	12.2099	14.3898	2.1799	14.3533	1.68	

Table 4.2.2 Experiment data of volatile matter content for Toyo ink

- Red color of Toyo ink contains 1.08% of volatile matter.
- Yellow color of Toyo ink contains 1.30% of volatile matter.
- Blue color of Toyo ink contains 1.22% of volatile matter.
- Black color of Toyo ink contains 1.66% of volatile matter.

4.3 Pigment content (see Appendix III)

4.3.1 Pigment content in Christol web press ink

Web press ink color	Sample No	G.W.+ W.P.I.W.	G.W.	W.P.I.W.	P.W.+ C.T.W.	C.T.W.	%Pig.	Average %Pig.
Red	01	110.5234	100.2013	10.3221	66.1239	62.8069	32.13	31.96
Red	02	115.4859	101.2018	14.2841	67.3459	62.8063	31.78	
Yellow	01	111.9726	101.7263	10.2463	67.9802	62.8936	49.64	49.21
Yellow	02	116.1148	104.6732	11.4416	35.2003	29.6204	48.77	
Blue	01	116.5915	105.8081	10.7834	68.2438	62.8062	50.42	50.23
Blue	02	116.7819	105.8085	10.9734	68.2957	62.8057	50.03	
Black	01	114.873	104.6731	10.1999	35.1027	29.6172	53.78	54.04
Black	02	114.8862	100.2019	14.6843	37.6874	29.7149	54.29	

Table 4.3.1 Experiment data of pigment content for Christol ink

- Red color of Christol ink contains 31.96% of pigment.
- Yellow color of Christol ink contains 49.21% of pigment.
- Blue color of Christol ink contains 50.23% of pigment.
- Black color of Christol ink contains 54.04% of pigment.

4.3.2 Pigment content in Toyo web press ink

Web press ink color	Sample No	G.W.+ W.P.I.W.	G.W.	W.P.I.W.	Pig.+ C.T.W.	C.T.W.	%Pig.	Average %Pig.
Red	01	117.3467	106.8621	10.4846	77.1257	72.4782	44.33	43.78
Red	02	117.2564	106.3252	10.9312	77.2514	72.5269	43.22	
Yellow	01	118.6459	105.6687	12.9772	69.4145	62.7747	51.17	50.43
Yellow	02	117.3664	105.9526	11.4138	78.0426	72.3698	49.70	
Blue	01	116.3367	104.7812	11.5555	69.2772	62.7554	56.44	56.93
Blue	02	118.4571	104.2584	14.1987	70.9268	62.7731	57.43	
Black	01	117.2365	104.7179	12.5186	79.8921	72.4952	59.09	59.49
Black	02	118.4765	105.1147	13.3618	70.8874	62.8845	59.89	

Table 4.3.2 Experiment data of pigment content for Toyo ink

- Red color of Toyo ink contains 43.78% of pigment.
- Yellow color of Toyo ink contains 50.43% of pigment.
- Blue color of Toyo ink contains 56.93% of pigment.
- Black color of Toyo ink contains 59.49% of pigment.

4.4 Varnish content (see Appendix IV)

4.4.1 Varnish content in Christol web press ink

Web press ink color	Sample No	G.W.+ W.P.I.W.	G.W.	W.P.I.W.	J.W. + V.W.	J.W.	%Var.	Average %Var.
Red	01	110.5234	100.2013	10.3221	40.0182	34.1399	56.95	57.25
Red	02	115.4859	101.2018	14.2841	43.2863	35.0652	57.55	
Yellow	01	111.9726	101.7263	10.2463	39.1083	34.9776	40.31	39.94
Yellow	02	116.1148	104.6732	11.4416	38.5691	34.0412	39.57	
Blue	01	116.5915	105.8081	10.7834	40.4744	35.0773	50.05	49.54
Blue	02	116.7819	105.8085	10.9734	39.0248	33.6432	49.04	
Black	01	114.873	104.6731	10.1999	37.5976	34.0443	34.84	34.11
Black	02	114.8862	100.2019	14.6843	39.8911	34.9901	33.38	

Table 4.4.1 Experiment data of varnish content for Christol ink

- Red color of Christol ink contains 57.25% of varnish.
- Yellow color of Christol ink contains 39.94% of varnish.
- Blue color of Christol ink contains 49.54% of varnish.
- Black color of Christol ink contains 34.11% of varnish.

