

## Formation of an Oil Paint Using Alkyd Resin from Soyabean Oil

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**Abstract:** Soya bean oil was extracted from Soya bean seed. The colour of oil is pale yellow and the percentage oil content of the Soya bean seed was found to be 57.6%. The oil was reacted with glycerol at a temperature of about 250-260°C to convert the oil to its monoester. The resulting product was polymerized with phthalic anhydride to produce an alkyd resin. The resin product was highly viscous fluid with a light brown colour. An oil paint was formulated with the resin product as the binder and titanium dioxide as pigment. The paint is white in colour. Many tests were carried out and the results showed that the paint compared well to standards.

**Key words:** Soya Bean Oil • Alkyd • Resin And Paint

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### INTRODUCTION

The term paint is normally used to describe any liquid, liquefiable or mastic composition that, after application to a substrate in a thin layer, is converted to a solid film [1]. It can also be used to describe liquid material before application and coating after it has been applied and dried. The purpose of paint is to protect the surface of metals and wood from attack by rain, dust and gases in the air, it can also be applied to impart beauty and protection [1].

Paint is the group of emulsions generally consisting of pigments suspended in a liquid medium used as decorative or protective coating [2]. Its earliest appearance was recorded 30,000 years ago [2].

New colours were also first discovered in Egyptian blue dates around 500BC and red Lead was discovered by accident in 2500BC [3].

Renaissance–In the 16<sup>th</sup> century they discovered easier way to extract the intense warm blue (ultramarine blue). Cobalt blue glass offered a brilliant sky blue, though this had to be scattered on paint vanish to get full effect [3].

In the 1620s, the Dutch greatly increased the availability of white lead and lowered the cost by invention of the stack process. Later in the century, vermilion a manmade type of pigment was developed, as was king's yellow [4].

18<sup>th</sup> century- The discovery of Prussian blue provided a much needed intense deep blue, readily available after 1724.

19<sup>th</sup> century-Painting had received a rapid and strong impulsion, which finally led to the great painting of the Renaissance. But the technique is not enough alone to create a near perfect art and many improvements would be yet achieved. Each following generation will bring his brick to the building.

Oil is able to dry and polymerize to a semi-fluid state if it contains enough unsaturated fatty acids preferably di-or tri-unsaturated [4]. The participation of mono-unsaturated (oleic) acid is not well known but rather limited [5].

Since several years, varieties of vegetable and non-edible oils are used in paint industry as they are able to dry quickly, sometimes more quickly than linseed oil. gsoyabean oils [6]. The drying process itself results in a polymerization upon uptake of oxygen. The complex mechanism includes mainly the oxidation degradation

of unsaturated fatty acids leading to formation of aldehyde groups later transformed into carboxylic groups. Thus dicarboxylic acid are progressively formed with aging of the mixture. Pimelic, suberic, uzelaic and subacic acids being mainly found in an old paint [7].

The main components of paints are binders, diluents, pigment and additive. The binder, commonly called the vehicle, is the film-forming component of paint. It is the only component that must be present [3]. It is the part of the paint in which the pigment is suspended.

It is often referred to as carrier, just as anything else is used to carry something. The binder imparts adhesion and strongly influences properties such as gloss, durability, flexibility and toughness. Binders include synthetic or natural resins such as alkyds, acrylics, vinyl-acrylics, vinyl acetate/ethylene (VAE), polyurethanes, polyesters, melamine resins, epoxy, or oils [4]. Binders can be categorized according to the mechanisms for drying or curing. Although drying may refer to evaporation of the solvent or thinner, it usually refers to oxidative cross-linking of the binders and is indistinguishable from curing. Some paints form by solvent evaporation only, but most rely on cross-linking processes [5].

Diluent is the volatile component of paint and does not become part of the paint film. The main purposes of the diluent are to dissolve the polymer and adjust. It also controls flow and application properties and in some cases can affect the stability of the paint while in liquid state [6]. Its main function is as the carrier for the non volatile components. To spread heavier oils (for example, linseed) as in oil-based interior house paint, a thinner oil is required. These volatile substances impart their properties temporarily once the solvent has evaporated, the remaining paint is fixed to the surface.

