

**PRODUCTION AND CHARACTERIZATION OF WOOD  
FINISHES: GLOSSY WOOD FINISH AND SANDING-SEALER  
WOOD FINISH USING NITROCELLULOSE SOLUTION**

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**DEPARTMENT OF CHEMICAL ENGINEERING  
FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,  
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ENGINEERING AND ENGINEERING TECHNOLOGY  
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NIGER STATE, NIGERIA.**

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## ABSTRACT

Wood finishes are paints in form of a liquid, paste or gel that can be spread thinly onto wood panel to protect and decorate the surfaces. The major four categories are: Glossy wood finish, matt wood finish, sanding sealer wood finish and wood stain finish. The project work investigated the production and characterization of glossy and sanding sealer wood finishes using nitrocellulose solution.

The wood finish produced was found to give the following:

- (i) The drying which is by process of evaporation of solvents very fast process as compared with the relating slow process of oxidation of oleresinous finishes dry.
- (ii) Due to speed of application, drying time and easy of handling, there is less necessity for expensive production equipment (mainly agitation/mixing).
- (iii) Due to better control of chemically pure raw materials e.g. pigments, resin e.t.c. and various additive paint products of more uniform characteristics were obtained.
- (iv) They have remarkable, durability water resistance e.t.c. which place nitrocellulose wood finish paints among the highest protective wood coatings industries.

The results showed that glossy wood finish paint has initial viscosity of 122seconds drying time of 25 minutes and gloss level of 85% while sanding sealer has initial viscosity of 135 seconds and drying time of 30minutes, gloss level of 4%, very low because of matting agent added to it. And the cost of materials used, cost of production of paint was found reasonable.

In formulating and production of wood finish paint the materials cost, and functions of raw materials and quality are important parameters for proper consideration.

## ACKNOWLEDGEMENT

My acknowledgement goes to God Almighty for His guidance, favour, protection, provision and mercy with divine insight to the project work and assistance throughout my University Education.

My profound gratitude goes to my supervisor, Dr. F. Aberuagba who acted as a father and rendered necessary assistance throughout the course of this project work. In which without his valuable contributions, this work would not have come to reality. I appreciate his effort and thank him greatly. May his dream come true.

I also appreciate the financial and moral support of my sweet mother indeed Mrs F.O. Akinsowon , my sister Mrs Oluwasola Kikelomo Betsy and pastor Oluwasola Timothy, towards my academics pursuit and excellence.

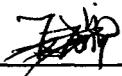
My sincere gratitude goes to Mrs. Akinsowon Omoseeke (Star), Mr Akinsowon Bunmi, Mrs Ogunsan Simisola, Joyce, Dele, Mr Terry. Engr. Saka, and Mr. Onala wood finish company for their immerse co-operation and priviledge given to me in the usage of their facilities for my project work.

I cannot forget the support of my friends James Omekafe, Clement Yari, Abiodun Joy, Mrs Bright Robert, Dare Jayeola, Emma Okerie (Notica) Ameh Oche, Sani Kwara (Guru), Henry and Usman, Owaroh Joy those I can not mention their names.

## CERTIFICATION

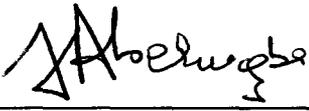
I hereby certify that this project: "The Production and Characterization of Wood Finishes: Glossy Wood Finish and Sanding Sealer Wood Finish Paints" was solely carried out by Mr. Akinsowon O.S. Precious (99/8073EH) under the supervision of Dr. F. Aberuagba. It is hereby certified that he has neither copied anybody's work nor been copied.

Mention has properly been included in the reference section of authors whose materials have been found useful, in the course of this Project Research Work.

  
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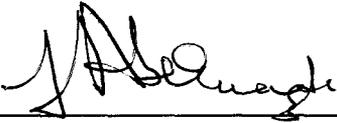
Student's Signature

Date: 1st DEC. 2005

  
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Supervisor's Signature

Date: 12/12/05

  
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Head of Department's Signature

Date: 01/12/05

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External's Signature

Date: \_\_\_\_\_

## DEDICATION

This project work is dedicated to God Almighty and my beloved parents Mr and Mrs Akinsowon and pastor and Mrs Oluwasola (CBF) for their moral and financial support during my course of study and to Mrs. Akinsowon omeseeke (Star) and beloved brother Bunmi Henry and my sisters Ogunsan Simisola (Mrs) Akindele (Director) Mr and Mrs Omofunmiola, Joseph Adepoju, Ranti Omotunde, A.O Joy, and simidele Joyce for their moral support and assistance to make this work and my university Education a successful one.

God bless you all.

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## 1.0 INTRODUCTION

1.1 **WOOD FINISH:** From the early Roman time, the technology of wood preservation and decoration discovered for whatever purpose the wood is used. It required a finishing treatment of some sort whether on interior or exterior furniture work.

The precise type of finish depends on the condition under which is to render service and wood type being used. Since some woods are naturally immune to all destructive agents (Fungi), further preservation and final finishing with decoration are required with the aid of manufacturing of a chemical liquid product called WOOD FINISH.

**WOOD FINISH:** The term finish is a liquid, paste, or gel that can be spread thinly onto wood. It can be classified as an organic liquid product which is used as a protective finishes in form of polish, oil, Lacquer, paint and vanishes all of which form a trends that focus on prevent attack by insects and fungi and finally keep furniture products more beautiful, protects the wood from scratches, dirt, and wear. Enhance woods natural beauty, colour, figure patterns, grain and depth.

Wood finish also preserves wood from water oxidation and the sun's ultraviolet rays. Then, it also changes woods appearance by adding colour and hiding defects.

There are two basic classification of wood finish, those that form a film or coating on a wood and secondly those that penetrate the wood surface during application.

**FILM FINISHES:** Which cure hard and can be build up in layers, include: Varnish, Shellac, Lacquer, water and latex base semi-transparent stains, and solid colour stains.

**PENETRATION FINISHES:** are oil-base and do not cure to a hard film. These include oil finishes, that tang and linseed oil and oil base stains.

Wood finishes, rather than paints, are often used to show case the natural beauty of wood grain such as floors and interior trim, outside, wood finishes are equally used on decks and siding.

## 1.2 ORIGIN OF EARLY WOOD FINISH PAINT

Paint technology started as the beginning of history. The cavemen first described his artistic abilities by daubing and coloured clay on the walls of his cave. The Egyptians decorated their walls with painting executed in distemper. The Roman combined pigments with plaster to decorate interior surfaces. Also during colonial days white-wash was used as an all purpose finish.

In 1865, the first united state patent was issued to D.P.F LIWN, which covered a water base paint of Zinc oxide, potassium hydroxide, resin, milk and linseed oil. Oil paints originated when the artist of early centuries (A.D) added drying oil to their colours. The literature is not defined in regards to the exact date, but generally associated with the great painters of the fifteen century.

Particularly in Africa, the art of painting was at the early stage period which was primary decorative. Some works of art of paintings were of durably substances that were extracted from trees. Some were mixed with charcoal and blended with coloured pigments, which serve the artwork the beauty that is designed.

In Nigerian painting is not a new art. Each tribe is peculiar in its nature in portraying the art practiced in the country. Northern part of the country, Paints are used on calabash which is hung on the walls as decorative art.

In the Eastern part, among Ibo's the use of Uri (an extract from a tree) is widely used to decorate walls and the body of a pride during marriage ceremonies. In the western part, it is used to paint portraits and hung on the walls of the house.

Therefore, the art of making paints and varnish remained in the hands of the painter until the civil war. From those early days up to about the end of nineteenth century. Paint formulation was regarded as an art and artists and craftsmen mixed their own paint according to specific formulations handed down. Such formulations emerged from trial and error, with little understanding of the fundamentals principle involved. Then in the early part of this century, science started to be used to produce improved products but still the vast amount of empirical knowledge accumulated over the centuries.

Gradually, science played an increasing importance part with the result that formulation today is based on scientific principles.

### **1.3 FUNCTIONS OF PAINT**

The purpose of coating or the uses of paint are for decorative protection. Decorative effects may be produced by colour, gloss or texture. A secondary decorative function is lighting as the colour of the surface effect of the reflectance.

The proportion of light reflected by a surface is expressed as a percentage of complete reflectance. The protective coating may be the paint on furniture, wooden boat for protection against rotting, the interior lining of metal cans or drums which prevent corrosion from foods and chemicals, the fire retardant paint which protect combustible surface. It may also be the coating on plaster or concrete which makes for ease clearing. Etc.

An example of functional use of paint would be as a traffic paint which wants the centre and edge of a road for safer driving.

### **1.4 COMPONENTS OF WOOD FINISHES**

(a) **PIGMENTS OR DYES:** These are basically used in wood finishes to add colour and hide flaws. Pigments are finely divided solids of various shades used to give colour, opacity, consistency, durability and other properties to the surface of coatings. Pigments are insoluble powdered substances imparting colour and opacity to the paint film. While some soluble dye stuff is added to adjust colour but has no other function. Pigments in order of word are fine solid particles used in the preparation of wood finish and are substantially insoluble in the vehicle. Vehicle is used to describe the liquid part of the paint. Vehicle is the entirely liquid portion of a paint which includes the binder or film former volatile solvent and anything that is dissolved in the liquid portion.

