# THE PRODUCTION OF PAINT USING LOCALLY AVAILABLE RAW MATERIALS.

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## CERTIFICATION

I hereby certify that this project " The Production of Paint using locally available raw materials " ing Znic oxide as a substitute for Titanium oxide and synperonic Nx for Genapur was wholly and solely rried out by Mr. Sheriff Olarewaju Jinadu (92/2695) under the close supervision of Mr Duncan; epartment of Chemical Engineering, Federal University of Technology, minna.

It is hereby certified that he has neither copied anybody's work nor been copied.

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Supervisor's Signature

Date:-......14 – 12 – 98......

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Head of Department's Signature

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External Supervisor's Signature

Dr. J.O Odigure

Date:-................................

Date:-................................

# DEDICATION

This project work is dedicated to my beloved Late Father Chief Gbolageshin Mukandansi Junadu ho departed from the world on the 3rd of November 1997. May his sincere gentle soul continue to rest perfect peace. (Amen).

And to my Uncle's wife Late Mrs Shutonwa who slept in the hands of the lord on the 10th of ovember 1996. May her soul rest in perfect peace. (Amen).

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To my Siblings; I wish to put on record my appreciation of support given by my brother Mr Olajide K. Jinadu. My profound thanks also to goes to my sister Aramide Jinad Mrs Bolanle Jinadu Aremu and Shinko Babatunde Jinadu for their moral of encouragement.

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## ABSTRACT

This project is a feedback of production of paint using locally available raw material Titanium ɪxide T1O2 in existing paint formation can be effectively replaced by zinc oxide (Zno) and Genapur could o be replaced by synperonic NX; the quality control parameters for the new formulation closely proximate that of existing ones.

Viscosity was 7.5 poises, Dispersion test was below 25 microns and weight per litre at 1.45. rying time, opacity test and Adhesion were all in line with the standard set points.

Economic analysis shows that new formulation will reduce the production cost by 35%.

The substituted material are readily available and cheap. The Zinc oxide can be found in Nigeria as ns/Pbs as the chief Ore at Abakaliki and on further processing zinc oxide is produced while synperonic NX manufactured locally by Doshi Group of company. At Oke-Aro in Ogun State. The synperonic has the ame properties such as viscosity, PH, and forming agent with genapur also, zinc oxide has a very good overing power and it is wettability by oil and exhibit all pigment properties like Titanium dioxide

# CHAPTER ONE

## 1.0 INTRODUCTION

Paint is used in motor/car, building, wood industries, civil and structural, engineering e.t.c. It touches virtually all aspect of human life either directly or indirectly.

Water thinned paints date back to antiquity. They were not commercially important until casein based paints were developed about 1925. Resin-emulsion paints have been widely used since the first world war, but later-base paint introduce commercially in 1948, have had spectacular growth. More than 70 percent of interior paint sale are this type. This type of paint were developed a meet demand for greater case of application, quick-drying, low-odour, easy-cleaning, great durability and impermeability to dirt.

However, water-based paints in early century were later resin based paint. Through paints is composed of pigment that hides the subtract (base on which it is applied) and impact colour and a vehicle or binder, that carries the pigment unto the substrate and bind it there. Lead pigment was formerly used in early century but with development and research work, more effective resins and better pigment were developed.

In modern day paints Titania or Titanium oxide ($T1O_2$) is used as the base pigment and improvement in research work various types of binder suitable for specific brand of paint.

From the research poly vinyl acetate (PVA) was found to be suitable for water base paint and it could be source locally in Nigeria.

The poly vinyl acetate (PVA) is the films forming component which hold the pigment particle together and attractes them to them to the surface over which they are spread. Titanium oxide is an imported material likewise Genapur, Nitrogen and some other adebitire. The major problem of paints industry in Nigeria was the mobility of manufactures to secure license of import raw-material. The result was high cost of production and high price of finished goods. There is now a wide spread belief that paint manufacturers are experiencing difficulty in disposing their product, due to customer resistance to high prices.

However, the research work is concerned with finding a substitute into some of the paint production formulation. In this project Genapur is substituted with synronix NX. In which the production technique will be discuss in subsquence chapter. Also Titanium Oxide is replaced with Zinc-oxide. Zinc-Oxide can be found in Nigeria as ZnS/PbS as the chief Ore deposited at Abakaliki and on further processing Zinc-Oxide is produced.

## 1.1 AIM AND OBJECTIVE

The objective of this work is to source for locally available raw-material and cheap substitute in the production of water based paint. Titanium oxide is one of the major pigment used in the production of paint likewise genapur is one of the additive used. Therefore, Zinc-oxide is used as a substitute for Titanium Oxide while synronic Mx is used as a substitute for Genapur. So as to achieve a reduction cost of the production of about 35%, in order to increase customer purchasing power by production of cheaper product of good and reliable quality.

## 1.2 SCOPE

The scope of the research work is limited to the production and testing of water based paints using cheaper substitute such as Zinc-oxide and synperonic Nx for Titanium oxide and Genapur respectively.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### ORIGINS

Paints were in use for representational and decorative purpose for thousands of years before the idea of using them as protective coating appreared. The earliest know paintings, found in the caves of Lascanx, france with iron oxide and applied without binder; date from early as 15,000 BC. Early people in Africa and America also used paints to decorate temples and dwellings. In 17th century white lead paint became widely available yet ordinary houses and even such important structure as bridge remain unpainted for the most part until the 18th century, when there was an increased availability of 60th vehicles and pigment Expensive exploitation of linseed oil from the flax plant and pigment grade Zinc-oxide produced a rapid expansion of the paint manufacturing industry. In 19th century for the first time the two ingredients, pigment and vehicle, were brough together before the paint was marketed.

The begining of the making and used of paint by man go back far into pre-history. The activitity probably arose from his desire to decorate the wall of his home with reminders of this he preized. These painting were probable produced by smearing the vock with a finger dipped in a rudimentary mixture of coloured earth and water or perhaps animal fat. These simple constitumen'ts coloured poweder and fluid carried have remained through the ages the esssensial ingredient of paints.

## 2.1 SOME EARLY PAINTING PRODUCT

### 2.1.1 VARNISHES

A varnish is an unpigment colloidial dispersion or solution of synthetic and or natural resin in oil and or thinners used as protective and / or decorative coating for various surface and which dries by evaporation, oxidation and polymerization of portion of its constituent.

The start of usage of variansh is not really know but sample of varnish of pre-historic hue has been found in the polished tombs of Egyptian mummies which are been preserved in museums all over the world.

### 2.1.2 LACQUERS

Lacquer is a loosely used term, it refers to a coating composition based on a synthetic, thermoplastic, film forming material dissolved in organic solvents, which dries primarily by solvent evaporation. The world is derived from the way in which insect produce lac or shellac on certain trees in

India and inducing lacquer made from tree sap were used in china about 400BC, Japan intersurpassed China in quality of Lacquer was associated with ornamental finishes on wood or porcelain object of Art.

## 2.2 THE NATURE OF PAINT

### 2.2.1 CLASSIFICATION OF PAINT

Paints could be either water based paints or oil based paint. The main types of paint are emulsion paints, water paints and distempers solvent paints, oil paints, hard glass paints, enamel and synthetic resin paints.

#### 2.2.1.1 EMULSION PAINTS

The typical emulsion paint is a synthetic resin (e.g poly vinyl acetate P.V.A) emulsified in water, but other umulsifiable binders are oil, oil varnishes, resins, rubbers and bitumen. Others ingredient are usually stabilizer, which prevent coagulation. The drying action of these paints is due to evaporation of the emulsifying liquid. A useful feature of these paints is that their paint film are initially and sometimes permanently, permeable, which make some suitable for decorating new plaster and other damp surface for external us PVA emulsion paint are alkali-resistant and so may be used on cement, concrete asbestos-cement and plaster. They are suited to poller and brush application.

#### 2.2.1.2 OIL PAINTS

These have a vehicle consiting of drying oil, or oil varnish, mixed with a thinner. They are typified by group based on linseed oil with white spirit, which constitute the traditional readily mixed oil based paints, but other natural synthetic oil and thinner are also used. These paints are obtainable in a eider variety of colours and suit most purposes for both internal and external use.

#### 2.2.1.3 HARD GLOSS PAINTS

These have a vehicle consisting of a special treated oil varnish or drying oil (with or without resin) mixed with a thinner. They are capable of giving a better gloss than ordinary oil paints, and are often more rapid in drying. They can be used externally, although their durability may not equal that of a good quality oil paint.

## 2.3 DEFINITION OF PAINTS

Paint could be defined as any fluid material that will spread over a solid surface and dry or harden to an adherent and coherent coloured obscuring film. It usually consist of a solid powered (the pigment) suspended in a liquid (the vehicle) medium or binder.Paint as formulated contains three primary and one secondary class of ingredient.

These are:

(1) Binder

(2) Pigment

(3) Solvent

(4) Additives (Secondary)

Individually these can be discrible as follows.

## 2.3.1 BINDER OR RESIN

A binder is a substance which binds the pigment and give the paint a hard durable surface on drying. It dries off usually by evaporation, oxidation or polymunization. Emulsion paint for intance dries by evaporation. The binder in this paint consist of a suspension of polymer particle in water. The drying of oil-based paints generally contain a binder which is a mixture of oil and resin when the paints is brush out the large surface exposed give access for oxygen in the air to cause oxidation and with simultaneous polymerization, the paint dries out. Some paints which dry by polymerization will only do so at high temperature very broad range of substances used as binder in paint except oil, may occur naturally or produced synthetically (e.g)

Natural - Congo, copal daminar resin and shellac

Synthetic - Alkyd, polyester, acrylic, vinyis.

Synthetic resin type may be thermosetting or thermoplastic. All thermosetting have high resistance to molecular and are available for external use P.V.A. paint are thermoplastic synthetic resin (polyving acetate) emulsified in water. They are re-softumed by moisture but are popular for internal uses.

Also binder is a component present as a liquid in the paint which converse to a solid state after the film has been applied. Binder are usually high molueuleu weight organic compounds. The conversion to a solid can occur by a number of processes, the mayor of which are.

### 2.3.1.1 AUTO-OXIDATION

The binder is oxidized by oxygen in the air and crosslinks to form a higher molecular weight solid.

### 2.3.1.2 SOLVENT LOSS OR EVAPORATION

The binder is already in a high molecular state in the liquid paint but is held in the liquid state by the presence of solvent. When the solvent evaporate the binder converts to a solid no chemical change occurs.

### 2.3.1.3 CHEMICAL CROSSLINKING

The binder consists of a reachable mixture, the application of heat, or introduction of a catalyst use the individual component to crosslink to a high molecular weight solid

.3.1.4 Binder can be sub-divided dependably upon the type of film that they form.

### .3.2.1. CONVERTIBLE

The film is produced purely by solvent evaporation, since the chemical composition is unchanged the film can be redissolved by the original solvent.

