International Journal of Sciences & Applied Research

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Formulation of a Semi-Gloss Paint Using *Luffa aegyptiaca* Seed Oil-modified Alkyd Resin as a Binder

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Abstract

In this study, *Luffa aegyptiaca* seed oil-modified alkyd resin was used as a binder in the formulation of a solvent based Semi-gloss paint. The physicochemical characterization of the paint indicates that it's a good paint with relatively very low VOC emission which conformed with the standard of the environmental pollution regulatory bodies in terms of chemical toxicity. The formulated semi-gloss paint has a pH of 7.82 which is a good pH for domestic paints. The paint has viscosity of 128 centipoise which makes it suitable for application by either brush or spray. The formulated paint exhibited good adhesion, tackiness, opacity, flexibility and hardness properties. The paint also possesses good resistance to blistering; hence, it indicates that it has good external exposure resistance and thus; can perform well when exposed to environmental conditions such as rain and sun. The formulated semi-gloss paint has a drying time of < 2 hours and < 6 hours for surface dry and tack-free property respectively. The paint has a refractive index 1.48, this contributed in the glossiness of the paint. The paint also shows very good resistance to chemical mediums (Ionic, Alkaline and Acidic), hence, the paint possesses a good Stability and durability properties.

Keywords: Semi-gloss, Solvent based, Alkyd resin, Binder, Paint

Introduction

Paints may possibly be described as a colloidal combination of chemical ingredients, when diffused on a surface in a thin layer they form a dense, consistent and adherent layer [9]. They are used regularly in our life for ornamental purposes, and for preventing surfaces of being affected by different environmental influence as UV-radiation, chemical invasion and mechanical stresses [9]. Paints are mechanical mixtures consisting of pigments and extenders suspended in a vehicle (binder), in other words, paints are organic coatings applied to surfaces with the sole aim of imparting both protective and aesthetic functions [5]. Paints consist of a pigment dispersed in a substance usually called a vehicle or binder, usually

polymeric in nature which adheres to the substrate [2]. A vehicle (binder) is film-forming oil, to which other liquids are added [8, 13]. These liquids are diluents or thinners which are generally volatile liquids like mineral turpentine or organic solvents like xylol or acetone [13]. However, the diluents are classified as Volatile Organic compounds, VOCs that are known to be environmentally unfriendly [13]. Therefore, there is need to formulate paints that are environmentally friendly. Formulations such as oil modified alkyd paints, dimethylol urea formaldehyde paints and amino resins paints among others have been found to be environmentally manageable [14]. Paints constitute pigments, extenders, vehicle or binders, thinners and driers [8]. The composition of paint determines the type of paint which includes gloss paints, semi-gloss paints, Eggshell, satin or low sheen paint, flat paint or emulsion paint and latex paint [7]. Gloss paint is the toughest and most durable of all paints - and the shiniest, too. This very high sheen paint is often used on doors and in areas susceptible to getting dirty. It is also used for trim, baseboards and door frames [19]. Paints with a semi-gloss appearance are excellent for use on many of the same areas as gloss paints [19]. They are ideal for walls and wood works which are subjected to wear and these include kitchens and bathrooms, hallways, foyers, children's rooms, playrooms, doors and doorways, window and trim [19]. Perhaps, preparation of semi-gloss paints using materials obtained locally could be a positive idea in identifying raw materials that could be effective as a substitute to the conventional binders previously employed for such formulations [16]. Environmental pollution has been a matter of great concerns worldwide hence the need to check it [4]. In painting, when an organic solvent-based paint dries after application, large volumes of hydrocarbons are released into the atmosphere, and these affect air quality, at least temporarily at the site. Cumulatively, such paints contribute to the buildup of hydrocarbon in the atmosphere, polluting the air due to Volatile Organic Compounds (VOCs) [14]. This study aimed at formulating a semi-gloss paint using *Luffa aegyptiaca* seed oil modified alkyd resin (LASOMAR) as a binder.

Materials

Luffa aegyptiaca Seed oil modified alkyd resin (LASOMAR) was obtained from Department of Chemistry, ModibboAdama University of Technology, Yola, Adamawa State, from the Study carried out by [16]. Analytical grades reagents of $CaCO_3$ (Extender), TiO_2 (Pigment), PbO (Drier), Ethylene glycol, Kerosene, Thinner and Stabilizer. The glass wares used were 500 ml and 250 ml beakers, Glass rod, Electric Stirrer, Digital pH meter, Digital Refractometer and Gloss meter.

Methodology

A semi-gloss paint was formulated using the procedure outlined by [3]. A portion of 50 g of alkyd resin was measured and placed in a clean dry beaker; it was washed and rinsed with distilled water. Extender, $CaCO_3$ (10g) and pigment (TiO_2) 40 g were measured and added to the alkyd resin in the beaker and stirred continuously for about 30 minutes. Ethylene glycol and kerosene 1:1 (30g) were added also and stirred continuously for another 5 minutes. Stabilizer 2g was added and stirred for another 3 minutes and finally 5.0g of diluents (Thinner) was added and the mixture was stirred vigorously. The procedure of varying the quantities of ethylene glycol and kerosene (that is 2:1) was adopted. A semi-gloss paint was formed with a very glossy appearance which was ready for detailed study.