4.4.2 Varnish content in Toyo web press ink

Web press ink color	Sample No	G.W.+ W.P.I.W.	G.W.	W.P.I.W.	J.W. + V.W.	J.W.	%Var.	Average %Var.
Red	01	117.3467	106.8621	10.4846	38.9124	34.1621	45.31	45.03
Red	02	117.2564	106.3252	10.9312	39.1018	34.2101	44.75	
Yellow	01	118.6459	105.6687	12.9772	39.2497	34.1254	39.49	39.01
Yellow	02	117.3664	105.9526	11.4138	38.5086	34.0896	38.72	
Blue	01	116.3367	104.7812	11.5555	38.1147	34.0702	35.00	34.74
Blue	02	118.4571	104.2584	14.1987	39.0679	34.1723	34.48	
Black	01	117.2365	104.7179	12.5186	37.8547	34.2001	29.19	29.76
Black	02	118.4765	105.1147	13.3618	38.1512	34.0991	30.33	

Table 4.4.1 Experiment data of varnish content for Toyo ink

- Red color of Toyo ink contains 45.03% of varnish.
- Yellow color of Toyo ink contains 39.01% of varnish.
- Blue color of Toyo ink contains 34.74% of varnish.
- Black color of Toyo ink contains 29.76% of varnish.

4.5 Comparison of major constituents according to color

Variation of ash percentage according to color

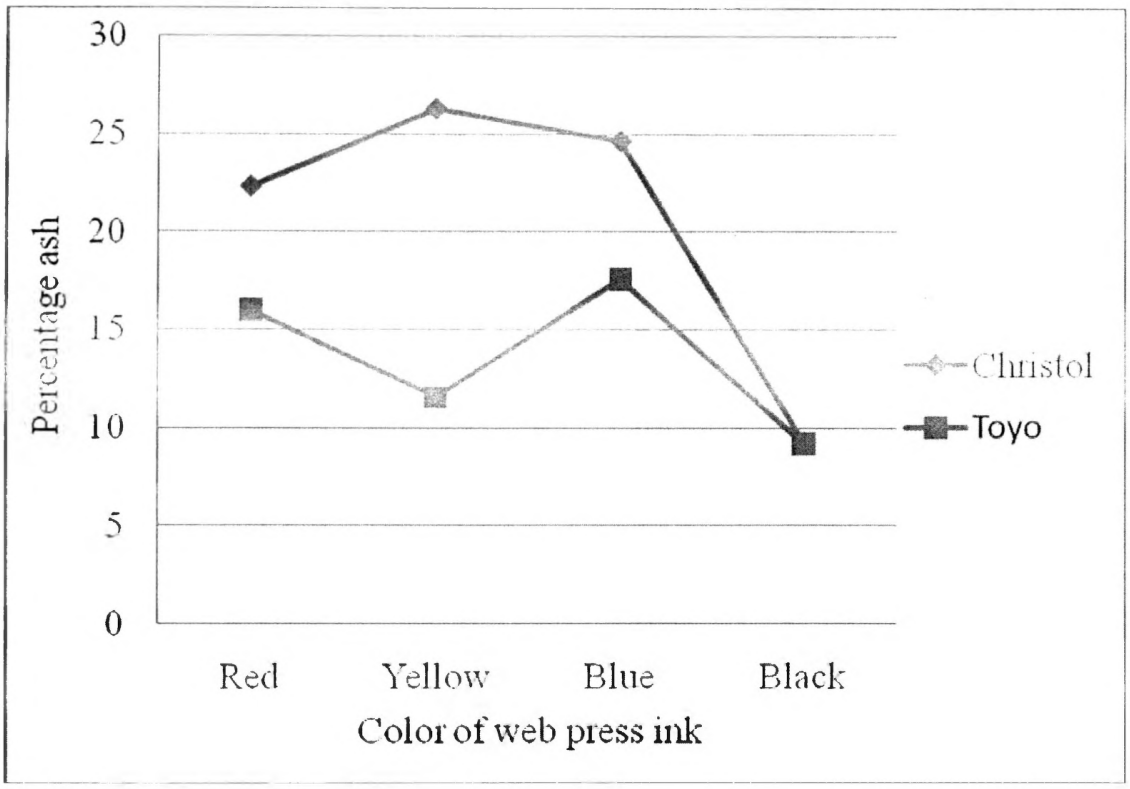

Fig 4.5.1 Variation of ash percentage according to color

According to the graph, Christol ink contains higher percentage of ash than that of Toyo ink.