### 2.3.2.2 NON - CONVERTIBLE

The film is form by reaction after solvent has evaporation. This type of film cannot be redissloved in the solvent originally used in the paint.

### 2.3.1.5 THE PROCESS OF FILM FORMING

In Emulsion base paints, the film forming materials are the various hatics with or without others addition. Film formation takes places largely through coalescence of dispersed resin particle to form a strong continuos film. The vehicle for this class of paints is an emulsion of binder in water; the binder may be oil, or an acrylic or polyvinyl acetate P.V.A or another emusifiable binder.

### 2.3.1.6 PAINT VEHICLE

The vehicle, or medium is the liquid part of a paint. Its primary function is to facilitate application by giving the paint mobility (the ability to flow), but it often serves also as a binder for the pigment on drying, and gives adhesion to the surface painted. In fact, the nature of the vehicle will largely determine the characteristics and properties of the hardened (dry) point film. The vehicle may also include a thinner, such as turpentine (a tree extract) or white spirit (a petroleum derivative), added to give increased mobility water, various volatile solvents (often with gum or resin content), emulsion, drying oils and oil varnish are used as vehicles._A gum is a carbohydrate soluble in water an example of which is gum abrabic, a tree extract. Adrying oil is an oil (a natural extract, or synthetic) which has a property of hardening to a paint film when exposed to the atmosphere, wholly or party by chemical action with absorbed oxygen. Drying oils may be natural extract or synthetic and are mainly vegetable extracts, such as linseed oil from the seed of the falx paint, tung oil from the seeds of certain trees, and soyabean oil. Such oils are usually subjected to special processing in order to reduced their natural drying (hardening) time, which is often excessive. For example, linseed oil has a natural drying time of many days or weeks, but when subjected to certain heat treatment (e.g as in the case of "blown" liseed oil, "stand" oil and "boiled" linseed oil) this is considerably reduced. Oil varnish is a substantially transparent, pigment free composition of drying oils, natural or synthrtic resins and solvent. These composition are also know as oleo-resins.

## 3.1.7 P.V.A RESIN

One of the synthetic addition polymers that has largely replace natural resin is P.V.A.This bstance is a clear transparent resin that softens below the boiling point of water. It is sensitive to water d decomposes in acids and bases. Its solubility in a wide variety of organic solvent is good. It also has excellent adhesion properties.

P.V.A resin are marketed either dissolved or suspended in an organic mecum like the natural resins or polymerized and marketed as aqueous emulsion called latexes.

## 2.3.2. PIGMENTS

Pigment is the universally accepted term for the particulate matter dispersed in liquid or solid binder. They are usually present in poweder form in suspension in vehicle. Pigment are either inorganic or organic in composition and either naturally or can be synthenised.

Natural pigment are referred to as extenter which are of low obliterating (capacity) power while synthesised once are pigment with better obliterating power. For example Titanium oxide, Zinc oxide, Carbon black, Lithopone e.t.c.

### 2.3.2.1 FUNCTION OF PIGMENT

(i) To protect the film by reflecting the destruction ultraviolet light.

(ii) To strength the paint film

(iii) To impart an aesthetic appeal

(iv) To aid film former in protecting the surface.

(v) To provide opacity and good covering power (hiding power) and colour of the paint film.

(vi) To confer durability or corrosion resistance to the surface painted or both.

Also pigments should posses the following properties:-

* It should be weltability by oil.
* It should be chemically mertness
* It should be non-toxicity or low toxicity and
* It should be reasonable cost.

### 2.3.2.2 EXTENDER

These are also form of pigments. They are usually white substance such as barium carbonate, tale and silicate. Although these materials impact very little clour of opacity to paint, they are usually added o cheapen paints and improve its brushing characteristics and toughness and at the same time reduce gloss.

Externder are pigment of low obliterating power & are frequently added to high opacity pigments because they impact some desirable property for example they make application easier, or may assist the suspension of solid parties. Also Extender are certains organic salt that have little hiding power by themselves can used to extend or conserve the more expensive hiding pigment. They are generally white in colour and are only effective in water based paints because of their transparency in oil paints.

### 2.3.2.3 PROPERTIES AND USES OF EXTENDERS

To reduce the pigment cost and in many cases to increase the covering and weathering power of pigment by complementing pigment size this improves flowing properties or consistency, leveling and settling of paint. Also provide a degree of roughness in the film of undercoat and to improve adhesion in finishing paint. Reinforcing the film by particle size, shape and to improve the hardness of paint films.

### 2.3.2.4 DESCRIPTION OF SOME PIGMENT AND EXTENDER

**Titanium Dioxide:-** The most superior pigment from stand point hiding capability is T102. It is marketed in two crystallibe forms, anatase and the more stable rutile. Almost all the T102 used in paints is the futile form. Anatase can be converted to futile by heating with small amount of aluminum, autonomy, silicon, to 700 to 950 c. T102 is widely employed in exterior paint and also in emblems and laeque. A typical exterior white. Paint contains about 60% pigment of which 20% is T102 60% talc and 20% mica. Such formulation has long life through controlled chalking (a layer of loose pigment powered on the surface of the paint film which act as a self-cleaner for the paint) and presents a good surface for subsequent repainting. About 50 percent of this pigment is consumed in paints varnishes and lacquer and the second most important consumer (23 percent) is the paper industry, another important used is in the colouring of plastics.Titanium dioxide is refined from inventive a black mineral composed to Titanium iron and oxygen in original process the ore ground to a fine powder and concentrated to remove sound and other impurities is dissolved in tetraoxosulphate II acid, non and other impurities are then removed from the solution and T102 is precipitated filtered washed to purify its further dried and calcined. It is then carefully ground to the proper finess for use as a pigment, also the chloride process can be used to manufacture T102, however Titanium pigment is chemically active and is not affected by dilute acid or by heat or light. T102 is non reactive with drying also it improve to paint a soft film for which if is generally used with other pigment.

### 2.3.2.5 BLACK PIGMENT

The only major black pigment are the carbon blacks. The carbon blacks are very opaque and have excellent durability, resistance to all types of chemicals and lightfastuess. They should not be used in direct contact with non and steel in primer coatings because the stimulate metal corrosion.

### 2.3.2.6 LITHOPONE (2nS+Baso4)

Lithopone is a composites material, formed by precipitating Zinc sulfate (2nSo4) and barium sulfide (Bas) together Antimony trioxide (Sb2O3) is an exceptionally white pigment obtained by washing antimony ore in air. Lithopone is a brilliantly white, extremely fine, cheap white pigment. It is particularly well adapted to Interior coatings.

### 2.3.2.7 BLUE PIGMENT

**Ultramarine Blue:-** This is a complex sodium albumin silicate and sulfide made synthetically because it has a sulfide composition, it should not be used on iron or mixed with lead pigment.

### 2.3.2.8 CALCIUM CARBONATE (CaCo3)

Calcium Carbonate or whiting is derived from both natural and synthetic sources in nature the material occurs as calcite, chalk, dolomite e.t.c. The natural deposit is converted to pigment by crushing and girding to pigment size. The griding may be done dry or wet with water, the synthetic material made bytreating line with either sodium carbonate or carbon dioxide. The precipitated calcium carbonate is wasted, separated in to desire sies and dried. It is abundant at Ewekoro.

### 2.3.2.9 LEAD PIGMENT

Lead pigment have been widely used in paint industry, however they are toxic and it has been estimated that 600,000 children in the united state have dangerous levels of lead in their blood from having ingested lead from old paints walls, realization of the use of lead pigment particularly for inside surfaces

### 2.3.2.10 ZINC OXIDE (ZNO)

Zinc oxide is also one of the most important pigment used in producing paint. It is widely employed in water based paint, enamel and lacquer.

Zinc oxide (2no) is made by oxidizing zinc metal by heating in the presence of air (the French process) or directly from the ore by heating with coke within excess air (the American process). But locally the 2no from the chief ore zinc sulphide /lead sulphide (2ns/pbs) was firstly crushed to give liberation sizes. Then it could either be sieve or the most better on through the process of flotation. The process of flotation use the basis of surface tension. This is carried out by dissolving the mixture crushed no water and them pump enough air in the system and there will be foam on the surface of system indicating Zns is hydrophilic while pbs is hydrophobic. Then Zns collected from the system will further be seperated by ubjecting it to oxidize where zinc is oxideze with the addition of some externder to enbody the pigment ike hychated aluminum silicate, calcium carbonate, talc, and little Titanium dioxide, while lead and nitomy.

Zinc oxide perform several important functions; it control chalking and the washingaction of rain i.e corrosion to weather resistance and it controls washing action of rain at it control colours relention in tinted paints contributes to the hiding power of paint and it is relative.ly opaque to ultral violet light it ptrotect the paint film from destructive effect of radiation water sensitivity of zinc to water. Also it is readily available and relatively cheap.

### 2.3.2.11 HYDTRATED ALUMINUM SILICATE (KAOLIN) (O2 SiO2H2O)

This is a comparatively mert pigment consist mostly of hydrated Aluminiu silicate. Kaolim has a tendency to impart to a paint the quality of easy brushing. It is used to some extent in exterior finishes and in considerable quantities in water thinned paints. The oil absorption rate of kaolin depends on the particle size and due to its mertness. It doesnot affect the vehicle, it is also used to prevent settling of particle in paint media. It could be soure locally in Jakara Kwara State.

### 2.3.3 SOLVENT

A solvent is a liquid which dissolves a substance the film forming consistency but whcih readily evaporate learing behind the dissolved substance unaltered. These include various alcoholic e.g methylated spirit naphthas and other coalter derivative and a very wide range of other organic chemicals OR Solvent are liquid which are mixed into paint to reduce. It viscousity and increase it flowing properties when preparing it for application to a surface. After the paint has been applied the solvent quickly evaporate. The solvent are refered to as thinner because of their inevitable to reduce the viscousity of resin by compatible with it. They are selected according to the type of ppiant been produced and its compatibility with the resin used. Plasticizer belong to the same category except that their volatility is not as pronounced of that expected of a solvent.

### 2.3.3.1 PROPERITIES OF SOLVENT

Act only on the medium of paints. They remain long enough in wet paints to allow easy application (white spirit kerosene platicizer). They are colourlesss and do not cause obscolouration. They are not strong enough to soften undelying coating.

### 2.3.3.2 GROUPS AND TYPES OF SOLVENT

**HYDROCARNON:-** White spirit, kerosine.

**ALCOHOLS:-** Mono ethylene glycol (M.E.G), methyl alcohol and propyl alcohol.

**ESTERS:-** Ethyl acetate, Butyl acetate.

**AROMATIC SOLVENT:-** Xylem, Toluenue.

**KETONIE:-** Methyl ethyl ketones, methyl iso Buthyl Ketone.

**WATER:-** The cheapest of all the diluents is water. It is non-toxic, non flamable, all other of the thinner are expensive, flammable and could be hazardous to men.