Pigments can be either organic or inorganic in composition and occur naturally or can be synthesised. Average particles size of which can vary from 0.2 to 10mm (micrometer). Some inorganic compounds which are something put onto paint to

partially replace true pigments, these are Extenders. They are characterised by low refractive index which is close to that of the binder. To reduce the cost of paint or production of wood finish, extenders were used to replace expensive pigment that are now used to impart certain specific properties as sanding, to build for flow, durability, adhesion, gloss, and rheology (imparting false body to reduce settlement). In conclusion, extenders are characterized as pigments.

(b) **RESIN:** is the natural or synthetic film – forming components of these finishes. Resin is also called binders, especially when used in stains or paints, because they hold or bind the pigment to the wood surface.

Resins include acrylic, vinyl alkyds, cellulose, epoxies, polyurethanes, and oils. The resin type determines the finish hardness flexibility, and resistance to stains, Solvent and water.

(c) **SOLVENTS:** These are also referred to as thinners are basically used in wood finishes to maintain the finish in liquid form. Solvents are needed to dissolve resins. While thinners are used to reduce viscosity (thickness) of the liquid. Some finishes contain both solvents and thinners.

Solvent – base coating typically use organic solvent such as alcohols, ketenes, glycol, ether's petroleum distillates (mineral spirit, toluene, xylene and naphtha), and turpentine. The solvent in water borne coating is usually glycol ether, and water is used as a thinner.

(d) **VARIOUS ADDITIVES:** These are used in smaller amounts to adjust drying time, prevent fungus and mildew growth, act as thickener. These are also included for specific properties such as improving flows, speed of chemical reaction and dispersion.

## 1.5 TYPES OF PAINT

Paints are of different type due to their functions and components of the paints. But in the industrial sector paints are classified into three sectors.

- (a) Industrial Finish
- (b) Decorative
- (c) Specialized Coatings

The different types are:

- (i) Emulsion paints industrial finish
- (ii) Wood Furniture finishes
- (iii) Stoving paints and finishes
- (iv) Marine paints
- (v) Anti-corrosive paints
- (vi) Heat resistance paints
- (vii) Insulating varnishes and wire enamel
- (viii) Synthetics enamel paints
- (ix) Bituminous, Mica paint

## **MOTIVATION**

Today, the world paints industry is fast improving unlike the advanced technology where the competition is very high in diversifying the use of synthetic raw materials. The big paint industries in Nigeria are trying yet the need and demand of people for wood coating is not satisfied. At the same time, decorating trends that focus on the warmth and beauty of wood in the form of exposed wood floors, walls and home furniture increase the demand for wood furnish as an alternative to paint. Therefore our local paint industries are still struggle with the problem of sourcing for raw materials locally, moving into oil paints section and subsequently improving on old formulation.

## **OBJECTIVES / AIMS**

The main objective of this research project is to formulate and produce wood finish paints using nitrocellulose solution that will withstand harsh weather conditions, enhance wood natural beauty, colour, figure pattern, grain and to preserve wood from water, oxidation and give good attractive appearance to the wood. Also for the protection of wood and decoration of wood for these paints

1. Nitrocellulose glossy wood finish paint
2. Nitrocellulose sanding sealer

These are based on the type of raw materials, costs, quality of finish and durability of the paints.

## **SCOPE**

Since many of the products used to coat wood around the home have traditionally contained volatile organic solvent and other toxic chemicals that have been linked to poor indoor air quality and possible health impacts, air pollution and chemical toxicity in household. The above scope or research is done which enable a small scale plant for the production of wood finishes using nitrocellulose solution which is low in volatile organic compound (VOCS) and are not toxic chemical. Reducing the cost of production and having good quality nitrocellulose wood finish that would be compared to those produced in big paint industries (CAPL and Berger paint)

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### A BRIEF HISTORICAL BACKGROUND OF WOOD FINISH

According to "THE ELEMENT STYLE" encyclopaedia as dated back to the Baroque Era (1625 - 1714) that wooden floors and wood finishes became elegant, starting with the French parquetry Marquentry patterns.

Designs were made by the hand scraped, of their over wood, scrubbed with stained and polished. These were only found in the most affluent and royal homes of their time. Some of the merchants' class would imitate this by painting a plant floor and wood with design

Wood Finishes did not get factory for mass produced until the America Victoria Era (1340-1910). Varnishes were usually slow curing tang oils introduced from China. These were not durable in themselves so the woods were hot waxed and buffered to shine with the wood finishes brush.

Varnishes improve hardness and curing time with addition of alkyl resin and in the 1930's polyurethane was the ideal no-wax finish for woods. This allowed wood to play a prominent role throughout the modern Era (1920-1950).

The modern day wood finishes are an oil paint consisting of a base often Lead, Zinc or Iron oxide, together with a pigments to colour the wood finishing. These are mixed with linseed oil which acts as binder for the pigments. Research work revealed that various types of binders are suitable for the specific brand of varnishes or wood finishes.

However, since some indigenous wood finish company or industry were founded in Nigeria some year back dated to the early 1975 due to the ever increasing price of raw materials.

Nearly all the raw materials are being imported, some are produce in Nigeria's and some locally while 68% are imported which cause high price of production. However, the research work is base on how to get substitute for most imported raw materials by using nitrocellulose resin for the production of wood finish formulation and improvement of the desire products.

Nitrocellulose can be supplied through dense granules in shape of original wood chips or Linters which inform similar to cotton wool and are derived from cotton seeds.

Nitrocellulose, which is being used in the production of wood, finishes paint. Cellulose which is the base for nitrocellulose is natural materials which form wood structure of plants.

**WOOD:** is almost pure cellulose, most natural source that most cellulose used in production industry is obtained.

The solvent used is available as a part of fractional distillation product of crude oil in Nigeria.

After proper formulation of the process material ratio in reliable proportion of standard mixing ratio of raw materials is gotten and proper cogitation of mixture. At the end of production processing, the following necessary test of product will be carry out. Viscosity, dispersion weight per litre. Also, at the end the economy analysis will be determined to see if the aim and objective of producing a nitrocellulose wood finish is achieved.

## **2.1 DEFINITION OF WOOD FINISH**

Wood finish is defined as a liquid, paste, or gel that can be spread thinly onto wood. Wood finishes rather than paints are often used to show case the natural beauty of wood grains, such as on floors and interior trim. Outside, wood finishes are used on decks and siding.

## **2.2 BASIC TYPES OF WOOD FINISH**

There are two basic types of wood finish as stated below:

- (i) Those that form a film or coating on the wood
- (ii) Those that penetrate the wood surface

Film finishes which cure hard and can be built up in layers include varnish, shellac, lacquer, water-and latex-based semi-transparent stain, solid colour stain.

Penetrating finishes are oil-based and do not cure to a hard film. These are oil finishes, e.g tung and linseed oil and oil based stain.

## 2.3 FUNCTION OF WOOD FINISH

**PROTECTION:** Wood finish protects the wood from scratches, dirt, and wear.

**PRESERVATION:** Wood finish preserves wood from water, oxidation and sun's ultra  
– Violet rays

Wood finishes enhances wood's natural beauty, colour figure patterns, grain and depth.

Wood finish changes wood's appearance by adding colour and hiding defects.

## 2.4 PIGMENTS USED IN WOOD FINISH

There are three general types of pigments used in wood finish production or paint production and the fourth extender.

1. Colour and pigments that absorb certain wave lengths reflected to the eye produce sensation of colour. The colours such as: Green, Blue, Yellow, Oranges, Red and Black.
2. The white Pigment: This type of pigments light entering, it is passed and reflected according to their refractive index. Except for minor absorption, is reflected completely to the eye as white providing the index of refraction of the pigment is greater than those in surrounding medium. These are also referred to as white hiding pigments.
3. Dust and Metallic powder constitute the third of pigment types and finally
4. Extenders are insoluble powdered substances that are fully or semi-transparent in oils and performing useful functions such as prevention of settlement of the flow, they have little or no effect on the colour. They may also be used to cheapen the products.

<b>Pigments</b>	<b>Composition/Ingredients</b>	<b>Function</b>
Black pigments	Cadmium Lithopone	To protect the film by reflection
Channel black	Orange Pigments	
Furnace black	Basic lead Chromate	The destruction ultra-violet light to
Vegetable black	Molybdenum Orange	strength, the film and to impact
Graphite	Cadmium Orange	an aesthetic appear
Blue pigments	Green pigments	
Ultramarine	Chromium oxide	Pigments should possess the
Copper phthalocyanine	Chrome green	following properties
Iron blues	Hydrated Chromium oxide	Opacity and good covering
Iron oxides	Cyanine Blue	power, wettability by oil chemical
Red pigments	Zinc chromate	
Red lead	Phthalocyanine green	Harmless non toxicity or low
Cadmium reds	Permanganate greens	toxicity, reasonable cost
& Lakes	Brown pigments	
Yellow pigment	Burnt sienna	
Green pigments		
White hiding pigments	Yellow pigments	
Titanium dioxide	Lithargo	
Zinc oxide	Ocher	
Lithopone	Lead or Zinc chromate	
Zinc sulphate	Hansa yellow	
Antimony oxide	Ferite yellow	
Metallic	Burnt timber	
Aluminium	Vandyke brown	
Zinc dust	Metal protective pigments	
	Red lead, Blue lead, zinc,	
	Basic lead.	