Product name	Red	Yellow	Blue	Black
Christol Ink	22.332775	26.295185	24.636655	9.2861055
Toyo Ink	16.006345	11.572490	17.595340	9.2038910

Table 4.5.1 Variation of ash percentage according to color

Variation of volatile matter percentage according to color

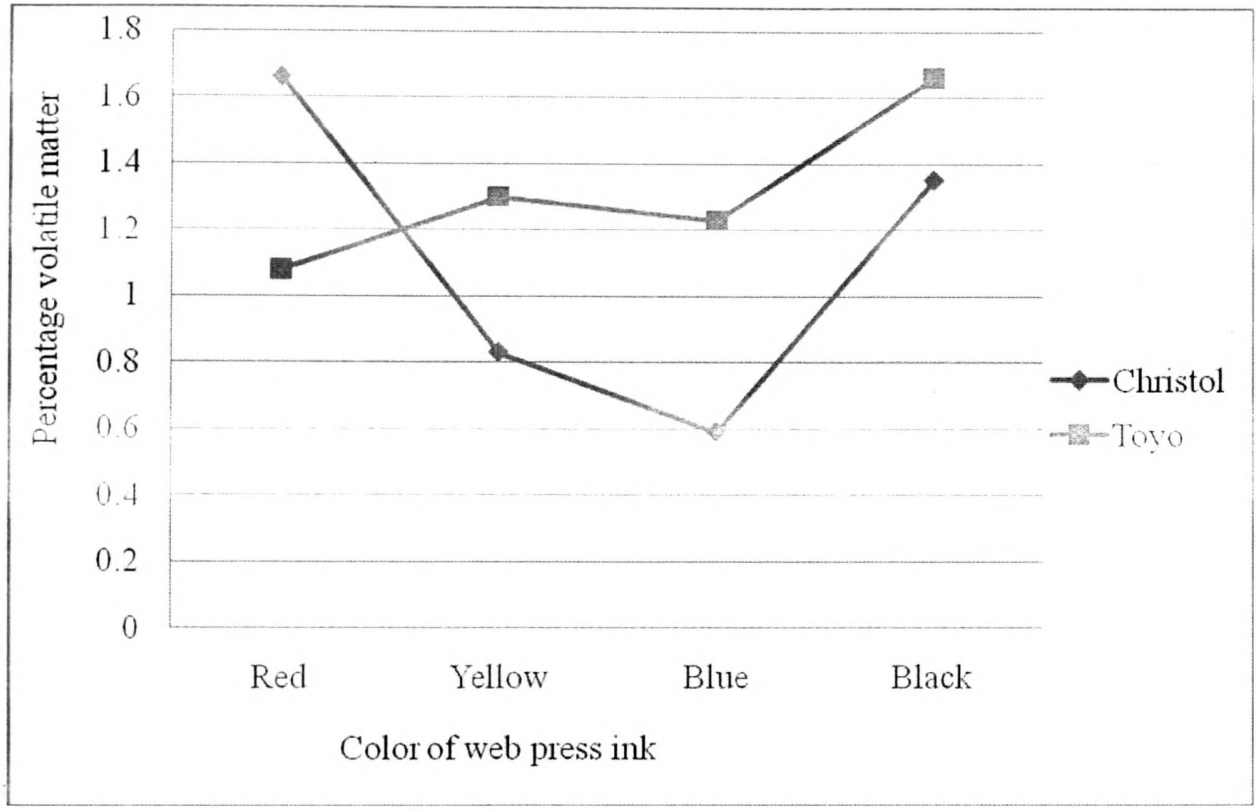

Fig 4.5.2 Variation of volatile matter percentage according to color

According to the graph, Christol ink contains lower percentage of volatile matter than that of Toyo ink for yellow,blue and black color. But it is slightly different for red color.