### 2.3.4 ADDITIVES

These are materials added to paint usually in small quantities to help the medium attain a certain charateristic level such as quick drying time, even flow thickening properties e.t.c.

#### 2.3.4.1 SOME ADDITIVES AND PROPERTIES

- **BODYING AGENT:-** These are added to increase the viscousity of paint and improve it properties e.g methyl cellulose, sodium carboxy methyl (Natrosol)
- **ANTI-SETTING AGENT:-** These are put into paints to retard sedimentation of pigments and increase shelf life. e.g Sodium Metaphosphate, (Calgon Pt).
- **LIGHT STABILIZERS:-** Some paints, particularly white and coloured ones with agency turn yellow. This result is done to exposure to light. Stabilizer which deal with this problem include dibutylehn dilaurate and M.E.G.
- **WETTING AGENT:-** It is added to paint film especially water base part to ease dispersion of pigment. e.g Synronic NX.
- **BIOCIDE ACID:-** Introduce to kill flies and prevent mould growth e.g phenol derivative, diedriri.
- **ANTI-FOAM OR DEFOAMER:-** To decrease the foaming ability of paint film.
- **DRIERS:-** These are catalyst introduced to speed up the drying

process e.g benzoic peroxide and cobalt napthenate.

- **AMONIA NH3:-** To adjust the P.H of the paint film.
- **ANTICIDE:-** Inform of pigment to prevent the paint film from bacterial in the cans/gallons.

## 2.4 PAINT PRODUCTION PROCESS

The process can be divided into two namely:-

(i) The general formulation of paint (ii) Paint manufacturer and the process are as describe below :

### 2.4.1 GENERAL FORMULATION OF PAINT

All paint is formulated to contain a blend of ingredients which give the properties required. Selection is thus made as follows.

(i) **PIGMENT:-** Selected to give the colour, opacity light fastures, durability (corrosion resistance) required. In addition the ease of dispersion and cost must be considered.

(ii) **BINDER:-** This is selected such that a film of the require form (in terns of hardness e.t.c) is obtained under the condition under which the paint can be applied.

(iii) Solvent are chosen to give generally the optimum balance of speed of dry and flow combined with minimum cost.

(iv) Additives are introduce only when combination of the primary ingredients does not give the precise properties required. The general parameters involved in selecting the correct proportion of specific binder and pigment to give the properties required are controlled by the gloss and opacity required. The solvent level is selected to give correct viscosity/solids relationship required.

### 2.4.2 PAINT MANUFACTURE

Paint manufacturing is the process in which raw materials ratio that has been formulated for paint is weighed out individually and mixed together to make up a paint with the aid of an agitator or mixer. The process of paint manufacture can be broken down into the following.

(1) Dispersion

(2) Mixing / making up

(3) Colour matching

(4) Testing

(5) Filling and Packing

**2.4.2 .1 DISPERSION:-** Paint manufacture involves bringing pigment particles and vehiche into close contact and achieving a through dispersion of the particle throughout the binder. Dispersion is infact the most important operation in a paint factory, the economics of plant operation are keyed to it. The design of dispersion tank depends on the types of paint manufactured and on the formulations and colours the equipment must handle. The most popular types are so-called ball mills, which grinned by tumbling heavy metal or ceramic ball through the paint in cylindrical container, and sound ginger, which circulate a suspension of sand in paint through a rotor assembly at high speeds. A fine grind can be achieved with ball mills operating for eight or more hour on a single batches or with sand grinder delivery a nearly continuous output.

Paint are no longer hand mixed most of the pigment properties of paint depend on the nature and extent of the inter faces (boundary surfaces) between the pigment particles and the vehicles. :If the pigment particles are not completely dispersed, with all pigment particles wetted by vehicle, they link together in à reticulated structure that leads to poor brushability, low gloss, and the appearance of over size particle in the film.

### 2.4.2.2 MAKING UP AND MIXING

The dispersion stage is highly pigmented and this can easily result in instability therefore, at this stage, resin, and solvent are basically added to stabilize the paint under manufacture also the addition of additive is alot carried out.

properties drivers, fungicides, and tint bases are added during the process of thinning and the paint is checked against a previously established colour standard. Skilled colour matcher have never been replaced in this phase of manufacture though instrument are use to quantify the colour value of hue, brightness and chron (purity). The purely technical aspects of the film are established instrumentally in sofar as possible and the observations are recorded instrumentally, but the final check is made by eye.

### 2.4.2.3 COLOUR MATCHING / ADJUSTMENT

Colour is difficult to quantify paint product must be uniform in colour, flow and other physical

## 1.2.4 TESTING

The paint just manufactured are tested vigorously in the laboratory before been approved for filling d packing some of the test carried out during paint manufacture is as listed.

(1) Viscosity test.

(2) Weight per liters / weight per gallon (3) Opacity or covering power

(4) Paint film drying time

(5) To show the permeability of paint film

(6) Particle size or dispersion test

(7) P.H. Test

(8) Adhesion test

## 1.4.2.5 FILLING AND PACKAGING

This is done when the paint has been certified to meet the required standards. It is filled into uitable containers. In Nigeria, paint is supplied by manufactures in containers is different sizes as shown elow:-

| | |
|---|---|
| Giant size | - 20 litters |
| Big size | - 4 " |
| Medium size | - 1 " |
| Mini Size | - 1/2 " |

loss reacts with plastic and as a result is packaged only in metal container. Emulsion could be packaged oth in metal and plastic containers. However,imported paints come mostly in 5 - line packs.

## 2.4.3 TYPE OF TEST IN PRODUCTION OF PROCESS OF PAINT

## 2.4.3.1 WEIGHT PER LITRE

**APPARATUS:-** Specify gravity cup or measuring cylinder (100 ml) baker, physical balance (to 01 g). The paint produced is powered to the specific gravity cup and filled to the brum and covered with its lid. it is then weighted on the chemical balance the weight is noted and divided by 100.

Weight of Empty Specific Gravity Cup = AKG

Weight of empty cup plus weight of Paint = BKG

Weight of Paint = (B-A) KG = C

S.G = (C/100).

Weight per Litre = (C/100)g/litre.

#### 2.4.3.2 P.H. TEST

This is done by taking small sample or paint and add one or two drops of :P.H. dictector and the colour change. This colour is compare with standard colour and if the colour does match or do not give required colour then PH. adjuster is added to the paint film (NH 3). The test is being carried out again.

#### 2.4.3.3 PARTICLE SIZE OR DISPERSION TEST

This is one of the most important test in paint factory. The test is been carried out during dispersion stage by dipping in pallate knife into the paint film and check for the particle side with naked eyes. And also it could confirm it on grinding guage.

#### 2.4.3.4 PAINT FILM DRYING TIME

This is carried out using a drier. The normal drying time for emotion when done mechanically is 30 minutes for hard dry. However, it is touch dry is one hour while the normal hard dry is 24 hours.

#### 2.4.3.5 OPACITY TEST

This is the obliteration power of the pigment used. This is done by brushing or rolling the paint on the wall and its covering power is observed. When its covering is high then Opacity is good, but when covering is low then the opacity is poor.

#### 2.4.3.6 VISCOUSITY TEST

The required viscoucity for emotion is 75-10 Poises depending on the grade of paint being produced. The test is carried out using a rotho thinner viscoumeter and the rotothinner works on the principle of newtonian motion which place rotaionally first of the spindle of the votothinner against the fractional force of the paint material in the medium.

#### 2.4.3.7 ADHESION TEST

The paint brush on the wall is easily tested by using hand to check if there is any crack or exfolliage when the hand is used. In fact, adhesion test is to know the adhesive level of the paint to the surface quoted.

### 2.5. THE CHOICE OF PAINT TO PRODUCE

The type of paint to produce came from an assessment of the most used type of paint by customers in the face of decrease in customer's purchaing power most paint producer faced the problem of developing a relatively clean per quality paint that consumer can afford. This is what actually lead to the choice of the water based paint known as emotion paint. The formulation and production carried out is discussed in the subsequent chapter.

#### 2.5.1 WATER PAINT

Water paint have a vehicle composed of a drying oil, oil vanish or synthetic or natural resin emulsified in water usually together with a stabilizer such as glue size or case in. Water paint are in fact, emulsion paint although there are not classified as such commercially. Pigment and extenders are added and product is usually supplied in paste form mixed with water, to be thinned with by the users to the constancy for application. They give a permeable paint film which is washable when hard, and most are unaffected, by alkalis.

## 2.5.2 PROPERTIES OF WATER BASED PAINTS

(1) Smooth easy brushing and absence of sickness.

(2) Good spreading and hiding powers.

(iii) Good adhesion.

(iv) Good recoatability that is, it should be able to stand reciting after 24 hours with defect.

## 2.5.3 THINNING

Water paints and basically thinned to working consistency, with water or with a special petrifying liquid supplied by the manufacturer. The advantage of using thinner is to improve its brushing and spreading properties over thinning of paint, should be avoided cause it impairs the opacity and reduces the binding properties of the emulsions.

## 2.5.4 WATER PAINT STAINER

Various colour stainer used for water based paint. The ratio in which they are used is about twenty grams of stainer to about 100g of paint unstaining of paint, mixing should be carried out and colour tested by using brush to apply on the card. The colour is compared with the standard and the viscousity of paint is tested again to check its viscousity.

## 2.6.0 THE PURPOSE OF PAINT

Paints is applied to an object normally for a combination of two reasons:

1. To protect

2. To improve the appearance or decorate (that is cosmetic).

The formation of paint is therefore carried out to obtain the balance of these properties that are required. The balance the paint upon the subtrate, the purpose to which the finished object will be put, the conditions to which the object will be subjected and actual appearance required.

To take each of these attributes in turn.

### 2.6.1 PROTECTION

In general the following types of protections are required although the balance of the protective properties obviously depends upon the end use of the product.

### 2.6.1.1 WOOD

This subtrate can change colour and infact be destroyed by combinaton of sunlight, moisture and funges and therefore protection is required. In addition some damage can caused by physical abrasion. To resist all these factors a coating may be applied.

### 2.6.1.2 CEMENT, PLASTER etc.

This type of subtrate can powder or chalk and be permeable to moisture and therefore need to be coated.

### 2.6.1.3 ALUMINIUN ALLOYS etc.

This non ferrous subtrates generally are naturally fairly resistant to normal corrosion. However, sometimes oxidation can take place and must be prevented, or the subject might be exposed to abnormal condition such as high acidity or alkalinity to which the subtrate is not resistant.

### 2.6.2 COSMETIC

The cosmetic appearance depends on less on the subtrate than the final end use of the product. Thus decorating paint have a high cosmetic requirement, motorcar paint also have a high cosmetic requirement although this is combined with a high protective requirement. For wood the appearance varies depending upon whether the finish is transparent to allow the grain to be seen or is coloured.