## PIGMENTS COMPOSITION AND THEIR FUNCTION

PIGMENTS	COMPOSITIONS	FUNCTION
Extender or inert		To reduce the pigments
China clay	Gypsum	Cost and in many cases to
Talc	Mica	increase the covering and
Asbestos (short fibres)	Barivite barrimo	weathering power of
Silica and silicates	Sulphate	pigments by complimenting
Whiting	Blanc fixe	pigments particle size, thus
Metal stearates		improving consistency level
		of setting

### 2.4.2 PROPERTIES OF PAINT PIGMENTS

The following properties as in opacity, build, consistency are formed with the aid of pigment to the surface coatings as a results of the under listed properties.

They are:

1. Chemical Nature and Wavelength
2. Specific Gravity
3. Refractive Index
4. Particle size and Particles distribution
5. The Nature of Pigment Surface and Coating on the Pigment Particle
6. Crystal Structure and Shape

#### 1. CHEMICAL NATURE AND WAVELENGTH

The colour of a pigment is determined by the selective absorption of the various wavelength of visible light that is impacted upon it. The wavelength range between 0.4-0.7  $\mu$ m. Blue pigments appears because it reflect the blue wavelength in the incident light and absorbs the other and white pigments reflect the visible wavelength. Basically they are based on visible spectrum.

The reason for the difference absorption and reflection characteristics of pigments are associated to the arrangement of the electrons within the molecules of

pigments and their energy and frequency of vibration. Besides the opacity effect of a pigments is determine by their chemical structure. Hence carbon black absorbs light and titanium dioxide scatters light. This is governed by the absorption and scattering in the different region of visible spectrum.

## 2. SPECIFIC GRAVITY

According to Stokes law at which a solid particle settles in a liquid is proportional to a difference between the specific gravity of solid and liquid. This is applied to pigment in paints, where those with high specific gravity such as red lead of specific gravity of as settle rapidly where as carbon black with specific gravity.

1.8 shows little or no tendency as red lead.

## 3. REFRACTIVE INDEX

The refractive index of material is the key to its performance as a pigment. The greater different between the refractive index of pigments and that of the medium in which it's dispersed, the greater the opacity effects. Example is simply by considering the refractive index of some typical extenders which affect gloss, flows, ease of application of finish, e.t.c and white pigments shows that titanium oxide will give higher opacity then zinc oxide.

## 4. PARTICLE SIZE & PARTICLE SIZE DISTRIBUTION

Particles size is usually expressed as the average diameter of the predominant primary pigment, particle assuring sphericity particle size distribution is generally expressed as a percentage by weight falling within bands of the first coarsest.

### TYPICAL RANGES ARE

**Organic Pigments:** They are ranged between 0.01-1.00  $\mu\text{M}$  and inorganic pigments: 0.01-5.00  $\mu\text{M}$ . Apart from carbon black, the distribution of particles size typically 0.01-0.08  $\mu\text{M}$ , and titanium is between 0.22 – 0.24  $\mu\text{m}$ . Extenders are of coarsest size distribution with an extremely wider range of sizes up to 50  $\mu\text{M}$ .

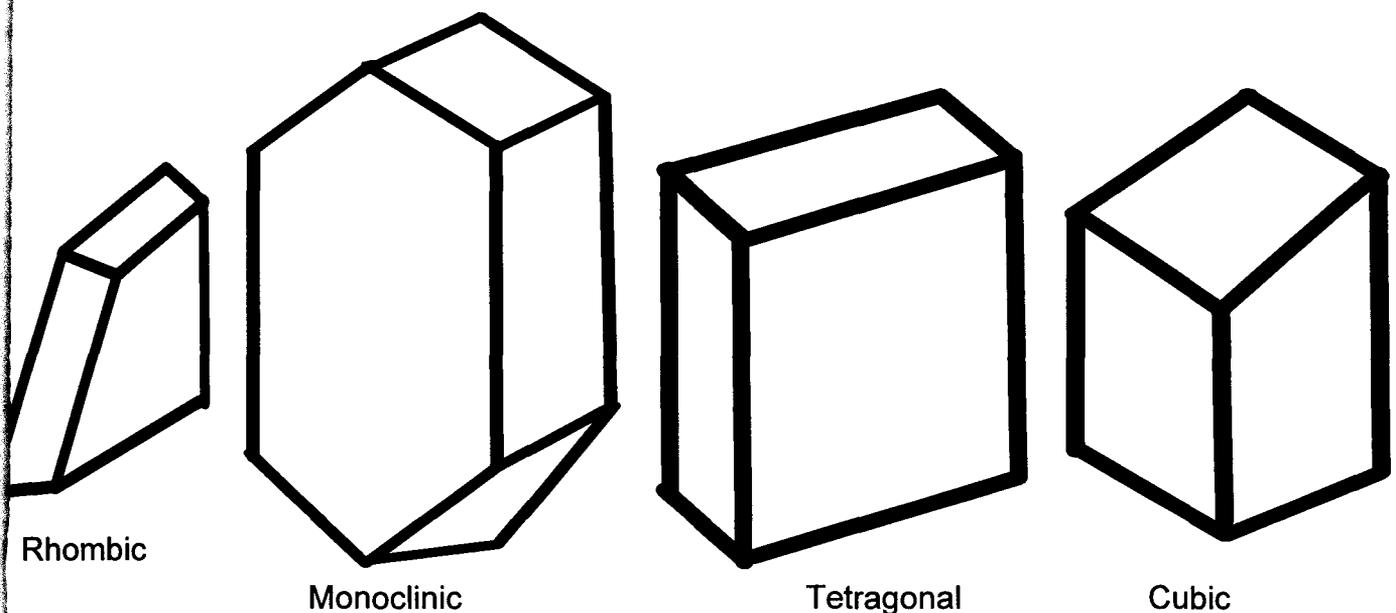
The particles size affects the opacity properties in paints and the colour line. This is mostly exemplified in form of sphere particles size of 0.17 to 0.17 to 0.09 to  $0.12 \mu\text{M}$  give yellow toner reds and larger size of 0.17 to  $0.7 \mu\text{M}$  give increasingly blue toner red. Also the gloss of paint film is also affected by particle size and distribution, high gloss being generally obtained from pigments with smaller particles size and vice versa. The tinting strength and strength and the durability is affected by particle size and distribution but varies for pigments.

## 5. CRYSTAL STRUCTURE SHAPE

Pigments are basically crystalline (possession) definite or characteristic structures or amorphous.

They are capable of existing in different crystalline forms and these are known as polymorphic materials. The shape of the crystal faces and the angels between them can be used as a means of identifications if the size is not reduced.

The particle shape influence the shape of colour of pigments as in the case of Beta copper phthalocyrine pigments give different lines, depending on the deviation form isometric. It also affects the dispensity, since it determines the way they are packed in a point film.



## 6. THE NATURE OF PIGMENTS SURFACE & COATING ON PIGMENTS PARTICLES

The nature of the surface of the pigments particles is a very important feature. Its polarity governs the infirmity of alkyds polyesters acrylic polymers, etc carried in

solvent. It determines how readily pigments are deaggregated and hence affects dispersion and the stability of liquid paint; this is due to the hydrophobic properties of pigments. When pigment powders are exposed to the air the particles absorb gas and/or moisture on the surface and liquid film is added, it has to displace the absorbed gas and moisture.

## 2.50 BINDERS

Binders refer to the ability to bind particles of pigments together and also remain in the film. Film properties are determined by the choice of binder employed in production. Although these properties may be modified to a considerable extent by the use of pigments. Among the important film properties are stated below:

- (i) Gloss: all binders are "glossy" at the same time, there are some differences between different binders.
- (ii) Adhesion to the substance being painted referred to as substrate.
- (iii) Mechanical properties: basically the general description covers such properties as hardness, flexibility and resistance to sudden shocks.

When binders present as a liquid in the paint, which convert into solid state after the film has been applied. The conversion to a solid can occur by number of some processes the major of which are listed below:

- (a) Auto-oxidation: The binder is oxidised by oxygen in the air and cross-links to form a higher molecular weight solid.
- (b) Chemical cross-linking: These binders consist of some reactable mixture, the application of heat or use of catalyst, result in individual components to cross-link to a high molecular weight solid.
- (c) Solvent Lost: The binder is already in a high molecular state in the liquid paint but is held in the liquid state by the presence of solvents. No chemical change occurs because as the solvent molecule evaporates the binder converts to a solid.

## **2.5.0 BINDERS USE IN PAINTS PRODUCTION**

### **2.5.1 OILS**

Historically oils performed the important role in paints production. And can be referred to as sole binder in paints. Nearly all oils used in countries are triglycerides of glycerine with long chain fatty acids. The nature of fatty acids impacting different properties, of which the degree of unsaturation which can be readily oxidized by oxygen in the atmosphere to produce a hard cross linked material.

Drying oils are occasionally used as sole-binder but more frequently are converted to or combined with alkyds, epoxies, and polyurethanes to form Binders which eventually improved film properties.

Non-drying oils contain number or very little unsaturated such that they cannot be converted from their original state, they used as plasticizers in many polymers which would otherwise be too inflexible for normal use.

All oil used in binders has glycerol and the nature of the fatty acid can vary considerably between (9-22) carbon atoms. The degree of unsaturation varies from single to double bond to triple bond as a general maximum.