Pigment and Fillers can be seen as solid powder which may be fine or appear as grains [6]. Pigments are granular solids incorporated in the paint to contribute color. Pigments can be classified as either natural or synthetic and inorganic and organic in composition. Inorganic pigments contain both coloured and white pigments while the organic are all coloured [7]. Natural pigments include various clays, calcium carbonate, mica, silicas and talcs while Synthetics include engineered molecules, calcined clays, blanc fixe, precipitated calcium carbonate and synthetic pyrogenic silicas.

Hiding pigments which include titanium dioxide, phthalo blue, red iron oxide protect the substrate from the harmful effects of ultraviolet light. Fillers are a special type of pigment that serve to thicken the film, support its structure and increase the volume of the paint.

Some pigments are toxic, such as the lead pigments that are used in lead paint. Paint manufacturers began replacing white lead pigments with titanium white (titanium dioxide), before lead was banned in paint for residential use in 1978 by the US Consumer Product Safety Commission. The titanium dioxide used in most paints today is often coated with silica/alumina/zirconium for various reasons, such as better exterior durability or better hiding performance (opacity) promoted by more optimal spacing within the paint film.

Besides the three main categories of ingredients, paint can have a wide variety of miscellaneous additives, which are usually added in small amounts, yet provide a significant effect on the product. Some examples include additives to modify surface tension, improve flow properties, improve the finished appearance, increase wet edge, improve pigment stability, impart antifreeze properties, control foaming and control skinning [8]. Other types of additives include catalysts, thickeners, stabilizers, emulsifiers, texturizers, adhesion promoters, UV stabilizers, flatteners (de-glossing agents), biocides to fight bacterial growth and the like.

Additives normally do not significantly alter the percentages of individual components in a formulation [9].

Scientific reasons were advanced that pigments make opaque and lasting coatings consist of several component including resins, vegetable oils and solvents. Vegetable oil impart valuable properties to coating but in order to furnish these properties, the oil must be incorporated into the formulation either by cooking, simple blending or by melting resins into the oil.

Soyabean oil is generally supplied as refined oil characterized by pale colour, low odour and low acidity substitutes for linseed oil as a drying time regulator and to reduce yellowing. The main advantages of using this soyabean oil is that the need for traditional solvent as white spirit can be effectively eliminated which leads to the following benefits:

- Zero volatile organic content.
- Eliminate healthy risk associated with solvent in respiratory systems.

- Environmental friendly, solvent free and 100% biodegradable in nature.
- Brushes and other equipment can be easily cleaned with water.
- Minimize fire risk.

**Aim of the Research:** The main aim of this research is sourcing of local raw material used for the formulation of oil paints. Emphasis was on improving the quality of alkyd resin using low cost soyabean oil as alternative for high cost oils like linseed oil.

### MATERIAL AND METHODS

The basic operation in manufacturing of paints (oil based and water based) is the dispersion of pigment in the paint media. There variation in composition and handling methods. The procedure for both paint production are outlined below:

- Mixing of the binder and solvent to form the vehicle.
- Dispersing pigments in some area of the vehicle to form a paste with addition of some additives.
- Thinning by the addition of solvents and vehicles.
- Straining and clarifying to remove coarse particles.
- Checking/ controlling the physical properties to conform to specification.
- Filling, canning and packaging.

**Paint Formulation Principles:** This is the process of mixing the right kind of raw material (pigment film formers and additives) in correct weight proportions to provide paint with specific properties. The principles and experimentally determined facts of physics and chemistry is a special guide to the formulation of paints required to meet special conditions of domestic and industrial use. The following requirements are considered before any formulation

- Consistency in the viscosity.
- Appearance (e.g colour).
- Package conditions.
- Application properties : type of coating- whether an exterior or interior and the type of material it will be applied on.

**Extraction of Oil:** Soya bean oil (Glycine max.L) can be extracted continuously using the hydraulic presses introduced at the beginning of the 19<sup>th</sup> century. Modern solvent extraction methods use light paraffin petroleum

fractions, such as hexane or trichloroethane in extraction [9]. The seed is separated from the spiny husk mechanically or by sun drying in the open until the casing splits. The soya bean oil was extracted by variety of process or combination of processes to remove the bulk of the oil remaining in the press cake, crude soyabean oil is pale coloured oil, but turns colourless after refining and bleaching.

