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THE DESIGN AND FABRICATION OF 500 KILOGRAM PER BATCH DOMESTIC PAINT PILOT PLANT

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ABSTRACT

A 500 kg per batch domestic paint pilot plant consisting of Water tank (TO1), Geneform tank (TO2), PVA tank (TO3), Ammonia tank (TO4), Premixer (MO1), Paint mixer (MO2), Mixer Pump (PO1), Filter pump (PO2), and Filter FO1) was designed and fabricated based on a combination of QWATE and Kroma Technologies. Various emulsion paints consisting of Pigments (CaCO3), Kankara kaolin clay and TiO2, Binder (PVA), Solvent (H2O) and Additives (deformer, ammonia, silicate and anticide in approximate proportions were produced using the fabricated plant. Properties of the paint such as opacity, durability, ease of application, cover were assessed before and after application using standard methods. The results revealed that the paints produced gave different hues and colours, easily produced, were of high quality; good cover, good aesthetic appeal, fast to light, durable after being applied on walls and found wide application domestically.

1.0 INTRODUCTION

Paint is coloured substance that, when applied to a solid material or spread over a surface and allowed to dry, leaves a thin decorative or protective coating (layer). In other words, paint is a solution of a pigment in water, oil or organic solvent used to cover wood or metal articles either for protection or for appearance (Austin, 2004.) Paints are formulated for specific purposes; **outside house paints** and **exterior varnishes** and are intended to give good service when exposed to weathering; interior wall paints are formulated to excellent coverage and good wash ability; whereas **lacquers** are formulated for rapid drying.

With the exception of artists paints and marking materials, all paints can be regarded as having the **dual functions of decoration and protection**. Decorative paints and varnishes place emphasis on decorative function (aesthetic characteristics) such as colour and gloss rather than protection. Exterior paints and varnishes place equal measure of importance on both decorative and protective functions (Kalu,2006)).

Household paint which are broadly categorized into **oil-based paints** are thinned with mineral turpentine or other organic solvents and **emulsion paints** which may be vinyl or acrylic based which are thinned with water. **Enamel paint** used for coating household appliances – washing machines, stoves, kitchen cabinets, refrigerators etc. Bituminous paints used for the protection of piping and tanks and for water proofing concrete, heat resistant paints e.g. aluminum pigment in a silicone resin which can withstand temperatures of 2500F, mansory paints e.g. road marking paints, casein paints which consists of pigments and extenders in a casein solution. Examples of domestic paints are: latex paint, acrylic paint which are water-based used

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commonly for interior walls, Oil-based paint used for interior walls, exteriors and doors, enamel paints which are good for spaces with high humidity e.g. kitchens and bathrooms.

There are four major steps involved in the manufacturing of paints:

Preassembly/premixing; in which the liquid materials (e.g. resins, solvents, oils and /or water) are mixed in containers. Pigments and other solid raw materials are added to the liquids to form the viscous (thick) mill base, grinding/milling/dispersion; the mill base is processed further by milling to break up aggregation and agglomerates (cluster) of solids thereby producing a uniform dispersion of finely divided solid particles in the liquid vehicle. Milling consists of wetting, grinding and blending.

Product finishing/blending. This is achieved by thinning, tinting and blending. Thinning consists of diluting the milled dispersion with binder, solvents and /or diluents to achieve product characteristics such as viscosity, drying time, etc. tinting refers to adjustment of the product colour by the addition of tinting base**. Filling.** This refers to adding fillers (minerals, polymers or organic compounds) to enhance properties such as texture, viscosity, strength. The process also involves transferring the finished blend to holding tanks or hoppers and is pumped or gravity fed through filters to remove solid impurities such as pigment agglomerates, dust, skinned resin, etc.