Table 1. Recipes for the formulation of a Semi-gloss paint

Components	Amount (g)
Alkyd resin (binder)	50
Extender ($CaCO_3$)	10
Pigment (TiO_2)	40
Driers (PbO)	5.0
Ethylene Glycol	15
Kerosene	15
Diluents (Thinner)	5.0
Butanol (Stabilizer)	5.0

Results and discussions

Results

Characterization of the Semi-gloss paint.

Table 2 presents the physicochemical properties of the semi-gloss paint formulated using Luffa aegyptiaca seed oil modified alkyd resin as binder.

Property	LASOMAR paint	Standard Organization of Nigeria (SON)
Stickiness	Pass	Pass
pH	7.82	7 – 8.5
Adhesion	Pass	Pass
Blistering	Pass	Pass
Viscosity (centipoise)	128	22 – 150 (NIS, 1990)
Glossiness	Pass	Pass
Opacity	Pass	Pass
Flexibility	Pass	Pass
Stability	Pass	Pass
Refractive index (27.8 °C)	1.480	1.47 – 1.50
Drying time Surface dry (hours) Tack – free dry (hours)	 2 < 6	 2 – 3 5 – 8

Table 3 presents the Chemical resistance of the Formulated Semi-gloss paint.

Medium	Distilled water	0.1 M HCL	0.1 M NaCl	0.1 M NaOH
Effect	a	a	a	a

Key: a= No effect, b= Wrinkle and c= Film removed

Discussion

Discussion on the physicochemical properties of the formulated Semi-gloss paint.

Some physical properties of the semi-gloss paint formulated from *Luffa aegyptiaca*seed oil-modified alkyd resin (LASOMAR) was given in Table 2. As seen from the Table, properties such as pH, viscosity, flexibility and opacity of the paints fall within the acceptable ranges for paints (SON, 1990). The paint exhibited good adhesion, tackiness and hardness properties as shown by SON, 2006. Resistance to blistering of the paint formulated was also provided in Table 2. The paint from the LASOMAR binder passed the resistance to blistering test. This result indicates that the paint formulated have good external exposure resistance as it has been reported for other oil paints [18]. This implies that the paint can perform well when exposed to environmental conditions such as rain and sun. The drying time of the formulated LASOMAR Semi-gloss paint met specifications for oil paints, the LASOMAR paint gives < 2 hours and < 6 hours for Surface dry and tack free respectively. The result can be compared with the < 2 hours and < 5 hours for surface dry and tack free respectively reported by [3] for *Ximenia Americana* seed oil-modified alkyd resin (XASOMAR) paint. The average drying time displayed by the paint can be associated to the nature of the oil (*Luffa aegyptiaca*seed oil) used to synthesize the binder (alkyd resin) [12]. The gloss results also indicated in table 2 show that the LASOMAR paint have gloss value within the range specified for a semi-gloss paint. The paint has a slightly higher gloss due to the higher refractive index of the paint which is strongly attributed to the degree of pigment dispersion and higher volume of the alkyd resin against pigment (Pigment Volume Concentration; PVC) [4]. The cream colour of the paint is attributed to the colour of the alkyd resin used for the formulation. The paint formulated passed the standard stability test because of the addition of butanol (stabilizer) during formulation. The paint formulated show better resistance to scratching. Resistance of coated material against scratching is a function of surface hardness [15].The viscosity of the formulated paint was also given in table 2. The range of viscosities observed for the paint sample makes it suitable for application by brush or spray. The interaction of various constituents determines its viscosity [1]. Viscosity affects the application and flow properties of a coating and is generally adjusted to the intended application [6]. According to [10], the minimum viscosity for gloss and semi – gloss paints shall be 22 centipoises. The percentage non-volatile component of the formulated paint also falls within the acceptable range for environmentally friendly coatings.

Discussion on the Chemical resistance of the paint formulated with (Luffa aegyptiaca seed oil modified alkyd resin) LASOMAR

The chemical resistance of a paint/coating film may be a significant factor determining its stability and durability after application. The result of the effects of three typical mediums (i.e. NaCl; ionic, NaOH; alkaline and HCL; acidic) on the surfaces coated with the paint sample is presented on Table 3. The paint sample shows no effect, hence a good resistance to these mediums indicates that the paint is hence suitable for application and can thus withstand some environmental condition. Similar observation was reported for other oil paints [3].

Conclusion

A Semi-gloss paint was formulated using an oil modified alkyd resin as a binder. The physicochemical properties of the paint indicated that it’s a promising paint that can

withstand environmental conditions. The relatively low VOC emission of the paint compared to other oil-based paints also makes it suitable for application in an environment already faced with the challenges of pollution due to VOCs.

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