Product name	**Red**	**Yellow**	**Blue**	**Black**
Christol Ink	1.656569977	0.8332532780	0.5863642035	1.3525716230
Toyo Ink	1.0769117585	1.2972665180	1.2276902690	1.6565699770

Table 4.5.2 Variation of volatile matter percentage according to color

Variation of pigment percentage according to color

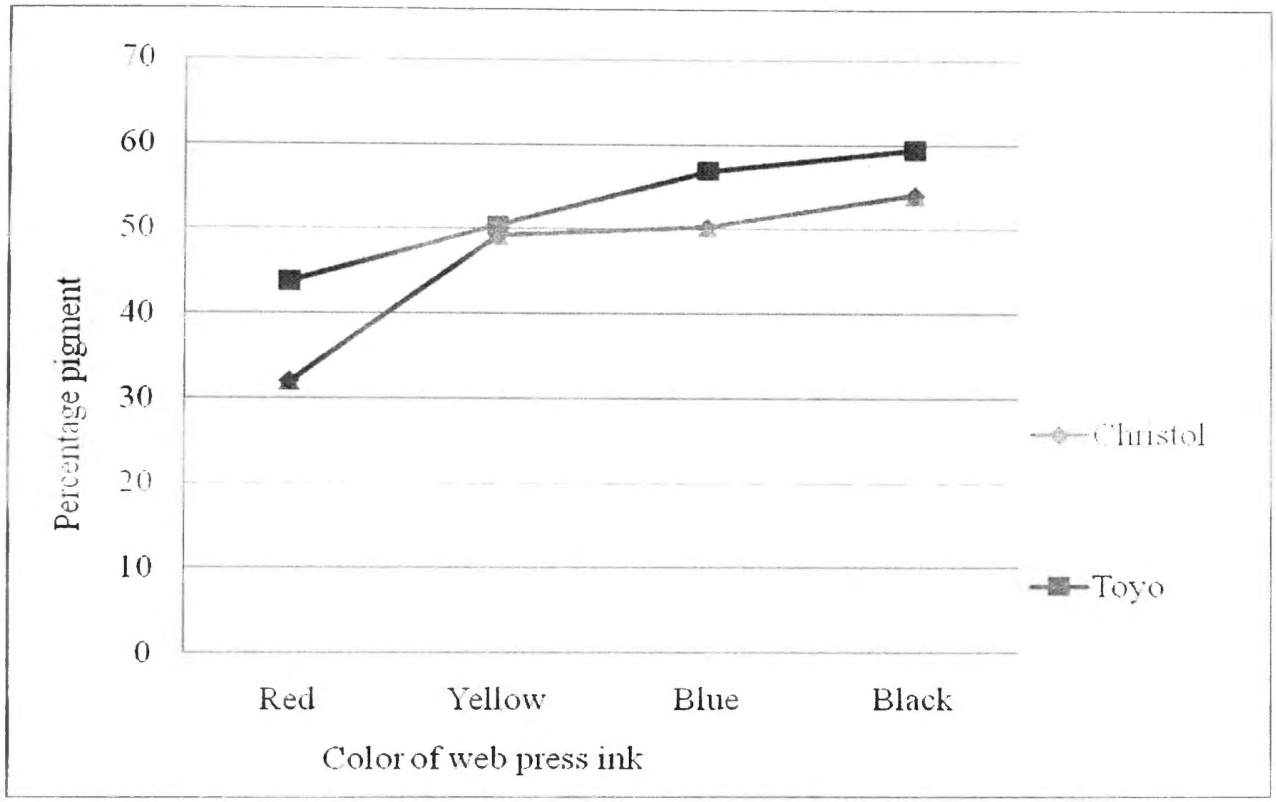

Fig 4.5.3 Variation of pigment percentage according to color

According to the graph, Christol ink contains lower percentage of pigment than that of Toyo ink.

Product name	**Red**	**Yellow**	**Blue**	**Black**
Christol Ink	31.95785	49.20590	50.22790	54.03630
Toyo Ink	43.77360	50.43315	56.93230	59.49060