2.0 MATERIALS AND METHODS

2.1 Paint Raw Materials

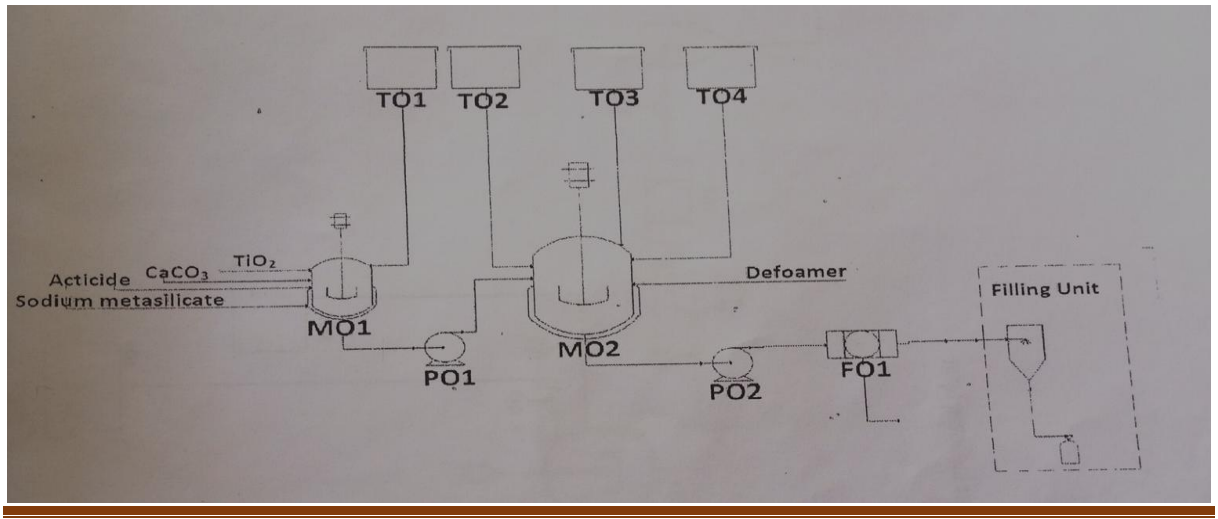
Kankara kaolin clay

Pigment (TiO2/ Fe2O3, CaCO3)

Solvent (water, geneform)

Binder (PVA- Polyvinyl acetate)

Selected technology process flow diagram



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2.2 Legends

PROCESS UNITS	LABELS
TO1	Water tank
TO2	Geneform tank
TO3	PVA tank
TO4	Ammonia tank
MO1	Premixer
MO2	Paint mixer
PO1	Mixer pump
PO2	Filter pump
FO1	Filter

2.3 Fabrication of the Paint Pilot Plant

The basic components of the pilot plant namely: water tank, geneform tank, PVC tank, ammonia tank, premixer and paint mixer were fabricated separately using engineering methods according to specifiactios (i.e. the required length, height and width). The mixer pump, filter pump, filter and electric pump consisting of 3hp capacity electric motor were purchased. A careful choice of the materails for construction was made for optimum results, maintenance and durability.The components were assembled together according to mechanical and electrical engineering techniques and expertise. After the assembly, the pilot plant was test run for efficiency of productivity, power and reliability.

2.4 Process Description

The selected process flow diagram is shown above. The crushed Kankara clay was charged to the premixer. Half the water in tank TO1 was charged into the premixer MO1 by gravity where it mixes with the Kaolin clay.

Other solid components which are TiO2/ Fe2O3 in alternate, CaCO3, acticide and sodium metasilicate were charged manually into MO1 just as the stirring in MO1 was done continuously.

Pump PO1 then channels the paste in MO1 to the mixer MO2 while the remaining water in TO1 was used to wash the paste left in MO1 into mixer MO2 via PO1.

Kerosene and ammonia in tank TO2 and TO4 respectively were then charged into MO2 by gravity just as stirring was carried out continuously. Geneform was added so as to improve the quality of paint to be produced.

Finally, the binder (PVA) in tank TO3 and defoamer were charged into MO2 to bind all the components together to avoid phase separation.

This stirring was for a duration of 60 minutes to ensure appropriate homogeneity. Pump PO2 then pumped the paint to the filter FO1 to remove any undissolved solid particles and then flown by gravity to the filling unit for packaging into containers.

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3.0 RESULTS AND DISCUSIONS

Having assessed key efficiency parameters of the pilot plant such as transfer efficiency (TE), flow rate (output capacity), viscosity control, high volume low pressure (HVLP) and operator technique (OT), performance evaluation on the plant gave a high production rate of the emulsion paint (500kg equivalent to 500 liters per batch in 30 minutes) at relatively low cost.

The paints so produced were of two colours; white emulsion paint based on Titanium dioxide (TiO_2) pigment and red emulsion paint based on Iron III oxide (Fe_2O_3).

The appearance of the paints was of good texture, smooth and bright indicating homogenous mixture of the pigment.

The rheology of the paints gave a consistent flow which was an indication of good viscosity which enhanced spray during application. When applied on wall surfaces, the paints gave an adequate deep cover which was a clear indication of a reasonable opacity; an important property of an emulsion paint. The paints dried easily on application with no bleeding, giving bright shades and showed little or no significant fading, implying excellent fastness property after exposure to light for a long duration of time. The inference drawn from these properties is that the paints produced are easy to apply, have very good aesthetic appeal, cost effective, affordable and highly durable.

4.0 CONCLUSION

A paint mixer aimed for domestic use was designed and fabricated locally. Production of paints on the machine simply consisted of dispersing and stabilizing pigment particles, a binder (resin), additives and a vehicle (solvent). Combining these ingredients formed a paste, which was then put through a sand mill which broke them (silica) to smaller particles, scattering and blending them evenly throughout the mixer.

The type and amount of each component determined the performance such as, adhesion, coverage, durability of the paint.

The fabricated mixer produced 500kg per batch of paint consisting of locally sourced (available) raw materials such as (Kankara kaolin clay), Pigment (TiO_2/Fe_2O_3, $CaCO_3$) Solvent (water, geneform), Binder (PVA- Polyvinyl acetate). A Full description of the paint production process was given. The results of the findings gave a good insight of the availability of paint raw materials locally in Nigeria and the use of simple, cheap and easily operated technology to produce high quality, yet affordable paints for domestic application.

Considering the high cost of foreign exchange and its weight on importation of raw materials and machinery on developing countries such as Nigeria, it was thought wise to use local raw materials and simple technology at relatively cheaper cost to produce paints for domestic use. This is in addition to providing entrepreneurial opportunity to our teaming unemployment indigenes.

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