### **2.5.1 SOURCES & PROPERTIES OF OILS**

The following are the sources of oil and their respective properties:

- (i) Linseed Oil: This oil is obtained from the seed of flax or cotton. It has ability to give yellow colour and medium rate of drying.
- (ii) Tung oil: Obtained from the nut of the tung oil tree with excellent drying properties and has good alkali resistance nature
- (iii) Coconut oil: From coconut husks, the oil is totally non-drying and is usually converted into non-drying alkyds for use as plasticizer or to cross-link.
- (iv) Tall oil Acids: This is obtained as bi-product from the paper industries. It's used in alkyds where its properties similar to Soya beans oil.

### **2.5.2 ALKYD RESINS**

Alkyd resin in air-dry or cross linking system provide probably the major single type of binders used in paint production. They have the advantages of being relatively low cost,

usable with low cost solvent and producing films with good durability, toughness, flexibility, colour and gloss retention. Alkyd can be blended with much other type of binders to produce coating with widely varied properties. It's formed by the polyester reaction product of a poly basic acid with a polyhydric alcohol. The polyester is in fact modified with oil to produce a binder, which is sufficiently soluble and flexible for use in paint.

### 2.5.2.1 PROPERTIES OF ALKYD

The following parameters define the properties of an alkyd;

- (a) **OIL LENGTH:** The percentage of oil or fatty acid plus reacted glycerol in an alkyd.

The effect of increasing oil is shown below

	Drying	Colour
Tung oil		
Linseed oil	very fast	poor
D C O	↓	↓
Tall oil	Decrease	Increase
Soya Bean oil	↓	↓
Coco Nut oil	Nil	Good

- (b) **OIL TYPE:** The general relationship of most common alkyd is as shown above. Thus it is assumed that the drying properties of an alkyd are largely determined by the type of oil in association with the length.
- (c) **ACID TYPE:** Acids are added to give modification of properties. Kind of acids use is phtalie anhydride acids.
- (d) **ACID VALUE:** Alkyd resins are very fully reacted they always possess an acid value. In drying alkyds high acid value gives poor water sensitivity and slower drying.
- (e) **FREE HYDROXYL:** Increasing the free hydroxyl content accelerates the speed of reaction this also makes the alkyd more water sensitive and slower drying.
- (f) **ACID ALCOHOL TYPE:** The choice of alcohols has significantly affect the properties of the alkyd. Alcohols used are ethylene glycol, glycerol pentacrythritol, Trimethylethane, etc.

Other properties are viscosity, solid or non volatile content of the alkyd resin and solvent in which the alkyd resin is dissolved.

### 2.5.3 CELLULOSE RESINS

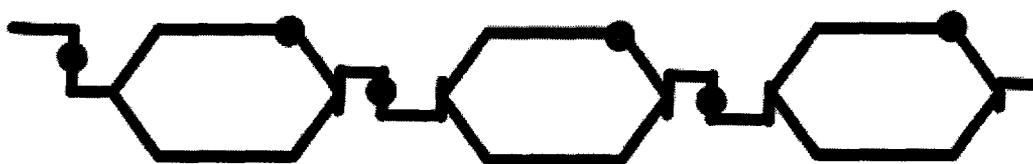
There are three main classes of cellulose resins that are being used in paint industry.

1. Nitrocellulose (N/C)
2. Cellulose Acetate Butyrate (CAB)
3. Ethyl Cellulose (E.C)

Essentially, of these three classes, nitrocellulose, which is being used in the production of wood finishes paint, is the most important proceed by CAB while Ethyl Cellulose is rarely used.

Cellulose, which is base for nitrocellulose, is a natural material, which forms a basic structure of most plants. That is wood is almost pure cellulose. It is from this natural source that most cellulose used in industry is obtained.

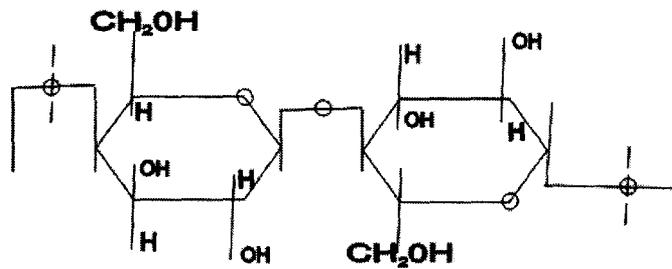
Cellulose itself can be considered as the condensation product of glucose.



**B - 1, 4 Linkage (Glucose chain of cellulose)**

Cellulose is a major structural component of all plant cell and algae to tree is also most abundant organic compound on earth. Cotton and wood are two common examples of materials rich in cellulose. Each cellulose molecule is a long unbranched chain of D-glucose.

Submit with a molecular weight ranging from 50, 000 to over million.



**B - 1, 4 Linkage (Glucose chain of cellulose)**

Structurally, the glycoside bond in cellulose occurs between the 1 and 4 carbon of successive glucose units.

Basically, cellulose is not soluble in an organic solvent; it can be readily esterified or etherified with acids or alcohols respectively to make it soluble.

Thus:

- (i) Cellulose plus Nitric Acid gives cellulose nitrate which is now referred to as Cellulose plus Acetic acid and butyric acid gives cellulose acetic acid and butyric acid gives cellulose acetate Butyrate (CAB).
- (ii) Cellulose plus Ethyl alcohol gives ethyl cellulose.

Since natural cellulose has a molecular weight of 300, 000 to 400, 000 these product have too high molecular weight to be soluble in normal solvents, therefore ester or other products are hydrolysed with dilute acids to reduce the involvement weight.

### 2.5.3.1 PARAMETERS FOR COMPOSITION OF NITROCELLULOSE RESINS

#### 1. DAMPING MEDIUM

Hundred percent of raw nitrocellulose is explosive and therefore after the nitration process. The water is replaced by a medium such as alcohol or plasticizer which renders the nitrocellulose safe. The nature and quantity of the required medium can vary, the most common are: Isopropanol (IPA) at 30%, Methylene Alcohol at 30%, Dibutylphthalate at 18%, Butanol at 30%. The nature of damping medium is very important in respect to the paint production using nitrocellulose.

#### 2. NITROGEN CONTENT

Nitrocellulose is supplied at three levels of nitration and their effect on solubility.

- (i) HNC, grade dissolves in esters, ketones and alcohol blends
- (ii) MNC, grade dissolves in esters, ketones, alcohol & hydrocarbon blends
- (iii) LNC, grade dissolves in alcohol and hydrocarbon blends.

#### NITROGEN CONTENT OF NITROCELLOSE

- (a) High Nitrogen Content (11.8-12.2%) HNC
- (b) Medium Nitrogen Content (10.5-11.2%) MNC
- (c) Low Nitrogen Content (9.5-10.2%) LNC

### 3. FORM

Nitrocellulose has been supplied in the following forms:

- (i) Linters which is from similar to cotton wool and are derived from cotton seed
- (ii) Dense granules in shape of original wood chips
- (iii) Fibrous form which is dense form that has been mechanically converted or teased.

### 4. MOLECULAR WEIGHT

The molecular weight spread for nitrocellulose is widely varied from 80, 000 to 300,000. Various systems were used for defining molecular weight all of which are related to solution viscosity.

Molecular weight is important mostly in paint production because it largely governs viscosity or solids flexibility and durability. The relation with respect to this molecular weight is:

High molecular weight – gives low solid, good durability and flexibility

Low molecular weight: -- gives High solid, poor flexibility and durability

#### 2.5.4 ACRYLIC RESINS

Acrylic resins are formed fundamentally from the polymerisation of Esters of two prime unsaturated acids (acrylic and methyl acrylic acid)

Base on Acrylic resins manufactured procedure they fall into three basic categories

1. Thermo plastic
2. Thermo Setting
3. Emulsion

The properties are extremely varied and depend on the type of monomers used and the molecular weight

#### **2.5.5 NITROGEN RESINS**

The type of resins called nitrogen resins reacts almost exclusively with other resins to produce cross linked films. The particular reaction is known as condensation reaction between methyl group [ - CH<sub>2</sub>OH] on the nitrogen resin with hydroxyl group on the secondary resin.

There are two type of Nitrogen resins formulation

1. Melamine formaldehyde
2. Urea formaldehyde

Basically, nitrogen resins are used to achieve full benefit in system where they can cross-link either with themselves or more frequently with secondary resins. The product obtained may be either of the two categories:

1. Single pack storing finishes
2. Two pack activated finishes

#### **2.5.6 CHLORINATE RUBBER RESIN**

Chlorinated rubber resin is manufactured by chlorinating rubber (isoprene) in solution giving some 65% chlorine chromate rubber resins are supplied in a range of viscosities corresponding to molecular weight range (3500 – 20, 000).

These resins used either as sole binder or in combination with other resins impact high resistance to acid and alkali and high impermeability to water. The resins do decompose above 125<sup>0</sup>C, which can impose a constraint on their use. Plasticization is necessary to impact flexibility into chlorinated rubber film

### **2.5.7 EPOXY RESIN**

Epoxy resins are long chain compound which contain terminal reactive epoxy groups, in addition to non reactive ether groups and esterifiable hydroxyl groups. Most epoxy resins are produced by the condensation of Epichlorhydrin and bisphenol, used to form high polymer materials of predetermined structure and size.