Table 4.5.3 Variation of pigment percentage according to color

Variation of varnish percentage according to color

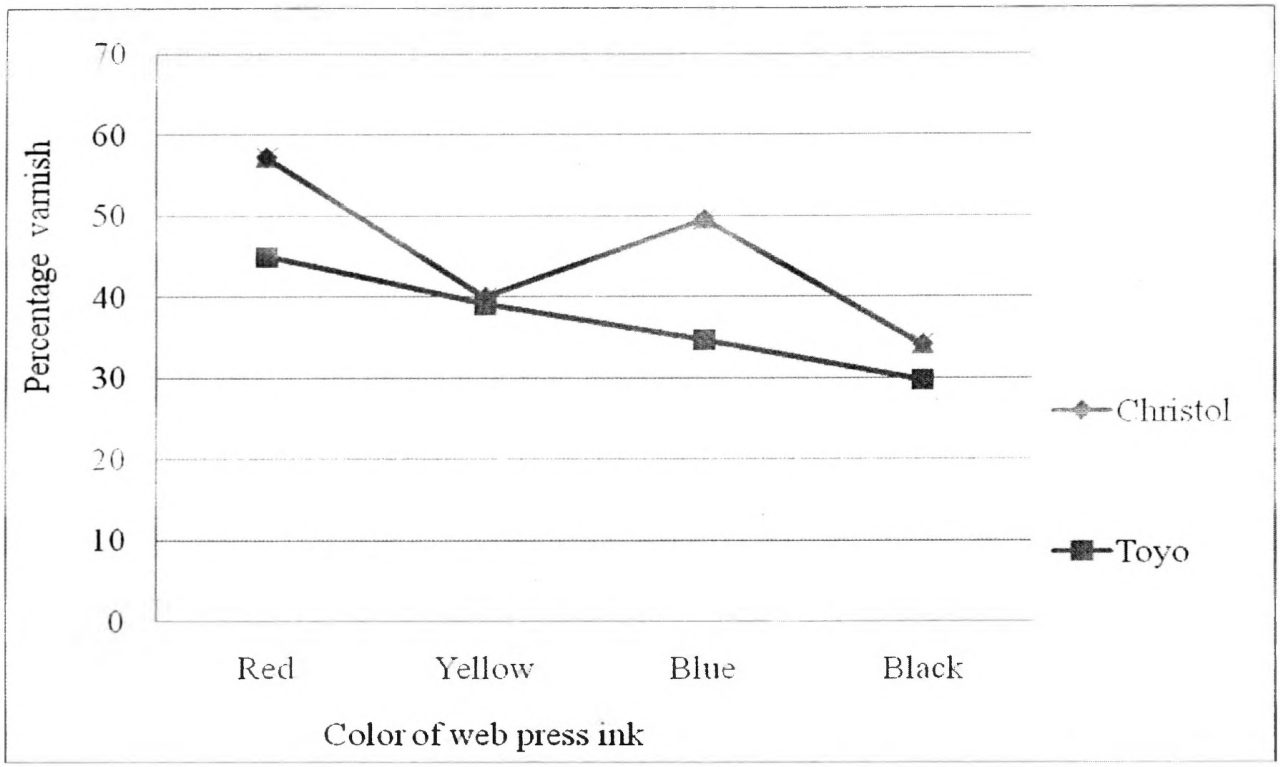

Fig 4.5.4 Variation of varnish percentage according to color

According to the graph, Christol ink contains higher percentage of varnish than that of Toyo ink.

Product name	Red	Yellow	Blue	Black
Christol Ink	57.251443275	39.944037610	49.546153180	34.106199175
Toyo Ink	45.028646730	39.101618575	34.739930965	29.759682130

Table 4.5.4 Variation of varnish percentage according to color

4.6 Discussion

4.6.1 Limitations of analysis

Even when conducted by a cautious and skillful technologist, ink analysis suffers from considerable limitations. For example, accurate identification of all the pigments present in an ink is virtually impossible, still less an accurate estimation of their proportions.

Some analyzers new to the subject seem to think that eventually the analytical methods will become more accurate and refined and that a really skilled investigator, given time will be able to arrive at a very accurately analyzed.

4.6.2 Suggestions for product improvements and developments

Making percentage of major constituents' information available as product-wise will assist the ink producer in choosing the proper combination of major constituents for their quality product. Because the ink manufactures face the severe problems due to the lack of international standards for the web press ink. The Christol ink is also the faced the same problem. Due to this reason, competitor product information is very important.

An analytical test gives data about only analytical nature of web press ink. As well as additional tests for non-analytical nature of web press ink check the opacity of an ink is also greatly important. Because of better quality of web press ink depend on both analytical and non-analytical nature of ink.

The analytical method should be reserved for occasions when it must be used, and attention should be concentrated on finding out the material which confers and important property on a particular ink. The analysis should never be conducted as a slavish exercise, nor by following a hard and fast procedure. The analytical method, however, is a very powerful one, if used by a trained and discriminating investigator, who is fully aware of the limitations of the method, knows exactly what reliance he can place on his results, and how to interpret the information.