**Sample Collection:** The soyabean seeds were collected from the market, dried under the sun, ground and soaked in n-hexane, the whole set was left for two days, the extracted oil and the solvent were collected. The oil was separated from the solvent using simple distillation and heating at temperature between 60-80°C. The distilling solvent was condensed and trapped in the thimble, while the oil remained in the round bottom flask

$$\begin{aligned} \% \text{ oil} &= \text{weight of oil/weight of seed} \times 100/1 \\ &= 130/22.8 \times 100/1 = 57.6\% \end{aligned}$$

**Synthetic of Alkyl Resin:** Alkyd resins were prepared by reacting polybasic acids and polyhydric alcohol with an oil or fatty acid. Fatty acid method was used. This involves direct esterification of phthalic anhydride and glycerol at a temperature range of 210-240°C. The alkyd produced from the fatty acid method is diluted with oil to a desired concentration at an elevated temperature.

**Sample Preparation:** White oil based paint was produced by mixing thoroughly the raw material below with stirrer.

**Quality Control Test on the Formulated Paint:** The adhesion of a paint to a surface depends on good wettings and therefore on the cleanliness of the surface. In practice, it is impossible to remove all impurities and paints must therefore tolerate degree of dirt [3, 4]. Thus it is likely that tolerance of dirt is an important factor in the adhesion

Table 1: List of raw materials and quantity used

Raw materials	Quantity Used (g)
Pigment(TiO <sub>2</sub> )	50.0
Kerosene	70.0
Alkyd resin	130.0
Mixer drier (cobalt, lead & manganese)	10.0
Antiskin	5.0
Zinc Naphthanate	5.0

**Procedure:** A rough asbestos plate was cleaned properly and allowed to dry. A coat of the paint was applied and allowed to dry for hours. Adhesive tape method was used. A piece of pressure sensitive adhesive type was applied to the panel and the area covered by the tape cut round through to the asbestos with razor blade. The end of the tape was then pulled sharply at right angle to the panel.

**Water Resistance:** This test was carried out to show the stability of the paint in the presence of water swelling, blistering and absorption. Moisture absorption taking place in paints can lead to swelling of the film and if this severe blisters form. However, highly pigmented films exhibit less swelling but the greater permeability to both air and moisture can lead to severe blistering.

**Procedure:** In this test initial panel was used. After application of paint sample on the panel the brush out were allowed several hours (about 24h) to dry. The test panel were immersed in a beaker of water and allowed to remain for 48 hours

**Drying Time:** Drying time is the time required of paint from time of application to dry to hard resistance film. Drying mechanism involves paint drying on the surface but remains soft and tacks beneath. This requires special type of drier like zinc Naphthanate.

**Procedure:** The paint samples were applied and the time was noted. They were then allowed to remain for some time being monitored at some interval.

**Brushability and Weathering Test:** Brushability is the ease with which paint flows as it brushed on a surface. It depends very much on the viscosity of the paint in question.

**Procedure:** A hard brush was used to brush out the paint samples. After the brush out, the paints were exposed to the atmosphere to determine the effect of weather change on it. The two most important agents of weathering are sunlight and rain.

## RESULTS AND DISCUSSION

**Drying Time:** Drying time of paint depends on the environment, mainly on temperature and humidity. The result revealed that oil paint had the drying surface time of 24 hours which is in conformity with the standard.

Table 2: Summary of the results

Colour	Excellent
Drying time	24 hours
Adhesion	Excellent
Resistance	Good
Brush	Very Good

The paint film applied on a brushed tinplate pane became hard dry in not more than 24 hours from the time of the application.

**Brushability:** The paint brush easily and possess good leveling property when applied at a spreading rate of approximately 10m<sup>2</sup> per liter to a cream faced, gypsum plaster board. These complies to the Standard Organization of Nigeria.

**Opacity:** Small quantity of high quality paint covers a given surface area whereas a paint of low quality requires a large volume to give coverage to the surface. This paint has good opacity and was able to cover well at not more than two coats which is according to the standard [7].

## CONCLUSION

An oil modified alkyd resin was successfully prepared from the soybean oil. The iodine value of this oil classifies it as semi drying. The drying performance of the alkyd resin appears quite good, hence exploitable for the formulation of an oil paint.

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