Water paints are applied using brush, best result in application of paint is obtained when work is carried out in a systematic way which does not give room for any delay in joinng of wet edges.
However, old surfaces should thoroughly prepared before application, e.g. washing and scraping in advent at different colour of new paints to be added. In some cases a primer can be used to paint the surface before the application of the actuall paint for the surface. Ther primer aids the reception of the new paint on the surface by incresing adherence properties, however, to coating of paints is enough or primer is mainly used to avoid porosity.

## 2.7 TOOLS AND MATERIALS USED IN PAINT APPLICATION

**2.7.1** In the selecltion of a good brush the painter should note that a good brush must the capacity to hold more paint, carry it without dipping too much paint and not splashing much of the paints, it should be able to put on a smoother coat and cut a clean even edge. A good brush is more expensive than a less effiecient brush.

### 2.7.2 ROLLERS

There are three basic types of rollers,

1. The deep type
2. The fountain type
3. The pressure type

The pressure and fountain types are faster and they are used more on large jobs. Paint rulers can used in applying many types of finishes both interior and exterior, rollers are basically ideal for the large area painting adapt well to painting places that are hard to reach with a brush, such as high ceiling, over stairways. They

They can also be used in application jobs in ordinary rooms.

## 2.7.3 MECHANICAL SPRAY PAINTING EQUIPMENT

The mechanical method of applying paints with spraing equipment is used extensively since it is a practiacal and economical means of paint application. All types of coatings and can be applied, using spray gun and it is much faster than all other types of application equipment.

## 2.8 STORAGE OF PAINTS

Since most paints are essentially mixtures, their constituents are liable separate out to form different layers in the container during storage. Thorough remixing should therefore be the rule before and during use. Whenever a skin form at the surface, it will usually redissolve on mixing in solvent paint, but should be removed with non-solvent paints by straining the paints through a fine mesh fabric.

Some paints needs protection from excessive cold. For example water paint and emulsion paints are likely to deteriorate at near freezing tamperature. Paints containing organic solvent presents a fire-risk, and many give off toxic vapours, so the necessary precautions should be taken.

## 2.9 PAINT PROPERTIES

A paint should be applicable while liquid on application, all surface irregularities should smooth out, and paint film should flow with cracks and crevicies before it develop appreciable vicidity. If a fluid condition is maintained too long the coating will sag on vertical surface. Consequently, most paints and so formulatical that time of handling is kept short. This is done by adding what and called thexutrupic aqunts to the paint that cause the binchair to loose it structural vigidity as it is brushed onto the surface and to regain it shortly thereafter.

## 2.10 THE CHEMISTRY OF THE PROCESS

The chemistry of the process of mixing involved in the production of emulsion paint is a physical process of mixing at high speed by industrial mixers on agitators. Chemical convertion are involved in the manufacture of the constituent of paint as well as the drying of the film. The result as the medium on the vehicle of the whole content of the paint that is each component is present in the machine, however, it is believed that liquid emulsion paint can be separated back into various raw materials but through a very expensive and highly technical process.

## 2.11 IMPORTANCE OF STIRRING

Stirring or mixing is alone so as to intensify the solution of particular materials so as to increase the contents surface area, grinding of solid phases increase in the porosity and complete convertion of the solid solute in liquid and increasing the relative rate of mixing the two phases.

## 2.12 THE EFFECT OF TEMPERATURE

The temperature should be regularized at room temperature in order of an increase in temperature this enhance the rate of diffusion and kinetic control dissolution but however, there is destruction of crystalline matrix of paints produced and loss liquid viscousity as a result of inconclusive chemical reaction.

# CHAPTER THREE

## 3.0 EXPERIMENT

In the experiment to be performed the formulation of raw materials to be used is very essential and the formulation has to be in proportionate quantities which are weighed out respectively, after the formulated of the worksheet.However, the exeriment can be divided into the following.

i. Formaulation of the worksheeet

ii. Precedure of raw Materials to the used.

iii. Produce of make up and mixing of raw materials

iv. testing of products of the process.

## 3.1 FORMULATION

Proper paint formulation centre around the specific requirements of the particular application . These concept of pigment volume concentration (P.V.C) and it is equal to P.V.C =

$$\frac{\text{Volume of pigmentation paint}}{\text{Volume of pigment in paint} + \text{Volume of non-vilitile Vehicle consituet in paint}}$$

The P.V.C largely control such factor as gloss reflactant, rheobogical properties. The in hereent vehicle requirement of the pigment - extender combination being applied, however, affect the P.V.C used in a given formulation. The P.V.C of a given formalation serves as the guide for reformation work using different pigment or vehicle combination and as such is extremely useful to the paint formation. The addition of pigment continues to reinforce and improve the film-forming properties until a critical concentration, (C.P.V.C) is reached. at this point and beyond, the resistance properties of the paintdecreases as the film becomes pourous, causing the paint to weatherfaster and lose abrasion resistance and flexibility.

## 3.2 WEIGHING OF MATERIALS USED

This was carried out by using a digital balance for the production of 8 litres of paints. All the weighing of componet was in kilogrames. The equivalent percentage forthe production of 8 litre of paints is given on the table below . Taking the basis of 11.6kg.

| Raw matrials | Percentage | For the production of 8 litres |
|---|---|---|
| 1. Water | 15% | 2.4476 |

| | | | |
|---|---|---|---|
| 2. | Sodium Metaphosphate | 0.2% | 0.00232 kg |
| 3. | Synperonic NX | 0.2% | 0.00232 kg |
| 4. | Anti-foam | 0.2% | 0.00232 kg |
| 5. | Caco3 | 21.15 | 2.5346 kg |
| 6. | Hydrated Aluminum Silicate | 12.15 | 1.4094 kg |
| 7. | Tio2 | 8.5 | 0.986 kg |
| 8. | Zno | 13.00 | 1.508 kg |
| 9. | Natrosol | 0.5% | 0.058 kg |
| 10. | Aticide | 0.2% | 0.0232 kg |
| 11. | Anticochei | 0.2% | 0.0232 kg |
| 12. | P.V.A. | 18.5 | 2.148 kg |
| 13. | Formula | 0.20% | 0.232 kg |
| 14. | NH3 | 0.2% | 0.0232 kg |
| 15. | M.G.E. | 0.2% | 0.232 kg |
| 16. | White Spirit | 1% | 0.116 kg |
| | | 100% | 11.6 kg |

**3.3** Procedure of make up and mixing of Raw Materials. 2.4476 of water weighed was pour in the mixing vessel and the agitator was switched on, then 0.0233 kg of sodium metaphosphate in what form was added after which synperronic NX was added, follows by aticide what is a sahlt of sodium and mecury preservstive . All these was allowed to mixed untill sodium metarphosphate dissolved using a low speed agitator.

The pigment and extender wee the mont set of things added 2.5341 of CACO3 was added after which the titanium oxide amd Zinc oxide was at added according to the amount on the table . The mixture was subjected to high speed agitator. And after about 10 minute, the dispersion satge have been completed. Then white spirit and natrosol was added while the stirring continue after which 2.148 kg of poly vinyl acetate and formly was added meanwhile the speed of agitator was reduce to low speed agitotor while more ethylene glycol was added and anticide water was added again to the mixture to adjust the viscousity after which NH3 was added to afdgjust the PH.

## 3.4 THE ROLE OF INDIVIDUAL RAW MATERIALS USED IN THE PRODUCTION

-Water - It is used as a thinner or solvent.

-Sodium Methaphosphate - it is used to aid dispenrsion .

-Synonic Nx.- it is used as a wetting agent it also aid disprersion and make emulsion paints looks glossy.

-Aticide - It is sed to prevent the paint film in the containier .

-CAC03 - serves as an Extender or a Fillter to give body to the paint film.

-Hydrate Aluminum Silicate - Also serves as an extender or filter to give body to the paint film.

-White Spirit - Serves as a stabilizer i.e keep the paint in wet film.

-Natrosol - Serve as a thickness, To increase the viscousity of paint and improve and improve the properties.

-Tio2 (Titanium dioxide). - Serve as a pigment

-Anticide - Prevent the paint film after application.

Poly-vinyl acetate- Serves as a binder. It is also the medium or vehicle of content in the paints.

-NH3 - Used to adjust the P.H of the paint .

-Momo ethylene Gylocol- Some paint, particularly white & lightly cloured one with ageing turn yellow . This is due to exposure to light. stabilizer which deal with this problem is M.E.G.

### 3.5.1 DISPERSION TEST

This was carriedout during the making up of the part after the addition of pigment and exteners. This was done by using a palatte knife, the knife was dipped in the medium and later brought out, the film on the palatte knife was checked if particles could be seen, If there is non, then the mixture is well dispersed but in case particle could still be seen, then it is left to mix for a longer period. Also the used of grinding guage.

### 3.5.2 VISCOUSITY.

This was carried out using a Rotothinner Viscometer. Some of the paint produced was pour into a beaker and tested using rotothinner. The expected Visconosity should be between 7.5 -10 poises. A rotothinner works on he principle of newtonian force of rotational revolution of the rotothinner spindle against. Frictional force of particles.

### 3.5.3 SG, weight per litre and weight per gallon test.

This was carried out by using a specific gravity cup and a digital balance. Some sample of part produced was poured into the specific gravity cup and it was filled to brim and the liel was used to cover it after which it weight was measured on the digital balance. Since the weight og the SG cup was known and the weight of paint + cup was recorded. The weight of cup was removed from the weight of part + cup. So the weight of part obtained was divided by 100 to obtain the require weight pe litre output which was expected to be between 1.44 - 1.48.

mathematically,

weight of S.G cup = A kg ± 50kg.

weight of S.G + paint = Bkg = 195 kg.

weight of 100ml paint = (B -A) =C kg = 145

$$S.G = \frac{c}{100} = \frac{145}{100} = 1.45$$

Weight per litre = 1.45g/litres

weight per sallon = 1.45 x4 = 5.8 kg.

### 3.5.4 OPACITY

This test wa carried out by brushing or rolling the paint on the wall to test it covering power, a good covering power can easily be seen with naked eyes.

### 3.5.5 ADHESSION TEST.

This was done when the part his been brushed on the wall after drying, the level of adherence of the film to the wall by using hand to test by rubbing palm on it. If the particle do not break during the process of rubbing the palm on it, then the part is well adhered.

### 3.5.6 P.H. TEST

Some sample of paint produced was poured in a beaker after which two (2) drops of PH just detector was added to it after which the colour changes. The colonial changed was compound with the standard calibrated colour. The standard calibrated colour for could be analysisThe standard calibrated colour for emuision are between 7- 7 .5. The P.H could be adjust with $NH_3$.