### **2.5.8 UNSATURATED POLYESTER RESINS**

Unsaturated polyester resins are prepared by esterification of dehydric alcohols with unsaturated acid normally 1,3 or 2, 4, or 1, 4 butylene glycol. Ethyleneglycol or 1,2 propyleneglycol as alcohols and maleic or fumaric acids as acids, used in finishes such as that their properties are used for best effect.

### **2.6.0 SOLVENT AND ITS PROPERTIES**

Solvent is a liquid which produces a solution of the binder component while a liquid is simply the fluid component of the system.

Turpentine is the first know major solvent used in wood finish industries. It is derived from temperate woods. Since the exploration of crude oil in Nigeria in 1958 less expensive but suitable solvent are now in use to produce wood finishes. These are white spirit, cyclohexane and kerosene.

Solvent has the following properties:

- i. Solvency
- ii. Evaporation rate and boiling point
- iii. Chemical nature
- iv. Specific gravity and cost
- v. Flash point

Under normal condition of formulation, the binder must be dissolved by the solvent the major exception to this is in emulsion paint. Where the binder is carried as dispersion in the liquid.

The solvencing of a solvent for a particular binder is governed by the chemical nature of both components. The overall efficiency of a solvent is difficult to rate but

use method attempts to rate all solvents by assessing hydrogen bonding and establishing a solubility parameter. By this method all solvent can be divided into three groups for hydrogen bonding: -

- (a) Weak (Hydrogen bond, chloro and Nitro paraffins)
- (b) Moderate (Ketones, Ester, ethers and alcohols)
- (c) Strong (alcohols and water)

Also, the nature of the resin to be dissolved in particle determined the effectiveness of that solvent.

(i) Solvents are selected by proper consideration of the binder type

Long oil alkyds – Aliphatic hydrocarbon

Short oil alkyds – Aliphatic / Aromatic hydro carbon

Acrylic resin (Thermo setting) – Aromatic hydro / Esters and Ketones

Acrylic resin (Thermo Plastic) – Esters, & Ketones / Aromatic Hydrocarbon

Epoxy resin – Aromatic hydro carbon

Cellulose – Esters, Ketones aromatic hydro carbon & Alcohols

(ii) **EVAPORATION RATES & BOILING POINT**

Evaporation rate if the solvents must be considered when selection, with respect to the boiling point. That is, the lower the boiling points the faster evaporation usually proceed however there are exception e.g. Alcohols

The speed of dryness is determines by this property and the appearance and with the flow of the film. Solvent with low or slower evaporation rate has low solvent efficiency

(iii) **CHEMICAL NATURE**

Some certain solvents can react with binder and thereby may not chosen for this reason. While some solvents are toxic and can only be utilized in specific condition because of their chemical nature.

(iv) **SPECIFIC GRAVITY AND COSTS**

Choice of solvent always demands that the lowest cost blend to give required dry and flow properties (plus wet storage) is selected. This is because nearly all solvent evaporates and therefore does not contribute to the final film properties.

(v) **FLASH POINT**

The flash point of a solvent is the temperature over the liquid at which a mixture of the solvent vapour and air can require in the presence of spark. The higher the flash point the safer a particular solvent is considered to be in storage terms.

Chemical classes of liquid / solvent used in paint are stated below:

- (a) Aliphatic hydro carbons
- (b) Water
- (c) Esters, Ether and Ketone
- (d) Aromatic hydro carbon
- (e) Chloro and Nitro paraffins

**2.7.0 ADDITIVES**

Besides the major components, a number of so-called additives are used in paint production which are compounds added to fulfil a particular purpose or function.

These additives are:

1. **DRIERS:** These are additives which catalysed the oxidation and polymerization of oil, alkyd and oleoresins films. Driers are normally supplied at the highest possible metal content level. The acid radicals are largely irrelevant in the process of drying, it is the metal cat ion which acts as oxidation initiator.

The available metals and their particular properties are as follows:

- (i) **Lead:** This promotes drying through the film used at relatively high level. Lead is nearly used with together with another metal such as cobalt. Lead has disadvantage of reacting with acidic vehicles being toxic and reduce sulphide resistance of paint films.
- (ii) **Cobalt:** The most reactive metal promotes surface dry and provides the tack free drying. Excess of cobalt gives rapid surface dry and can produce wringling
- (iii) **Manganese:** it promotes both surface and thorough dry and can impact brittleness is used alone. It can replace cobalt plus lead. Combination of manganese and cobalt increase or promotes hardness.

- Calcium - This is a useful auxiliary drier
- Zinc - Use as an auxiliary drier
- Iron - Is used for high temperature reaction

Additives that are common use in paint industries are

1. Catalyst, and Activators
2. Accelerator
3. Anti – oxidation
4. Flow Acids
5. Thickeners
6. Flatting Agents
7. Fungicides and Bacteria acids
8. Dispersion Acids

## **CHAPTER THREE**

### **3.0 WOOD FINISH MANUFACTURE**

#### **3.1 WOOD FINISH PRODUCTION PROCESS**

Modern wood finish manufactures represents an increasing complex and challenging activities. Both technical and non technical consideration play, an significant role, and the technological application of physical and chemical principles must successfully accomplished with demanding time schedules in order to obtain optimum results

However the process may be considered as a stepwise programme at the efficient conversion of a wide range of raw materials. Also, the application of physical, chemistry and chemical industry have be used for an ever wide range of finisher products to meet consumers increasing need and level of development in the area of production.

Paint factories and laboratories required proper organisation with systematic produces and effective means of communication. For the goals of making profit and satisfaction to be achieved. There required competent and dedicated hard working workers.

#### **3.2 TYPICAL WOOD FINISH PRODUCTION SEQUENCE**

The typical wood finish production begin from the laboratory (small factory), where different tests are done or carried out on the raw materials, and small production of paints are produce. These products are subjected to further tests for specification and product required need. The formulation is later passed to the plant for larger production of the paint.

It is essentials for wood finish factory to have several raw materials depending on the kind of paint to be produced in the raw materials section.

Stored and whereby different batch number must be given for easy identification

### **3.3 THE PROCESS OF MANUFACTURE**

The processes together with sequence of wood finish manufacture are listed below:

- (i) Selection approved raw materials cover and stacked.
- (ii) Raw materials required selected from stock against manufacturing card and weighed or dispensed volumetrically in case of liquid involved.
- (iii) Already weighed items transferred to required area via fork, life trolley or manually.
- (iv) Raw materials items transferred into the reactor and agitation occurred for pigments or binder used
- (v) If required specification and meet additional medium driers or other additives are incorporated under mechanical agitation and brought to uniformity.
- (vi) Tinting operation where required.

### **3.4 QUALITY CONTROL TEST**

Quality control in paint testing is to maintain product gravity and the aim can be described as the means of preparation and execution of such measure as are desired necessary to maintain the standard quality. Quality can be related to either goods or services and in most industries including surface coatings, cover more that just the product in Can.

### **3.5 THE AIM AND OBJECTIVE OF WOOD FINISH TESTING**

There are three areas that are of great important for wood finish testing, these are:

- (a) To identify by limited test that a batch of a particular paint is up to required standard and specification.
- (b) To provide standard basis for specifying the performance required of paint by used of a limited serves of paint tests.
- (c) As a tool in research and development of paint formulae and Technology.

### **3.6 CONTROLLED TESTING CONDITIONS**

To obtain a better result from the test, we must ensure that all condition which can affect the result are known and put under controlled

Most tests involve control of a host of factors where many variation in one of them can affect results. Example are condition of substrate (this is very crucial in case of wood), thickness of paint (viscosity), temperature, humidity, period of film condition e.t.c. Where there is deviation from requirement, we can still obtain meaningful result if we incorporate into the testing a reference paint sample or paint film known to represent the desires quality.

### **3.7 TYPES OF TEST IN PRODUCTION PROCESS OF WOOD FINISH**

The various types of test required for effective production of paint (wood finish) are:

- 1) Viscosity test, consistency and Rheology
- 2) Opacity test
- 3) Adhesive and weight per litre test / specific gravity test
- 4) Capacity and Hiding power
- 5) Films Build measurement
- 6) Application and Application properties
- 7) Hardness
- 8) Drying

The experimental analysis of this project gives detail and test of wood finishes paint are performed.

### **3.8 WOOD FINISHING (INTRODUCTION TO WOOD)**

Finishes for wood furniture is a highly specialised branch of the surface coating industry, which involves the production of a number of materials of unique nature.

Woods used for furniture work may be classified into two classes:

- (a) The porous of the open grin species

(b) The Non porous of smooth species

The porous species have long pure cell that serve as ducts of the flow of sap. In this group are the oaks mahogany walnut, chestnut which require some filler materials to seal the pores

Non – porous woods include maple, beach, gum, poplar magnolia, and cotton wood, the pores are so small that filling is not required.

Wood is a valuable and non-uniform material. Its coating therefore presents special problem that based on the kind of wood being coated, the way of surface preparation and the coating type used on the surface. Wood is extremely popular materials for construction. Since many types are in used, selection of the optimum coating is a complex problem. Wood composition varies widely with respect to the type of wood and within the wood structure itself.

Specialized and specific conditions are required for selection of paint to be used for coating different type of wood – surface.