CHAPTER 05

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Under the research, It was identified Christol ink contain lower percentage of pigments than competitor product. To improve the quality of Christol ink, producer has to use pigments in an appropriate manner which takes advantage of its best properties and minimize its defects. Because of pigment is the main element for producing color and only the main coloring agent of any ink. It is very important for ink manufactures to lead the way and it is an absolute to have ink that will perform perfectly at faster speeds than current presses.

5.2 Suggestions for further studies

Modern ink manufacture is much more complex and a wide variety of binders are now employed, as well as a greater range of pigments. Issues for buyers include pricing, quality, ink performance, drying times and the environment. Ink suppliers are constantly looking at developing sustainable inks and this has been partly driven by customer demand.

Fulfill that kind of customer demand instead of research data, below mentioned categories of analysis also must be done.

A. The approximate proportion of pigment mixture which is inorganic;

B. Nature of pigments responsible for opaque white pigments;

C. Identify of major varnish constituents, e.g. alkyds, maleics, phenolics, vinyls, celluosic binders, shellac, etc;

D. Identify of driers, i.e. whether Cobalt, Manganese, Lead, etc.

REFERENCES

Adams F.R.(2001),Printing Technology,Fourth Edition,Delmar Publisher,UK, 05-15pp.

Banke W.H.(1981),Advances in Printing Science & Technology,16th Edition,Technical and Education Committees National Association of Printing Ink Manufacturers, Inc. And the National Printing Ink Research Institute,72-91pp.

Carvalho D. N.,Forty Centuries of Ink,(Accessed from http://www.worldwideschool.org /library/books/tech/printing/FortyCenturiesofInk/toc.html on 29/01/2009)

Components of printing inks (1998),(Accessed from http://www.hdm-stuttgart.de/ projekte/printing-inks/p_gercom.htm on 19/01/2009)

David N.C. (1995),Ancient and Modern Ink Recipes,(Accessed from http://www. djmcadam.com /ink-recipe.html on 16/01/2009)

Fisk,P.M.(1976),Printing Ink Technology(PartI),First Edition,Leonard Hill(Ltd), England,256p.

Fisk,P.M.(1979),Printing Ink Technology(Part II),First Edition,Leonard Hill(Ltd), England,317p.

Fisk,P.M.(1980),Printing Ink Technology(Part III),First Edition,Leonard Hill(Ltd), England,265p.

Flick E.W.(1985),Printing Ink Formulations,Second Edition,Noyes Publications,New jersy,U.S.A.,81-89pp.

Henk G. (2006),Inks for heat set web offset,(Accessed from http://lists.apple.com/ archives/colorsync-users/2006/Jan/msg00353.html on 16/01/2009)

Inks and Coatings (Accessed from http://glossary.ippaper.com/default.asp?req= knowledge/article/149& catitemid=24 on 22/01/2009)

Jeff B.,The bug that changed history(2006),(Accessed from http://www.gcrg.org/bqr/8-2/bug.htm on 22/01/2009)

Lowengard S.,The Creation of Color in Eighteenth-Century Europe,(Accessed from http://www.gutenberg-e.org/lowengard/ on 22/01/2009)

Manufacture of printing inks (1998),(Accessed from http://www.hdm-stuttgart.de/ projekte/printing-inks/p_gerrdy.htm on 19/01/2009)

NIIR Board (2002),Hand Book on Printing Technology (Offset, Gravure, Flexo, Screen), Second Edition,National Institute of Industrial Research,Delhi India,644p.

NIIR Board (1998),Modern Printing Technology,Fifth Edition,National Institute of Industrial Research,152p.

NIIR Board (2006),Paints, Pigments, Varnishes and Enamels Technology Handbook, Second Edition,Asia Pacific Business Press Inc.,Delhi India,170-220pp.

NIIR Board (2003), The Complete Book on Printing Technology, Second Edition, Asia Pacific Business Press Inc., Delhi India,742p.

Nosmot G. (2008), Web offset inks, (Accessed from http://www.printweek.com/ news/ 775640/Web-offset-inks/ on 15/01/2009)

Nosmot G. (2009), Web offset inks, (Accessed from http://www.printweek.com/ news/ 871554/Web-offset-inks/ on 15/01/2009)

Nosmot G. (2008), Web offset presses, (Accessed from http://www.printweek.com/ news 794246/Web-offset-presses/ on 15/01/2009)

Offset (Accessed from http://glossary.ippaper.com/default.asp?req=knowledge/article/

149& catitemid=24 on 22/01/2009)

Pigments Through the Ages (2007),(Accessed from http://webexhibits.org/pigments/ on 23/01/2009)

Smith T. (1984),Pigment and Resin Technology,13th Edition,MCB UP Ltd, India, 13-18pp.