### 3.5.7 THE SHEEM OR GLOSSINESS TEST.

The sheen of emulsion produce is expected to be at mild level, in water based paints their glossmess is dependent on the pigment/binder ratio and synperronic mx which formulating high level of binder means high sheen capacity, however for emulsion part, the gloss is expected to the mild, The sheen is determined by looking at the hard dry reflection.

### 3.5.8 EXTERIOR DURABILITY

This is done by coating surfaces and examing the surfaces after 1, 4, 10 and 12 Months respectively . For chalking, Cracking, Flaking, chart vetention and change of gloss and colour.

### 3.5.9 DRYING TIME TEST

This is the touch dry, normal dry and surface dry for recolating. This was done by brushing or rolling the paint on the wall and the drying of the paint film was timed. Touch dry was expected to be 24hrs. However, this is when the paint film formed is completely dried by eveporation.

**Table 4.1 The table of results**

| **Test** | **The Expected Results** | **Results obtained** | **Adjustment Results** |
|---|---|---|---|
| Viscousity test | Between 7-10 poises | 12 poises | 7.5 poises |
| Dispersion test | Below 25 micrions | Below 25 micrions | |
| Specific gravity test | Btween 1.44-147 | 1.45 | |
| Weight per lttre | Between (1.44-1.47) litres | 1.45 g/litre | |
| Drying Time | | | |
| (a) Touch dry | 1 hrs - 2hrs | 1 hr - 30 mins. | |
| Hard drying | 24 hrs | 24 hrs | |
| Surface coating dry | 3 hrs - 4 hrs | 3 hrs - 30 mins | |
| Opacity Test | Good covering power | Good covering power | |
| Adhesion test | Good adhesion | Good adhesion | |
| Sheem and whiteness | Brilliant white and small gloss | Brilliant white and small gloss | |
| PH test | Between PH No. 6-PH No. 8 | PH No. 13 | PH No. 6 |

## 4.1 ECONOMIC ANALYSIS

This chapter entails that market price including of raw materials engaged in standard paint industry and indices of raw material that was used in producing the water based paints. IN the industry, overall cost of production of paint product and costing and marking of process of paint products are necessary. However, the same method of costing and marking of prices was used in the paints produced too.

### 4.1.1 Market prices of new materials and overall production cost determination.

**Table 4.2.1**

| **Raw Material** | **% Composition Product** | **Price (N)** | **Value** |
|---|---|---|---|
| Water | 21.1 | - | |
| Synperonic Nx | 0.2 | 40 | 28.00 |
| Defaomer | 0.2 | 120 | 196.66 |
| Sodium metaphosphate | .2 | 120 | 24.00 |
| $CaCo_3$ | 21.85 | 9 | 196..65 |
| Hydrated aluminiun silicate | 12.15 | 7 | 84.05 |
| Zn0 | 13.00 | 100 | 1300.00 |
| Ti03 | 8.5 | 240 | 2040.00 |
| Formalin | 0.2 | 100 | 20.00 |
| P.V.A | 18.5 | 175 | 3237.50 |
| Natrosol | 0.5 | 1000 | 500.00 |
| Ammonia (NH3) | 0.2 | 40 | 8.00 |
| White spirit | 1.5 | 7 | 10.5 |
| Anticide | 0.2 | 165 | 33.00 |
| Aticide | 0.2 | 600 | 120.00 |
| M.E.G | 1.5 | 200 | 300.00 |
| | 100 | | 7908.70 |

Total Value = R.M.C. = 7908.70

$$\frac{RMC}{kg} = \frac{7908.70}{100} \Rightarrow N79.091k$$

Hence,

the cost of raw materials for one litre of paint

$$= \frac{\text{RMC x Weight per litre}}{\text{kg}} \quad => \quad 79.09 \times 1.45 = N114.68k$$

Therefore; cost of raw material for 4 litres of paints

= 114.68x4 = N458.72k

**4.1.2** However, it can be deducted from the calculation above that n458.72k is the total cost of raw material used in the paint product.

However, in order to achieve the requirement price indices level, one needs to make reference to the raw materials cost for standard water based paint which is shown in the next table.

**Table 4.3**

| RAW MATERIALS | % COMPOSITION | RATE | VALUE |
|---|---|---|---|
| Water | 21.1 | | |
| T102 | 27.65 | 240 | 6636.00 |
| CaCo3 | 20.85 | 9 | 187.65 |
| Sodium metaphosophate | 0.2 | 120 | 24.00 |
| Dieformer | 0.2 | 35 | 7.00 |
| M.E.G11 | 2 | 200 | 400.00 |
| Matrolsol | 0.5 | 1000 | 500.00 |
| P.V.A. | 25.5 | 17.5 | 4462.5 |
| Formalin | 0.2 | 100 | 20.00 |
| Amonia (Nitz) | 0.2 | 40 | 8.00 |
| Aticida | 0.2 | 600 | 33.00 |
| Anticida | 0.2 | 165 | 120.00 |
| Genapur | 0.2 | 400 | 80.00 |
| White spirit | 1 | 7 | 7.00 |
| | 100 | | 12,4845 |

Total value = RMC = 12,484.5

$$\frac{\text{RMC}}{\text{kg}} = \frac{12,484.5}{100} = 124.85$$

Cost of raw material for 1 litre of paint

$$= \frac{\text{RMC}}{\text{kg}} \times \text{weight per litre}$$

124.85 x 1.45 181.03k

Therefore, cost of raw materials for 4 litres of paint:

= 181.03 x 4 = N724.13k

### 4.1.3 SELLING PRICE DETERMINATION

However, to determine the selling price of products along with determined raw materials cost, one needs to know the handling loss, cost of container, total production cost also there is need to include the overhead which is placed at 10% and a profit margin of 15% all are illustrated in Table 4.4 below.

**TABLE 4.4**

| **Cost** | **New product (N)** | **Stamdard Product (N)** |
|---|---|---|
| Total raw material cost | 458.72 | 724.13 |
| Handling loss cost | 1.10 | 1.10 |
| Container cost | 48.00 | 48.00 |
| Total cost of production | 507.82 | 773.23 |
| 10% overhead | 50.78 | 77.32 |
| 15% Profit margin | 76.18 | 115.99 |
| | 634.78 | 966.99 |

However, on market survey, it was found that selling prices of 4 litres of paints for two of eh paint producing companies in Nigeria; namely [illegible]oshi paints and Berger paints have prices between N850 and N1000 respectively while the price of the product produced is placed at N634.78 only.

4.1.4 **CALCULATION OF COST SAVED AT THE NEW PRODUCT**

Cost of the paint produced = N684.78k

Cost of the standard product = 966.54k

Amount saved = Standard product cost - New product cost

= 966.54 - 634.78

= 331.76

% cost saved = $\frac{331.76}{966.54} \times 100$

= 34.33%

# CHAPTER FIVE

## 5.0 STIRRED TANK REACTOR

Stirred tank (agitated reactors consist of a tank fitted with mechanical agitator and sometimes a cooling jacket on with. They are operated as batch reactor or continuously seven reactor may be in service.

The stirred tank reactor can be considered the basic chemical reactor modelling on a large scale the conventional laboratory flask. Tank sizes range from a few litres to several thousand litres. They are usedfor homogeneous and heterogeneous liquid-liquid and liquid-gas reaction, and reaction that involves finely suspended solid which are held in suspension by the agitation. As the degree of agitation under designer control stirred reactors are particularly suitable for reactions where good mass transfer or its transfer is required. The power requirement for agitation will depend on the degree of agitation required and range about 0.2kw/m3 for moderate mixing to 2kw/m3 for intense mixing.

### 5.1 MIXING SYSTEM

Mixers consist basically of a motorised rotating immersed in liquid pool. Although the variety of impeller types and vessel configuration is large, only propeller and turbine agitators as significant and employed in chemical process plants. In addition to the mixing system are baffles which are flat vertical stripps normally set radially along with tank walls.

In general turbine agitators are best for suspension of solid, dispersion of immiscible liquid, its transfer enhancement and promotion of chemical reaction.

### 5.2 MIXING EQUIPMENT

The preparation of mixture of solid, liquid and gases is an essential part of most production processes in the chemical and allied industries; covering all processing stages from preparation of the reagent through to the final blending of products. The equipment used depends on the nature of the materials and degree of mixing required.

Mixing is often associated with other operations, such as reaction and its transfer liquied and solid mixing operation are frequently carried out as a batch process.

## 5.3 PAINTS MIXING VESSEL

Emulsion are suspension of immiscible paste in which the disperse droplet 1 to 1.5um in diameter are too small to coalesce and separate. To create an emulsion turbine agitators are employed with high specific power and high blade tip speed. This is a cylinderical open-ended shroud around the impeller, which forces all liquid to pass through the share mixing zone near the turbine blade. The bottom of the vessel could be dome shape or flat with dome or rounded bottom, shape regions unto which the fluid current could not penetrate is removed.

Impellers are important items for mixing but the atome do not control flow motion. The configuraton of the tank, the nature of the paint slurring and location of he impeller as just as important as the impeller design in determining the flow pattern and this factor must always be considered for mixing.

Mixing is of sub-division and blending of separate compound by miscroscopic means so that miscroscopic diffusion or shear will lead to more homogenieity.

## 5.4 IMPELLER

The three main types of impeller are propeller, paddles and turbine each types includes many variation and sub types.

**Propellers:-** A propeller is an axial-flow, high speed impeller for liquid of low viscousity.

**Paddles:-** For simplier problem of effective agitator consist of the flat paddle turning on a vertical shaft. Two-bladed and four-bladed are common. Sometime the blade are pitched more often they are vertical. It turns at slow to moderate speed in the centre of vessel.

**Turbine:-** Are multiblade paddle agitators with short blade turning at hgih speed on shaft mounted centrally in the vessel the blade may be straight, curved pitched or vertical turbine are effective over a wide range of viscousity.

## 5.5 FEATURE OF IMPELLERS

### 5.5.1 PROPELLERS

1. They are self cleaning operation
2. Used as at a wide range of speed
3. Do not damage disperse particles.
4. They are not effective in viscous liquid

## 5.5.2 VERTICAL, CURVED BLADE IMPELLERS

1. They are excellent for producing circulation
2. They are effective in fluid of high viscousity
3. They are expensive in fabrication
4. They are restricted to a narrow range of speed

## 5.6 REACTOR TYPE

The type of reactor used in production of water based paint is batch reactor. Batch reactors are fed only once reactant are left until the required extent of reaction After which the mixture is discharged. The reactant are expected to change the concentration with time and concentration of the product is expected to be uniformed throughout.

## 5.7 PROBLEM STATEMENT FOR DESIGN

To design a paint reactor to produce 2.5 million litres of water based paint per year. Using locally acailable materials.

## 5.8 MATERIAL BALANCE

In batch reactor all materials in will be equal material out.

Taking this basis of 5000 lines/batch. = 7250kg.