### **3.9 FACTORS AFFECTING THE DURABILITY OF WOOD**

An organic coating for wood is exposed to some external forces and stress that subject it to deterioration. These factors are:

1. Wood Structure
2. Moisture of the Wood
3. Ultraviolet and infrared light (Heat)
4. Mechanical and Chemical Forces (Chemical factors)
5. Fumes and pollution
6. Micro biological factors
7. Shock

### **3.10 NITROCELLULOSE WOOD FINISH PAINT**

Coating for wood is based majority on the type of binder used as earlier stated in this chapter. Among all the binders used nitrocellulose, which the end product gives a NITROCELLULOSE WOOD FINISH, has been proved to be comparatively

the best in Africa. Due to the major properties found with the nitrocellulose with that of the wood as describe below:

- (i) The dry by evaporation, it is fast process when compare with the slow process of oxidation by other binders
- (ii) Base on speed of application drying and easy of handling there is less necessity for expensive production equipment small floor space is needed and there are fewer effects.
- (iii) Because of better and easy control of chemical pure raw material such as nitrocellulose solvents resin and plasticizers, products of more uniform characteristics are obtained.
- (iv) They exhibit the following properties as in remarkable, durability, water resistance and abrasion resistance, hardness, colour – retention, chemical resistance, flexibility and toughness.

## CHAPTER FOUR

### 4.0 EXPERIMENTAL

#### 4.1 OBJECTIVE OF THE EXPERIMENT

The production of two types of wood finishes paint such as glossy wood finish and sanding sealer wood finish paint using nitrocellulose solution. The best compositions of raw materials, which can with stand harsh weather condition. And to produce coating for wood which is free from indoor air pollution and chemical toxicity in household and building products.

The quality and cost become the major consideration factors in the production of wood finishes and its characterization which enhances consumers to go for quality products that is durable and the cost is minimised or affordable with low price.

The project work gives a new formulation product of wood coating or finish paint and test with quality control.

##### 4.1.1 FORMULATION FOR WOOD FINISH

The use of nitrocellulose binder in wood finish formulation give rise to a rapid drying time and hardness properties which are refined in wood. The nitrocellulose needs or required. Plasticization to provide crack resistance film together with an alkyd resin film former which give an increase solid and thereby build. The plasticizer is selected to impact maximum flexibility with least volatility and must be not yellowing. The alkyd resin film former must be totally compatible with nitrocellulose, non-yellowing, give high solid and have good durability.

Nitrocellulose wood finish coatings are top coats. The properties of top coats are primary related to the type of binder used and in many cases similar binders are used with only perhaps minor modification to formulate finishes for different markets for glossy wood finish and sanding sealer wood finish.

Moreover, nitrocellulose has various grades, primarily the choice is made by choosing a blend of grade which gives the viscosity or solid balance required, a proportion of high viscosity is normally incorporated specifically for improved flexibility and crack resistance. For the improvement of solubility as needed. A low composition

of nitrogen content guide of nitrocellulose binder should be selected. This selection will enhance choice of solvents, in which a small percentage of nitrogen resin may be introduced to give faster initial hardening and improved gloss provided a gloss wood finish is required. Moreover, this modification can make formula sensitive with respect to alcohol level.

Solvent selectivity is particularly critical for this type of formulation in order that the correct balance of true solvents, latent solvents and diluents are maintained for stability in the reactor or high speed disperser used for agitation.

#### 4.2 MATERIALS

Materials: The chemicals used for the production of glossy wood finishes are Diobutylphthalate (DOP), methylisobutylketone (MIBK), isopropylalcohol (IPA); Normal Butanol (N.B) Nitrocellulose solution, Nycil resin, Silicate and xylene. While that of chemical components used for the sanding sealer wood finish are: Methylisobutyl Ketone (MIBK) methylethylketone (MEK), Toulene, Diobutylphate, Nitrocellulose solution, Nycil resin, Isopropanol (IPA), Zinc stearate and xylene.

These chemicals listed above were locally purchased, and nearly all are petrochemical products. Also mostly the nitrocellulose solution which is a natural material which forms from a basic structure of cellulose of plants or wood. That is the cellulose used in industry is obtained from the natural source that is wood. These chemicals and their uses are stated below:

<b>MATERIALS</b>	<b>USES</b>
1). Nitrocellulose solution	Blender for viscosity solid high viscosity for flexibility improvement.
2) Isopropyl alcohol (IPA)	Solvents
3) Diobutyl Phalate	Solvent plasticizer
4) Silicon Solution	Flow enhancement
5) Nycil (non-dying short alkyd)	Alkyd resin Binders
6) Mathyl ethyl ketone	Active solvents for low boiling

7) Ester Gum	Matting agent
8) Zinc Stearate	Flatting agent
9) Normal Butanol (NB)	Latent solvent for medium boiling
10) Methyl isobutyl ketone (MIBK)	Medium boiling active solvent
11) Diobutylphthalate (DOP)	Solvent plasticizer
12) Toluene	Fast boiling latent solvent

#### 4.3 EQUIPMENT

Equipment: The following under listed equipment, their specification and manufactures which were used for the successful production of the glossy wood finishing and sanding sealer wood finish.

EQUIPMENT	MODEL	MANUFACTURERS
Viscosity Flow Cup	BSB4	Haake
Gallows cup/Weight per Litre (WPL)		OK-Plastic
Weighing Machine	9731 – model	Ottans
Spraying Gum	Model: 486A1-B	Humbrol
Gloss Meter	623806	Mettler Toldo
Stop – Watch	-	Griffin
High Speed Disperser Reactor	-	Locally made (Fabricated)

This equipment and their application are shown below:

1. **VISCOSITY FLOW CUP BSB4:** Viscosity flow cup BSB4 is basically used purposely to determine the viscosity initial supply spraying of paint and to investigate the quantity of solvent require to thin it down to require viscosity of standard value. Application: A finger is place over the top of the cup,

which is then filled until it begins to overflow to the gallery. Then a scraper blade should be shown across the top to evacuate excess materials into gallery. Follow by a timing mechanism when the head is removed. At the break of the efflux stream into droplets the timing mechanism is finally stopped and required or corresponding time recorded. This viscosity is basically measured in time (seconds).

2. **WEIGHING MACHINE:** This is usually used in weighing of materials.
3. **GALLONS CUP/WEIGHT PER LITRE (WPL):** This weight per litre (wpl) or Gallons cup is used to measure the weight per litre of resins, solution, and paint and even to determine the specific gravity of the solution.
4. **SPRAYING GUN:** Basically employ for spraying the wood finish paint on the wood panels, which is usually operated at pressure of 50 bars – 65 bars.
5. **GLOSS METER:** This is used for measuring or taking the gloss – reading of paint on the wood panel.
6. **STOP WATCH:** This equipment is used in timing.
7. **HIGH SPEED DISPERSER REACTOR FOR AGITATION:** The high-speed disperser or reactor is used to disperse paint and for mixing or agitation of paint. This also consists of a serrated disc on a vertical shaft, which is rotated at a high speed inside a cylindrical vessel or tank. The equipment enhances the dispersion of some binder with solvent or pigments mill base totally and usually employ for pre-dispersion state for some more difficult system.

Reactor design with respect to the vote varies according to the manufacturers, the variable features being the number size and angle of flight on the rotor periphery (walls). Reactors for portable vessels are designed so that the head and shaft assembly can be raised to allow the placement and removal of missing vessel. This is achieved hydraulically. After about 30 minutes to 1hour running high speed disperser for current loaded dispersion should be attained.

#### 4.4 METHODOLOGY

The methods/procedures required for the production of wood finish. Glossy wood finish paint and sanding sealer wood finish paint are stated below:

##### 4.4.1 METHODOLOGY FOR GLOSSY WOOD FINISH PAINT

The production method of high quality of nitrocellulose glossy wood finish paint in which the formulation is stated clearly in chapter three or previous chapter is illustrated below: Weigh a 4 litres Can on weighing scale, which is taken. The weight of Can is measured and recorded on the weighting scale. Then 45.0g of Diobutyl phthalate (DOP) was weighted into the empty Can, following by 123.30g of methyl isobutyl ketone (MIBK) and 306g of isopropyl alcohol (IPA), 178.50g of Normal Butanol (NB) in addition.

The content mixture is subjected to high or strong agitation at high-speed disperser of 100rev/secs.

Furthermore, nitrocellulose solution (30%) of 1323g is weighted into another cut edge empty 4 – litre Can and 777g of Nycil resin is added to it and further subjected to strong agitation with a palette knife followed by 3.3g of silicone solution is addition and 243.9g of xylene is finally added. The second content is then added to the first content under high-speed disperser. The content solution is then run under this high-speed disperser for 30 minutes at 120rev/sec to obtain high quality dispersion. The paint is dropped and quality control test analysis together with initial supply viscosity to maintain the durability of the paint on the panel of wood and comparism with the standard product of Nigerian Industrial Standard (NIS). This above analysis is shown in table below.

Summary of Methodology Table for Glossy Wood Finish

Compositions	Weight % (Wt%) (g)	Wt % of 30(g)
Diobutylphthalate (DOP)	1.50	45.0
Methyl isobutyl Ketone (MIBK)	4.11	123.3
Iso propyl alcohol (IPA)	10.20	306.0
Normal Butanol (NB)	5.95	178.5
Nitrocellulose Solution 30%	Addition of this component with strong agitation at high dispenser.	
Nitrocellulose Solution 30%	44.10	1323.0
Nycil Resin	25.90	177.0
Silicone Solution	0.11	3.3
Xylene	8.13	243.90

**4.4.2 METHODOLOGY FOR SANDING SEALER WOOD FINISH PAINT**

The procedure for the production of sanding sealer wood finish formulation is shown below: weigh a 4 litre Can on the weighing scale, then weight of the Can is recorded on the weighing scale, 120g of MIBK was weighed into the empty Can. This was then followed by 115.5g of M.E.K, the solution is agitated with pallet knife or agitation reactor and 102.0g of toluene, 42.00g of DOP added and mixed. The mixture is subjected to high-speed disperser at 100 revolution/second.