Voet,A.(1952),Ink and paper in the Printing Proces,Second Edition,Interscience Pulishers ltd,London,206p.

Appendix I

Calculation of percentage ash content in Christol web press ink

%Ash = [(Final weight- Weight of Crucible)/ Weight of Web press ink] *100%

For Red color (Sample No 01)

Include weight of web press ink in furnace = 13.7118g -12.3127g

= 1.3991g

Weight of Ash in furnace at 600^0C for 2 hr

After the furnace reaches temperature = 12.6263g – 12.3127g

= 0.3136 g

Therefore,

Percentage of ash content in Christol web press ink = (0.3136g / 1.3991g) x 100%

= 0.224144092 x 100%

= 22.41441%

Average Percentage of ash content in Christol

web press ink for red color = (22.41441 + 22.25114) / 2

= 22.332775%

Above procedure is used to calculate percentage of ash content of all analyzed Samples.

Appendix II

Calculation of percentage volatile matter content in Christol web press ink

%V.M.=[(Weight of web press ink -Final weight)/ Weight of web press ink] *100%

For Red color (Sample No 01)

Include weight of web press ink in electric oven = 11.8609g – 9.3996g

= 2.4613g

Final weight of ink sample after heating in

an electric oven at 95^0C = 11.8437g – 9.3996g

= 2.4441g

Therefore,

Percentage of volatile matter content in

Christol web press ink = (2.4613g -2.4441g) / 2.4613g x 100%

= 0.698817697964490309 99%

= 0.698817698%

Average Percentage of volatile matter content

in Christol web press ink for Red color = (0.698817698+ 0.698878117) / 2

= 0.6988479075%

Above procedure is used to calculate percentage of volatile matter content of all analyzed samples.

Appendix III

Calculation of percentage pigment content in Christol web press ink

%Pigment = [Weight of Pigment (g) / Weight of Web press ink (g)]*100%

For Red color (Sample No 01)

Include weight of web press ink in Glass screw-top jar = 110.5234g – 100.2013g

= 10.3221g

Final weight of Pigment after dried in

an electric oven at about 70^0C = 66.1239g – 62.8069g

= 3.317 g

Therefore,

Percentage of Pigment content in

Christol web press ink = (3.317g / 10.3221g) x 100%

= 0.3213493378285x 100%

= 32.1349%

Average Percentage of Pigment content

in Christol web press ink for Red color = (32.1349+31.7808) / 2

= 31.9578%

Above procedure is used to calculate percentage of pigment content of all analyzed samples.

Appendix IV

Calculation of percentage varnish content in Christol web press ink

%Varnish = [Weight of Varnish (g) / Weight of Web press ink (g)]*100%

For Red color (Sample No 01)

Include Weight of web press ink in Glass screw-top jar = 110.5234g – 100.2013g

= 10.3221g

Final weight of varnish after dried in

an electric oven at at 100^0C - 120^0C = 40.0182g –34.1399g

= 5.8783 g

Therefore,

Percentage of varnish content in

Christol web press ink = (5.8783g / 10.3221g) x 100%

= 56.9486829230486%

= 56.94868292%

Average Percentage of varnish content

in Christol web press ink for Red color = (56.94868292+57.55420363) / 2

= 57.251443275%

Above procedure is used to calculate percentage of Varnish content of all analyzed samples.

National Digitization Project

National Science Foundation

Institute : Sabaragamuwa University of Sri Lanka

1. Place of Scanning : Sabaragamuwa University of Sri Lanka, Belihuloya
2. Date Scanned : ....2017-09-26.....
3. Name of Digitizing Company : Sanje (Private) Ltd, No 435/16, Kottawa Rd, Hokandara North, Arangala, Hokandara
4. Scanning Officer

Name : ....G.A.C. Gadaruwan.....

Signature : .....

Certification of Scanning

I hereby certify that the scanning of this document was carried out under my supervision, according to the norms and standards of digital scanning accurately, also keeping with the originality of the original document to be accepted in a court of law.

Certifying Officer

Designation : LIBRARIAN.....

Name : T.N. NEIGHSOOREI.....

Signature : .....

Date : ...2017-09-26.....

"This document/publication was digitized under National Digitization Project of the National Science Foundation, Sri Lanka"