From the relationship

$$d = \frac{m}{v}$$

Paint density = 1450 kg/m3

Volume = 5m3

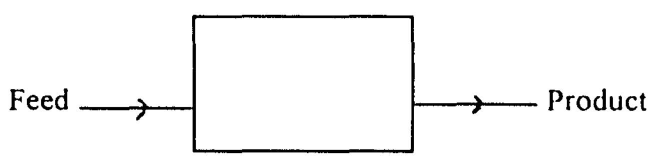
$$1450 = \frac{m}{v}$$

M= 7250 kg

**Table 1**

| Raw Material | % composition | Equivalent Mass |
|---|---|---|
| Water | 21.1 | 1529.75kg |
| Synperonic NX | 0.2 | 14.5 kg |
| Defoamer | 0.2 | 14.5 kg |
| Sodium metaphosphate | 0.2 | 14.5 kg |
| Caco3 | 21.85 | 1584.125 kg |
| Aluminium silicate | 12.15 | 880.875 kg |
| Zno | 13.00 | 942.5 kg |
| T102 | 8.5 | 14.5 kg |
| Formalin | 0.2 | 14.5 kg |
| P.V. A. | 0.5 | 1341.25 kg |
| Natrosol | 0.2 | 36.25 kg |
| NH3 | 0.2 | 14.5 kg |
| White spirit | 1 | 72.5 kg |
| Anticide | 0.2 | 14.4 kg |
| Aticide | 0.2 | 14.5 kg |
| M.E.G. | 2 | 14.5 KG |
| | 100% | 7250 kg |

## 5.8 ENERGY BALANCE




The production of water based paint takes place at room temperature. The heat evolved is as a result of mixing and will not affect the final product.

heat of feed = heat of product.

## 5.9 MATERIAL AVAILABLE

Raw Material

| | |
|---|---|
| Cacium carbonate | Caco3 |
| Zinc oxide | Zno |
| Titanium oxide | TIO2 |
| Polyvinyl acetate | P.V.A. |
| Hydrated Aluminium silicate | ALO2 510 2H20 |

<u>Additive</u>

| | |
|---|---|
| Synperonic | |
| Defaomer | |
| Sodium metaphosphate | |
| Formalin | HCHO |
| Mono ethylene glycol | M.E.G |
| Anticide | |
| Aticide | |
| Amonia | NH3 |
| Cellulose ethier | Natrosol 44 BR |
| White spirit | |

## 5.10 UTILITIES

Water

Electricity at 440V three-phase 50H3 with adequate incoming cable capacity for all proposed uses.

## 5.11 ON STREAM TIME

Time per batch = 4 hrs / batch

batches per day = 2 batches / day

therefore,

$$\text{on stream time} = \frac{4 \text{ hrs}}{\text{batch}} \times \frac{2 \text{ batches}}{\text{day}}$$

$$= \frac{8 \text{ hrs}}{\text{day}}$$

Also 250 working day per year.

Final on stream time $= \frac{8 \text{ hrs}}{\text{day}} \times \frac{250 \text{ days}}{\text{year}}$

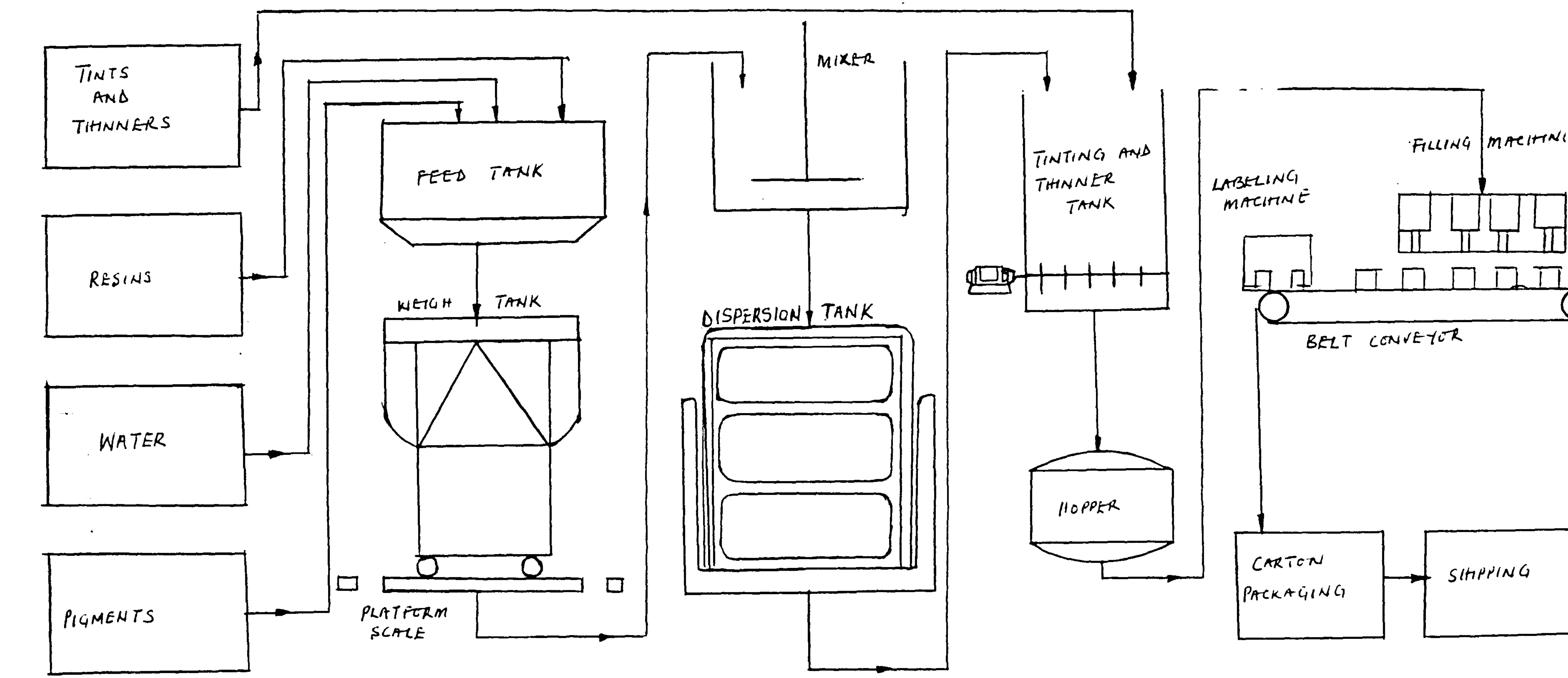
$$= \frac{2000 \text{ hrs}}{\text{year}}$$

## 5.12 PRODUCT SPECIFICATION

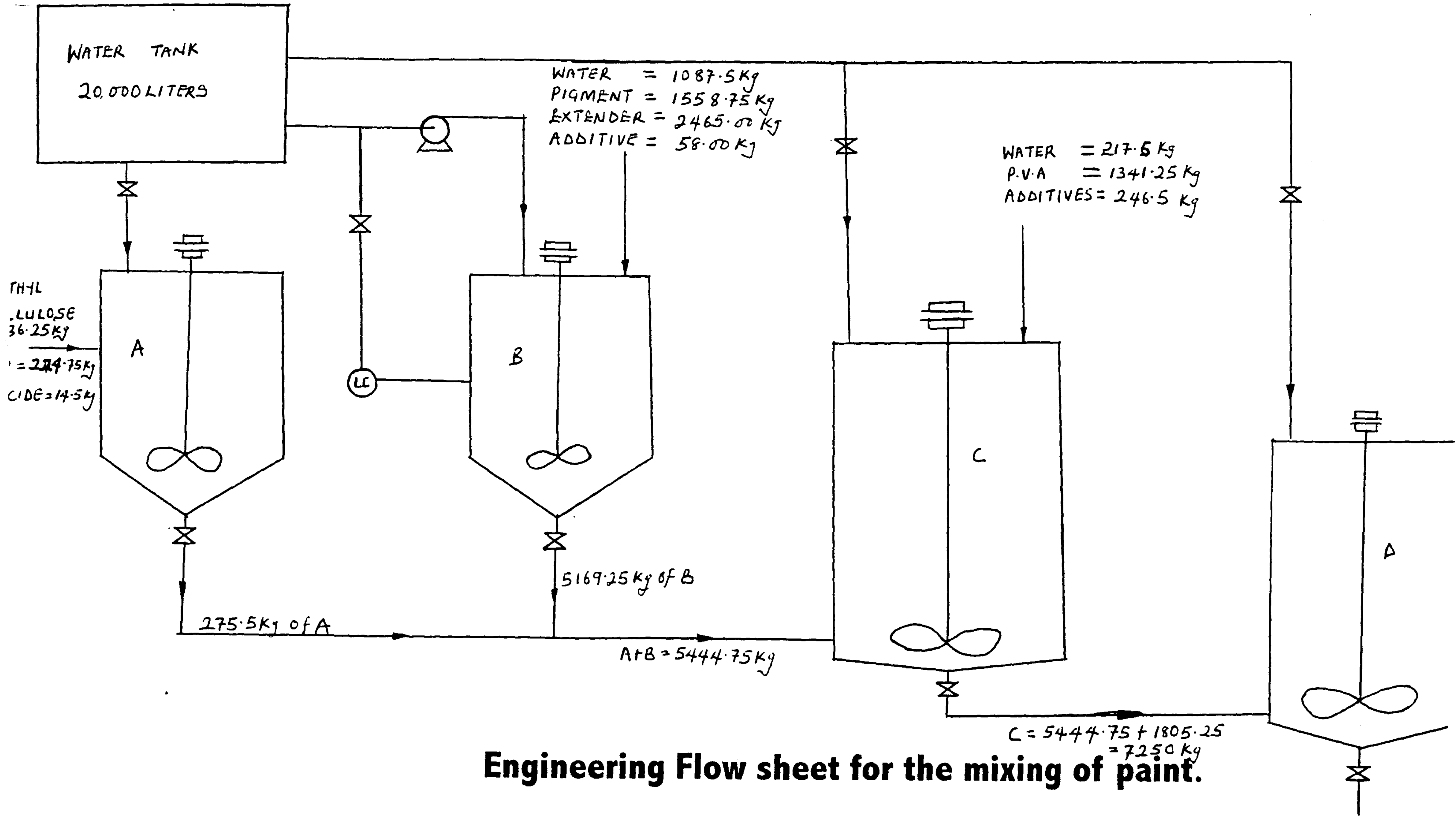
| | | |
|---|---|---|
| Viscousity | - | 7.5 poises |
| PH NO | - | PH No 6 |
| Dispersion | - | Below 25 microns |
| Weight per litre | - | 1.45g/litre |
| Specific gravity | - | 1.45 |
| Drying time | | |
| Touch dry | - | 1 hr - 2 hrs |
| Normal hard dry | - | 24 hrs |
| Opacity | - | Good covering power |