Nitrocellulose solution of 36% of 1287.8g is weighed into another cut edge empty 4 litres Can and 420.00g of Nycil resin added, this mixture is then mixed by pallet knife, followed by addition of 486.00g of IPA. Then the flattening agent of 186.3g of zinc stearate and finally 234.6g of xylene were added. This second mixture is then subjected to high agitation by the reactor used and introduced to the first mixture at high disperser. The paint is run for 35 min at 120 revolution/seconds to obtain good

dispersion. The paint is dropped and quality control test to ensure the durability of the sanding sealer wood finish paint.

The analysis of above production procedure for sanding sealer wood finish paint is shown in table below.

**Summary of Methodology for Sanding Sealer Wood finish**

The table below illustrates the summary of methodology for the production procedure of the sanding sealer wood finish paint.

<b>Composition</b>	<b>Weight % (Wt%) (g)</b>	<b>Wt % of 30(g)</b>
Methylisobutyl Ketone (MIBK)	4.00	120.00
Methyl ethyl ketone(MEK)	3.85	115.50
Toluene	3.40	102.00
Diobutyl phthalate (DOP)	1.40	42.00
Addition content with strong agitation at high dispenser.		
Nitrocellulose Solution 36%	42.92	1287.80
Nycil Resin	14.00	420.00
Isopropanol (IPA)	16.20	486.00
Zinc Stearate	6.21	186.30
Xylene	7.82	234.60

## CHAPTER FIVE

### 5.1 RESULTS

The Table below showing the results obtained during the experimental analysis

<b>Characterization Requirement for the Products</b>	<b>Glossy Wood Finish</b>	<b>Sanding Sealer Wood Finish</b>	<b>Nigerian Industrial Standard (NIS) 269: sUDU:667.6 Specification for Glossy Paint</b>	<b>Nigeria Industrial Standard (NIS) Specification for Sanding Sealer Wood Finish Paint.</b>
Initial Viscosity (Seconds)	122	135	100seconds (Minimum)	100 seconds Minimum
Adjust with xylene (grams)	10.40	15.20	0 – Kay	0 – Kay
Supply Viscosity (Seconds)	60	65	Vary	Vary
Spraying Viscosity (Seconds)	25	27	Vary	Vary
Touch dry Time (Minutes)	(20 - 25)min.	30 min	6 hours Maximum	6 hours Maximum
Hard Dry Time (Minute)	Overnight	Overnight	24 hours Maximum	24 Minimum
Gloss Percent (%)	85%	64%	65% Minimum	55% Minimum
Weight per litre	0.92	1.12	0 – Kay	0 – Kay
Exposure Test	0 – Kay	0 – Kay	0 - Kay	0 - Kay
Volume of Solid	24.3	18.3	-	-

## 5.2 DISCUSSION OF RESULTS

Base on the test carried out on the product, it was found out that various properties tested for were able to meet up with the expected result when compare with Nigerian Industrial standard.

Since one major objective of my research project work is to investigate and obtain a formulation for the production and characterization of the two types of wood finishes. Glossy wood finish and sanding sealer wood finish using nitrocellulose as a binder, besides, some certain factors, were carefully considered together for the proper formulation. These factors are stated below.

- i) Improvement of rate of drying time
- ii) Cost of materials and proper minimization of selling price of my product
- iii) Improvement of customers demand and desire for good and quality product to meet their need.
- iv) Durability, ability to withstand harsh weather condition, preservation of wood panel from fungi attack and give a good and attractive look for both interior and exterior decoration.
- v) Glossy-level in case of glossy wood finish product
- vi) Volume of solids consideration.

The final formula was achieved after careful test had been analyzed from the above stated factors. Besides the production of wood finishes paints which involved agitation (mixing), customers requirement for good and quality product at minimize price (cost and quality of products). These are best achieved with the formulation of glossy wood finish and sanding sealer wood finish paint using nitrocellulose solution as a binder.

The production of nitrocellulose wood finishes paint some tests were carried out to determine the property of the paint the drying time and quality with the paint durability. These are described below.

1. DRYING TIME TEST: Since drying time is of the most important parameter to be considered in production of wood finishes. And drying is sensitive to the film thickness. That is to say, the rate of film thickness is proportional to the drying time and the thicker the film, then the slower the dry. The condition of testing and terms are strictly followed to get accurate results. The spraying viscosity of wood finish paint is found to be between 25-30 seconds for the drying test. Also substrate affects the drying time; uniform wood panels are used, since different wood gives different results.

2. VISCOSITY TEST: The viscosity of the paint is basically depending on the temperature and the temperature coefficient varies from paint to paint. Due to the variation in temperature of environment when paint is applied the viscosity measured will not be generally the same. Different viscosities are measured at initial supply and final supply and from the results; sanding sealer product was more viscous initially than the glossy wood finish.

3. WEIGHT FOR LITRE TEST: The weight per litter of sanding sealer is greater than that of glossy wood finish paint. The weight per litre of the paint enhances further calculation of density of paint and specific gravity.

4. EXPOSURE TESTS: The film on woods is exposed to moisture, sun and atmosphere. These are done by dipping the panel in water, stored and exposed to atmosphere and monitored for some days. For good quality wood finishes paint no swelling of the grain of wood, contraction on drying, cracking and fungi on the wood panel or warping.

5. TOUCH DRY TIME: Touch drying time is referred to the time in which when touched with hand, the wood panels will not experience permanent damage on the film applied on the wood. For nitrocellulose wood finishes touch dry is found between 25mins-30min maximum.

6. HARD DRY TIME: This is the time at which the film has apparently the same hardness throughout its thickness. It is also time to know the thickness of the paint, which is done the next day of the application of paint on substrate.

7. VOLUME OF SOLID TEST: The volume of solid in the dry paint film are calculated, to estimate drying, the larger the volume of solid the faster the drying.

$$VOLUME\ OF\ SOLID = \frac{\text{Total volume of Resin}}{\text{Total volume of paint}} \times \frac{100}{1}$$

For nitrocellulose glossy wood finish paint

$$\text{Volume of Nycil Resin} = 26.43$$

$$\text{Volume of paint} \times \frac{100}{SG\ of\ paint} = \frac{100}{0.92} = 108.69\%$$

$$\text{Volume of solid} = \frac{26.43}{108.69} \times \frac{100}{1} = 24.3\%$$

$$\text{In case of nitrocellulose} = \frac{\text{volume of Nycil}}{(100/\text{specific gravity of paint})}$$

$$= \frac{16.32}{100/1.13} = \frac{16.32}{89.30}$$

$$\text{Volume of solid of N/C} = 18.3\%$$

Sanding sealer.

The table below summarized the comparison of the volume of solid and drying time (touch dry) for nitrocellulose glossy and sanding sealer wood finishes

	VOLUME OF SOLID	TOUCH-DRY
NITROCELLULOSE GLOSSY WOOD FINISH	24.3%	(20-25)MINS
NITROCELLULOSE SANDING SEALER	18.3%	(25-30)MINS

8. GLOSS TEST: This test determined how glossy paint is for glossy wood finish paint the gloss percentage is 85%, Hence for glossy paint, the glossy reading should be above 80%. Since sanding sealer, gloss is not required, and the compositions contain matting agents which inhibit the gloss to 4%.

### 5.3 ECONOMIC ANALYSIS

The economic analysis of the project research entails the market prices indices of standard product of wood finish paint industry and the imported product price indices together with price indices of raw materials required for the production of Glossy wood finish and sanding sealer wood finish using nitrocellulose solution. Also cost and marking of price paint of product is highly inevitable. However, similar method of costing and price determination of product was used in my own case.

### 5.4 MARKET PRICE OF RAW MATERIALS AND DETERMINATION OF PRODUCTION COST IN CASE OF GLOSSY PRODUCT

RAW MATERIALS FOR N/C GLOSSY WOOD FINISH	WEIGHT PERCENT COMPOSITION OF PRODUCT (KG)	VALUE OF PRICE PER (KG) ₦
Diobuty phthalate (DOP)	1.50	805
Methyl Isobutylketone (MIBK)	4.11	580
Isopropyl alcohol (IPA)s	10.00	1200
Normal Batanol (N-B)	5.95	650
N/C Solution 30%	44.30	6,200
Nycil Resin	25.90	980
Silicone solution	0.11	520
Xylene	8.13	1,150
	100	₦12,085

$$\text{Total Value} = \frac{\text{Raw material cost}}{\text{Kg}} = \frac{12085}{100} = 120.85$$

Therefore

Total cost of materials for 1 litre of Glossy wood finish using nitrocellulose binder

$$= \frac{RMC}{Kg} \times Wt. \text{ percentage}$$

$$= 120.85 \times 0.92 \left[ \frac{Nkg}{Kg} \right]$$

$$= N111.18k$$

Hence, for 4 litres Total cost of raw materials TCRM =

$$= N111.18k \times 4$$

$$= N444.73k$$

From the economic analysis calculated above, it can be deduced that the amount evaluated for the total cost for raw materials used for the production is N444.73 for four litres.