## 5.13 THE PROCESS

The manufacturing of procedure illustrated are for a mass production paint. The weighing, assembly and mixing of the pigments, extenders and vehicles tables places on the top floop. The batch masses are conveyed to the floor below where dispersion and further mixing takes place. In the engineering flow sheet; tank B is the dispersion vessel and is at the top floor where the pigment and the extender are subjected to high speed turbine agitator and at the end of 10 mins the pigmental stage must have been completed and the dispersion of the particle is being check with plastic knife and grinding guage. There is a pumping machine that pump the water and a instrumentation that switch off the pumping machine. At the end of the dispersion stage the control value is open and paints slurry goes into the master mixer that is tank C. Tank A is a pony mixer where the thickener (cellulose either) is




**Flow chart for the mixing of paint.**

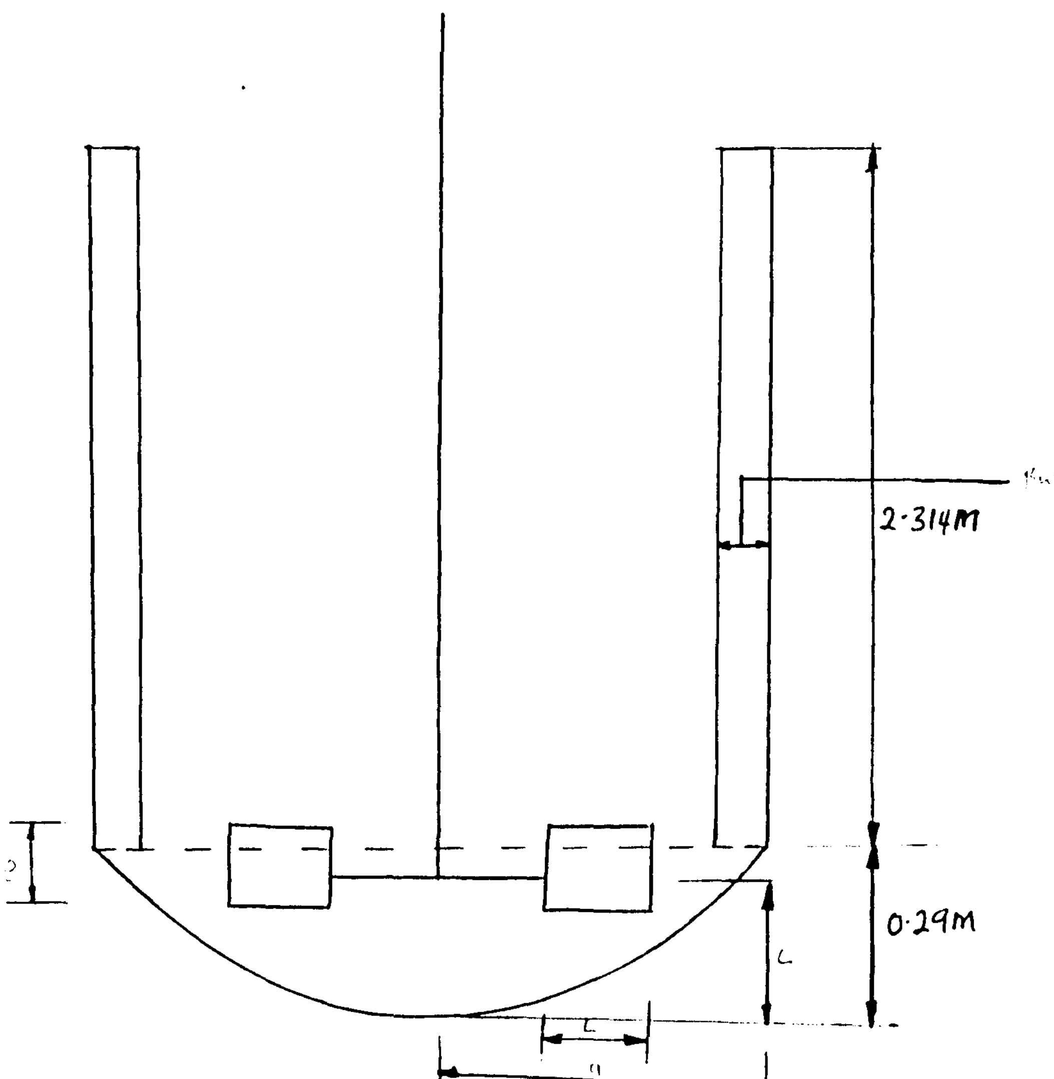



**Engineering Flow sheet for the mixing of paint.**

premixed with water, and aticide. The three component in tank A is allowed to mix well until gel is formed and at the end, the visicous liquid is allowed to flow into the master mixer (tank C) and mixed together with the slurry from tank B. In tank C the paint slurry is allowed to mix well and all other additive are added; the visicousity and the PH of the paint are checked in the master mixer and water is added to adjust the viscousity. The sizing of the master mixer is given the detail design stage. Also binding of all the components was done in tank C with aid of the binder (PVA).

After mixing, the paint is transfered to the next lower floor, where it is thinned and tinted in agitated tanks wihich may hold batches of several thousand litres. The liquid paint is streamed into a transfer tank or directly into the hopper of filling machine or the floor below. Centrifuges, screens or pressure filter are used to remove non-dispersed pigment. The paint is poured into cans or drums, lebelled, packed and move to storage.

## 5.14 SIZING OF THE MIXING VESSEL




The mixer is make up of the cylnderical section and capped with a semi elipsoid at the bottom.

V = volume of cylinderical section + volume of the elisoid.

Capacity = 5000liters = 5m3

batch

safety factor = 20% = 20 x5 = 1

100

Total  volume = 5m3 + 1m3 + 6m3

Volume of cylindrical porton = ^ D2C/4

Volume of semi elipsoid = 4^ab2/6

where a : b = 3:1

i.e a/b = 3/1

3b = a

b =a/3

from the figure 1

a = 0.5D

therefore,

B=0.5D

3

Also, Nr = 1.3D.

Total volume = volume of cylinder + volume of elisoid.

6/ = ^D2L + 4^ab2

4        6

6/ + ^D2(1.3D)  + 4^(0.5D) (0.5D/3)2

4        6

6 = 1.3 ^ D3/4 + 4^(0.5D) (0.25D2/9

4        54

324 = 17.55D3 ^ + 0.5 ^ D3

324 + D3 [17.55 + 0.5] ^

324 = D3 [18.05^]

D3 = 324   =   324

18.05^   56.706

D3 = 5.714

D = 3√5.714   =   1.78m

Diameter of agitator d = 1/3 D

Turbine dimension d = 1/3 x 1.72 = 0.593m

e=1/5 d

e = 1/5 x 0.593 = 0.119m

L = 1/4 d

L = 1/4 x 0.593 = 0.148 m

wide of baffle Bw = 1/10 D

=1/10 x 1.78 = 0.178 m.

ance of agitator to the bottom of the vessel C=1/3d

C=1/3 x 0.593 = 0.198

Therefore,

Total height of the vessel

= Hv + b.

= 1/3D + 0.5D/3

T = 1.3 x 1.78 = 0.5x 1.78 / 3

T = 2.314 + 0.2967

= 2.6107

T ~ 2.61m

nght of baffle is given by

Lb = D + b

Lb =1.78 + 0.5D / 3

Lb = 1.78 + 0.5 x 1.78 / 3 =2.1m

## 15 CHEMICAL ENGINNERING DETAILED DEESIGN

To get the agitator power requirment using Budrman and other correlation for differences in physical operities of suspended solid.

$$Nc = [Dp/Dp\ sand]^{0.2} \quad [q/qsand]^{0.8} \quad [B/Bsand]^{0.13}$$

correlating the particle used with sand particle

DpSand = 200NM

qsand = 1.59

Bsand = 11.1 [100 x weight of solid ]

[ weight of liquid ]

Dp - particle diameter = 100

q - density of particle = 100

B- 100 x $\frac{\text{weight of solid}}{\text{weight of liquid}}$ = 129.4

therefore,

$$Nc = \left(\frac{100}{200}\right)^{0.2} \left(\frac{1.55}{1.59}\right) \left(\frac{129.4}{11.1}\right)^{0.8}$$

Nc = 1.18

change in power = $(Nc)^3$

change in P = $(1.18)^3$ = 1.629

P/V =2.1 hp/1000 gal per sand

for the particle of paint used,

$\frac{p}{v}$ = 2.1 x 1.629 = 3.42 hp / 1000 gal

but volume = $5m^3$ x 264.17 => 1320.85 gal.

$p = 3.42 \times \frac{1320.85}{1000} = 4.52$

p = 4.52 hp x 0.74624 = 3.37 kw

p = 0.67 $kw/m^3$.

Density of paint slurry = $1.452/cm^3$

= $1.45 \ g/cm^3 \times 0.016018$

= $90.52 \ lb/ft^3$

Np = 1.27 for four blade turbine impeller

$$(N)^3 = \frac{Pgc}{Np\ q\ Da^5} = \frac{4.52 \times 550 \times 32.17}{1.27 \times 90.52 \times 1.99^5} \quad Da = \frac{1.78 \times 3.35}{3} = 1.99.$$

= $\frac{79774.62}{3587.68}$

3

N = 22.3

N = 3 22.3

Rotation speed N = 2.81 rps

168.6 rpm.

Turbine impellers move with a speed between

150 - 300 rpm.

## 5.16 MIXING TIME

From the literature the nixing time for liquid-soldi in a well agitator batch reactor is given by

$0 = 12,000 (NV/P)^{1/2} (V/1.0m3)^{1/5}$

where N is in = 0.75

P is in w/m 3 = 0.67 kw/m3

V is in m3 = 5.3

O is in secs

therefore

$O = 12,000 (0.7 \times 5/0.67 \times 1000)^{1/2} (5/1)^{1/5}$

$O = 12,000 \times 0.0748132 \times 1.3797297$

O = 1238.6639 secs

O = 20 mins. 6 secs

## 5.17 TIME TO EMPTY THE TANK

The time requireed for a paint to discharge from a tank by gravity is a funcction of the tank size and geometry, the discharge pipe size and geometry, the presure difference between the inside and the outside of the tank and physical properties of the paint.