To achieve the require price list or indices level there should be reference made to the production price and selling price of the standard product of glossy wood finish which the cost price is about N1,150 and selling price is N1529.20k

### 5.5 DETERMINATION OF SELLING PRICE

The total or proper evaluation of selling price of products together with the determination of raw materials cost one need to consider the handling loss, total production cost, container cost, and overhead cost which is considered to be 10% and profit margin of 15%. These are illustrated in the fig table 1 and 2 below

Table fig 1

<b>COST</b>	<b>NEW PRODUCT OF N/C GLOSSY WOOD FINISH (N)</b>	<b>STANDARD PRODUCT (N)</b>
Total Raw material cost (TRMC)	444.73	1150
Handling loss cost	15.35	15.35
Container cost	58.00	58.00

Total production	518.10	1223.35
10% overhead	51.81	122.34
15% profit margin	77.71	183.50
<b>Selling Price</b>	<b>647.60</b>	<b>1529.20</b>

Table Fig 2

COST	NEW PRODUCT OF N/C		STANDARD PRODUCT
	SANDING	SEALER	
	WOOD FINISHING (N)		(N)
Total Raw material cost (TRMC)	437.10		1150
Handling loss cost	15.00		15.00
Container cost	58.00		58.00
Total production	N510.10k		1223.00
10% overhead	51.01		122.30
15% profit margin	76.515		183.45
<b>Selling Price</b>	<b>637.53</b>		<b>1528.75</b>

#### 5.6 MARKET PRICE OF RAW MATERIALS AND DETERMINATION OF PRODUCT COST IN CASE OF N/C SANDING SEALER PRODUCT

Raw material for nitrocellulose sanding sealer wood finish	Weight percent of composition product (kg)	Value of price Kg (N)
Methyl-isobutylketone (MIBK)	4.00	550
MethylEthylketone (MEK)	3.85	430
Toluene	3.40	310
Diobutyl phthalate (DOP)	1.40	565
Nitrocellulose solution (36%)	42.72	6,320

Nycil resin	14.40	470
Isopropanol (IPA)	16.20	1050
Zinc Stearate	6.20	540
Xylene	7.83	480
	100	10715

$$\text{Total value} = \frac{\text{Raw Material cost}}{\text{Total (kg)}} \text{ Kg N} = \frac{10715}{100} \text{ Kg N/kg}$$

$$= \text{N}107.15$$

Hence,

Total cost of material for 1 litre of N/C sanding sealer wood finish product

$$= \frac{\text{RMC}}{\text{Kg}} \times \text{Wt}\% = 107.15 \times 1.12$$

$$= \text{N}120.008$$

Therefore for 4 litres = 120.007 x 4

$$= \text{N}480.00$$

#### TABLE OF COST ANALYSIS

COST	NEW PRODUCT OF N/C	STANDARD PRODUCT
	GLOSSY WOOD FINISH (N)	(N)
Total Raw material cost (TRMC)	480.10	1150/00
Handling loss cost	15.00	15.00
Container cost	58.00	58.00
Total production	553.10	1223.00
10% overhead	55.310	122.30
15% profit margin	82.97	183.45
<b>Selling Price</b>	<b>691.11</b>	<b>1528.75</b>

Base on the economic analysis above, the calculated results indicated that the total cost for raw materials used for the production of four litres is N480.00k and selling price is 691.11k.

### **EVALUATION OF COST SAVED ON NEW PRODUCT (SANDING SEALER)**

**Amount save** = Standard product – New product

$$\text{N}(1528.75 - 691.11)$$

$$= \text{N} 837.68\text{k}$$

$$\% \text{ Cost Saved} = \frac{\text{Amount save}}{\text{Standard product cost}} \times \frac{100}{1}$$

$$= \frac{837.68}{1528.75} \times \frac{100}{1}$$

$$= 54.80\%$$

### **5.7 ANALYSIS OF PRODUCT SELLING PRICE**

Conclusively, form the analysis of market survey of production of wood finishes for standard product. It was deduced that selling price of 4 litres paint for the most popular and foremost paint producing companies in Nigeria such as Berger paint and African paint. They have their selling price between N1400-N1500 respectively while the product made by me during this research project, the selling price is placed at the rate of N647.60k for the Glossy wood finish and N691.11k for the sanding sealer wood finish using nitrocellulose solution.

### **5.8 EVALUATION OF COST SAVE ON THE NEW PRODUCT (GLOSSY)**

Cost of my own product Glossy wood finish = 647.60k

**Amount saved** = standard product – new product

$$= 1528.75 - 647.60\text{k}$$

$$= 881.15\text{k}$$

$$\begin{aligned} \% \text{ Cost Saved} &= \frac{\text{Amount save}}{\text{Standard product cost}} \times \frac{100}{1} \\ &= \frac{881.75}{1528.75} \times \frac{100}{1} \\ &= 57.64\% \end{aligned}$$

Therefore, from the cost analysis above, it could be deduced that any customer is expected to save at least 50% of cost save provided/if he/she patronizes the product I made in my project work.

Besides, since one objective of this project research is to formulate and produce glossy wood finish and sanding sealer wood finish paint using nitrocellulose solution which improve the rate of drying time, high quality at minimize price to meet customers specification and also conformed with the Nigeria Industrial Standard (NIS) which was fully achieved.

## CHAPTER SIX

### 6.0 CONCLUSION AND RECOMMENDATION

#### 6.1 CONCLUSION

Conclusively, the major objective of this research is to investigate and obtain a formulation for the production and characterization of wood finishes in order to producing glossy wood finish and sanding sealer wood finish using nitrocellulose solution as binder.

The experimental results revealed that this aim of the research was fully achieved. Base on the fact that nitrocellulose solution which gives a fast drying time due to its high drying properties which is most important parameter for the formulation of wood finishes, production.

However, the economics analysis of the products research showed that any customer is expected to save at least 48% of purchasing selling price if he/she patronizes my product.

That is the products are at minimize and affordable price when compare with other leading paint industries in Nigeria and even local industries production. The production qualities of wood finishes produced were found durable on application. Experimental results also show that the products will surely withstand harsh weather conditions.

Preserve wood panel from fungi attack and give a good and attractive look for both interior and exterior decoration. The cost of the raw materials and the product were found reasonable. The results indicated that nitrocellulose glossy wood finish has weigh per litre of 0.92, drying time of 25 minutes initial viscosity of 122secs. Volume of solid 24.3% with 85% of gloss reading. While nitrocellulose sanding sealer has weight per litre of 1.12 drying time of 30minutes, volume of solid of 18.3% with little percentage of gloss reading of 4%.

The major problem encountered in the production process is the preparation of nitrocellulose solution, which is highly inflammable.

Finally, the results obtained from the experiment showed that, when compare with standard industries and most leading paint industries in Nigeria such as African

paint and Berger paint in Lagos the value is favourable and indicates improvement on the drying time in which all customer highly appreciate.

## 6.2 RECOMMENDATION

Because of the advanced technological development there is need for improvement most especially in our industrial sector to enhance good and quality production.

- i. These aspect include the machineries and the equipment for the research project and competent with well equipped development laboratories, for instance Gloss Meter and viscosity meter are not usually available in most wood finish paints industries in Nigeria
- ii. There is need for further development of the petrochemical industries which would enhance the development of paint and reduce the cost of materials. Because most solvents used in paint industries such as Isopropyl alcohol acetone etc. are produced in most of our petrochemical industries.
- iii. The sources of raw materials, for example the nitrocellulose solution can be obtained locally by looking into the wood fibres and ways of extracting the cellulose from it. From the table of materials cost. The cost of nitrocellulose solution is very expensive and can be reduced by utilizing local source.

## REFERENCES

- (i) Tubb, L.F.T: Painting and Decoration 3<sup>rd</sup> Edition, [Page 1-39]
- (ii) Paint and Colour finishing, 90 exhibition preview Issue August 2003
- (iii) Polymer Paint Colour Journal Volume 180 Number 4264: July 4<sup>th</sup> 1900.
- (iv) Tysall L.A. Industrial Paint Basic Principles [Page 40-48].
- (v) Journal of oil and colour Chemist Association, Volume 73, Number 7, July 2000.
- (vi) Nigeria industrial Standard (NIS) 269: 1989 UDC: 6676 Standard for Paints and Varnishes: Part 5: Specification for Varnish paints for decorative purpose.
- (vii) William Von Fischer, Paint and Pigment Dispersion, 2nd Edition.
- (viii) Vander Walker F.N. Complete Book of Wood Finishing. [Page 21-32; 43-56]
- (ix) [www. greenseal.org](http://www.greenseal.org)  
Choose Green Seal Report on Wood Finished, USA Environmental Protection Agency's Pollution Prevention Division.
- (x) Olatunji O. Adebola, Unilag Finish Paint, 1995.
- (xi) Baboo Lal Aggarwal, Technology of Paint Varnishes, Lacquers and Dries.
- (xii) William Bushwell, Paint and Decoration Encyclopedia Good Heart Wilcox. Publications, New York, 1982.
- (xiii) George Love, The Theory and Practical of Wood Work, 4<sup>th</sup> Edition [Page 58-59].