The time to empty the tank is given by

$$t = [ ( Z1 = PA - PB/qg)^{1/2} - [ Z2 + PA - PB/q) ]^{1/2} \; 2Dr^2/d \; \frac{1+8 ( R/qN2) L/d}{2g}$$

d = 100mm = 0.1m = pipe diameter
D = 1.78m

1) $\frac{2\,Dr^2}{d^2} = \frac{2 \times 1.78^2}{0.1^2} = 633.68$

2) $[Z1 + \frac{PA - PB}{qg}]^{1/2} \Rightarrow$

PA - PB = q air gz
= 1.225 x 9.81 x 2.28
= 27.4 N/M2

therefore

$$[3.11 = 27.4/1450 \times 9.81]^{1/2} = 1.764$$

(3) $[Z2 + PA - PB/qg]^{1/2} \Rightarrow [0.5 + 27.4/1450 \times 9.81]^{1/2}$

$\Rightarrow 0.7085.$

(4) To estimate the value L/d

actuall L/d = 2/0.1 = 20

but from the table the standard radius $90^0$ elbows L/d = 32

the gate value = 7

L/d = 20 + 32 + 7 = 59

(5) E/d Also from the table the roughnesss of pipe surfaces E for commercial steel and wrought iron = 0.00015 ft.

and the diameter in ft = 0.328

therefore

$$E/d = \frac{0.00015 \text{ ft}}{0.328 \text{ ft}} = 4.575 \times 10^{-4}$$

To estimate

$$\left(\frac{R}{\rho u^2}\right) N_{Re}^2$$

$$h_g \sim P_A - P_B / \rho g = 27.4 / 1450 \times 9.81 = 1.926 \times 10^{-3}$$

aint viscousity N = 0.75 kg /ms

$$\left(\frac{R}{\rho u^2}\right)(N_{Re})^2 = \frac{h_g (\rho^2 d^2 g)}{4 (L/d) N^2}$$

$$= \frac{1.926 \times 10^{-3} \times 1450^2 \times 0.1^2 \times 9.81}{4 \times 59 \times 0.75^2}$$

$$= 2.992$$

form the chart of friction factor dimensionless againt renold number BRu dimensionless
NRe = 1.2

$$\left(\frac{R}{\rho u^2}\right) N_{Re}^2 = 2.992$$

$$\left(\frac{R}{\rho u^2}\right) = \frac{2.992}{(1.2)^2} = 2.077$$

(7) $\dfrac{1 + 8 (R/\rho u^2)\ L/d}{2g}$

$$\frac{1 + 8 \times 2.077 \times 59}{2 \times 9.81} = 7.072$$

therefore

t = (1.764 - 0.7085) 633.68 x 7.072

t = 4730.1018 secs

1hr.19mins

## 5.18 COST OF THE REACTOR

Purchased equipment cost for turbine agitators. Cost includews motor, speed recher and impeller ready for insdtallation on the vessel

1982

CBm = FBm x Cp

1982

CBm = 2x500 10,000

as at 1982

but cost index 1982 = 3.15

and from fig 5.1 cost index 1998 at 10% inflation

0

Rate = 1000

therefore,

1982 1982

C = C

Bm Bm x Cost index 1998 / Cost index 1982

1998

C = 10,000 X 1000/ 3.15 = #31.746

Bm

As at November N 85.00 = #1.00

Therefore, #31746 = N2,698,410

## 5.19 MATERIAL OF CONTRUCTION

Stamless stel and carbon steel could be used for thr material of construction of paint reactor. All the raw material used in production of water based paint are not corrsive to the material mentioned above. But for the fact that staless steel are more expensive than carbon steel. Therefore, carbon steel is preferred. Carbon steel is the commonly used enginnering material; it is cheap, is availble in a wide range of standard forms and sizes, and can be easily worked and welded. It has good tensile strength and ductity.It is suitable for use with most organic solvent and most solvent used in paints manufacting are organic innature e.g Mono ethylene glycol. And also the PH of paint is alomst at the neutral point, that is the paints slurry is neithe acidic or basic in nature.

## 5.20 HEALTH AND FIRE HARAZRD (SAFETY)

Many of materila used in paint manufacture are potentially hazaradrous if mishandled, but e risks are generally well understood and only elementary percussion are required of the user. Among gments the compounds of lead and heavy metals have attracted particular notice because of the hazard to oung children with the habit of chewing or sucking flakes of old paint. As noted above, lead pigments are ow little used in decorative paints but some industries have organised action to remove or cover up old lead ase coating. It should be understood however, that a small proportion of lead compounds is necessary for he rapid drying of substantial cost in both price and performance. Appreciable levels of lead continue to be sed in industrial finishes where application by spraying is subject to control.

The solvent benzene is now rarely used because of danger of the lungs. Precaution are necessary with hlorinated solvent, and adequate ventilation is recommended with all spraying operation. It is also advisable o avoid contact with the skin and eyes.

Certain specialized materials present unusual hazards. Thus nitrocellulose (another form of which is also know as guncotton) is classified as an explosive, while the recently introduced power coatings (dry paints) are potentially capable of giving vise to dust explosions.

Most organic substances are combustible, that is, they will influence if heated strongly enough. The flash point which indicate the degree of flammability of a solvent, is the lowest temperature at which the vapour collected in a closed space ignites on the introduction of a small flame. The precaution to be observed in paint industry is that the temperature should not exceed 30 c for water based paints. Flameproof electrical equipment should be used.

Virtually, there is little or was for the water base paint reactor. The only disposable waste is got when the reactor is washed and waste is disposed in a soakage since it is biodegradable.

## 5.21 POLLUTION CONTROL

Industry as a whole has become increasingly conscious of its responsibility to avoid damage to the environment. This had led, in the paint industry, to close control of solid and liquid wastes. There has been some interest in the recycling of solvents, or their elimination in solvents coatings or power coating. There has also been a marked trend to water, based coating and much effort has been devoted to the search for a full gloss emulsion paint.

A side effect of pollution control has been some scarcity of titanium dioxide. Titanium dioxide do not give rise to coloured effluent. The widely used sulphate process for its manufacture gives rise to large quantities of coloured effbuent. So if there is shortage of T102. no is preferred.

## CHAPTER SIX

## 6.0 DISCUSSION OF RESULTS

From the table of result, it is was found that most of the properties tested for was able to meet the expected result.

In the result obtained from the viscosity test, the product was found to have a viscosity of 12 poise which mean the paint slurry is too viscous than the standard viscosity which is between 75 poises - 10 poises. However, water been the solvent of the medium was used to thin down the viscosity of the to 75 poises so as to be able to get the best performance from the paint produced.

The dispersion test was carried out during the mixing up of the pigment and the extender. The particle of the mixture was completely dispersion and the calibrated grading guage was used confirm the particle size and it confirmed the expected result which was blow 25 unicorn of particle size.

The drying test was carried out, it was found that it exhibit excellent drying qualities for both touch and normal hard dry and also the surface cating drying rate respectively as show in the table of result.

The specific gravity and weight our liter test was also carried out and it was found that the specify gravity of the paint produce was 1.45 which the weight per liter was 1.45 g/liter and the required weight per liter for water based paints ranges between 1.44 to 1.47. The result gotten show an indication of effective mixing of the medium and the appropriate range of pigment to binder ratio of the paint and volume pigment percentage of the paint produced.

The opacity test was carried out and it gives a neatly and well covered film as indicated on the wall. The adhesion capacity of the paint was also found to be very high due to it ability to break on palm rubbing of the film formed.

Sheen and glossiness was found to be relatively okay through, sunlight matting of the paint occur on test, which is due to high percentage of extender - precisely caco3 used; Also its exterior and interior durability over the little time available has been found to be okay on comparison with other standard products.

The whiteness of the paint (which was as a result of the pigment and caco3) too is also brilliant enough when check with the standard white on paint chart of paint producing companies.

The pH of the paint gotten was too high when compare with standard calibrated chart and it was adjusted with $NH_3$ to pH no. which is expected to be the best for water based paint.

## 6.1 ECONOMIC ANALYSIS

The analysis of the market prices for the raw materials used shows cheaper pricing for the raw material in table 4.2. However, on comparison with the pricing of actual raw materials enguage in paint industry shows a cheapter overall price of production for paint produced.

In the research work, imported raw materials was substitute in order to have a cheaper overall production rate which is shown on table 4.2 in which zinc oxide (Zinc) was used as a substitute for Titanium dioxide (T102) and T102 was reduced by 48.8 percent which lead to about 34.4 percent cost cut on the usage of Zinc oxide as pigment however, on comparison of table 4.3 and table 4.2 it was found that there is higher price for the overall production on usage of T102 as pigment only as shown on table 4.3.

Also, synpernic Nx was substituted for Genapur. The usage of synperonic Nx actually have access to easily available and cheaper wetting agent (to aid dispersion). Though, synperonic have the same flow rate, viscosity and pH with Genapur and it is cheap and readily available. From the pricing of raw material and costing of product proceed, it was found that the cost of a 4 liter container of the paint produced was N634.78 while that of standard companies cost between N850 to 950; the price is shown on table 4.4.

However, the total amount saved by customer on purchase was found to be about 34% of which is the sum of N331.76 on purchase. Hence, it could be deduced that with the new product more money is saved and consumer purchasing power is increased.

# CHAPTER SEVEN

## CONCLUSION AND RECOMMENDATION

In the experiment performed, the result obtained are as follow, viscosity test was 7.poises, Dispersion test was below 25 microns of particle size and and weight per liter at 1.45g/liter.

The drying time, the opacity and adhesion characteristics were found to confirm with expected result.

The economic analysis when carried out, it was found that there was 34% cost cut, however, the aim of the project work was achieved, hence the usage of zinc oxide is found to be suitable also the utilization of synperonic for wetting agent of the medium was also found to be effective.

All the substituted material are readily available and very cheap comrade to the very expensive ported materials. The synperonic Nx substituted for Genapur has the same flow properties, viscosity and the both have the same pH and it is marketed by Doyin group of company in kwara state.

There are still some locally made pigment that can be substituted for T102 like Gyposium (caso .21+2O), hydrated potassium mica or Biotthe or muscovite (6si0.H2O) in which the chief Ore can be found around Egbe area (kwara state) Ifedan Ijero Ekiti (Ekiti state). Majority of the paint constitute can be source locally in Nigeria. At least about 70% of the raw materials can source locally.

However, the utilization of cheaper and locally available raw materials is the only solution to the ever increasing price of paint.

During the course of this experiment, I went through so many difficulties one of which is Money. Because many of the paint industries do not ready to release there company's formulation therefore a lot of money was wasted on chemicals during the formulation and mixing up of the paint film.

I, therefore recommend that the department should find a way of assisting student undertaking final year project.

<u>APPENDIX</u>

# NOMECHATURE

Hv = Height of cylindrical vessel

b = Height of the elisoid

Bw = Baffle width

LB = Lenght of baffle

C = distance of agitator to the bottom of the vessel

d = diameter of agitator

T = total height of the vessel

P = change in power

N= Rotation speed

O = Mixing time

t = time to empty tank

CBm = base module capital cost

Cp = cost price

FBB = Installation factor, the purchase cost of equipment multiplied by this factor yields bare module cost.

sp = density of paint

<u>Data</u> E.M.C. Raw material cost

sp = 1450 $kg/m^3$

conversion rate of doller to Naira as of Dec '98 N85 - $1

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