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Artistic Variation in Relative Density Characteristics of an Agro-Organic Based Paint Thickness

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Abstract

This research involved determining the thickness of an organic paint in relation to its relative density as caused by variation in clay content in the paint. The paint being a product from agro-organic material bases: Gmelina (*Gmelina arborea)* seed extract and Teak (*Tectona grandis)* leaves extract, upon experimentation, the extracts solution was found to have the same density as water but variation set in while modifying its thickness through clay additives. The resultant weight of the solution was found to increase with increase in clay content additive. The paint thickness was determined by testing thirteen paint samples of different relative densities using a test plate of 20 cm x 20 cm cross section area. It was discovered that paint samples with relative density range of 1.040 – 1.05 having thickness range of 0.039 mm – 0.043 mm were in conformity with the standard paint thickness range of 38 microns to 43 microns. It was generalized that the relationship between paint relative density and thickness was "y = 1.3766x + 0.9902" where "y" is paint relative density and "x" is paint thickness. The general equation was found to have R^2 of 0.9784 which signifies a relatively precise paint thickness prediction.

Introduction

Paint is an essential tool for art work in which its availability at a relative low cost and in different alternatives are very important to aesthetic and preservative sector growth. This research work involved testing variability in thickness of an organic paint and at the same time determine the optimum paint thickness for economic paint production. Agricultural sector is blessed with natural

resources among which are forest plant resources which most of the parts has been wasting without distinct known usefulness (New India Express, 2018; Feinberg, 2015). In Nigeria, the most common forest trees found in forest reserves are Teak (*Tectona grandis)* and Gmelina (*Gmelina arborea).* Parts of these trees such as their seeds and leaves were in waste all over the country (Husen, 2015). The worst scenario is that they always aggravate fire outbreak during the dry season once the droppings are sufficiently dried. This has exposed Nigeria forests to yearly disasters and tending desert encroachment (InDG, 2020). One of need to maximize these wastes to the benefit of art work is to recycle them into other use in which one is paint production to the benefit of art, culture and painting. Gasparik (2019) conducted a research on colour and chemical properties of teak at varying thermal treatments. He discovered that the lightness in relation to the density of the wood is mostly affected during heat treatment. Teak has been previously used as a natural dye as discovered by Qadariyah et al. (2018) but using the teak as a major constituent of paint requires improvement in its density for economic purpose. Alhaji, et al. (2020) conducted a research on density test of clay soil using proctor and modified proctor test methodology. He affirmed that clay density affects consolidation parameters of clay such as its void ratio, compression index and compaction energy. Bulk density has been found to be an important factor in dispersion ability of clay. Gmelina seeds extract has been widely harnessed to for oil production purpose using different soft computing methods but it was discovered that the extracted oil was not edible and cannot dry (Chigozie & Okechukwu, 2016). Therefore, using the seeds as a solvent and pigment adhesion catalyst to clay was to clay colloid as paint base is crucial to this research. Clay was found to have highest dispersion ratio among other soil types (Rasheed, 2016). This research work entails determining the optimum thickness of a product of paint obtained from agro-organic bases (teak leaves and gmelina seeds). Variation in thickness detected due to clay additive differences which invariably varied both relative density and dry density of paint was found to be very important in economic production of the paint under consideration. In Nigeria of today, it is a fact that all current in use paints and colours presently in circulation are health hazardous less ecofriendly and relatively cost effective, this research provides a window for a broad alternative as a more ecofriendly, less cost effective and less to non-hazardous and hence enhance sustainability of industrialization since it bases were from organic matter wastes.

Methodology

This research was carried out at Federal Polytechnic, Bida Experimental Farm, Bida, Niger State, Nigeria. The institution is sited in the Southern part of Bida, Doko, Lavun Local Government Area, Niger state, Nigeria which lies on the latitude $9^0\ 08^1$ N and longitude $6^0\ 01^1$ E at an elevation of about 118 m above the sea level. Bida is in Northern Guinea Savannah Ecological Zone of Nigeria with an annual rainfall of about 900 mm (Awoniyi, et al., (2023). The experiment involved taking paint solution made from agro-organic bases of Gmelina (*Gmelina arborea)* seed extract and Teak (*Tectona grandis)* leaves extract. The solution density was varied by adding clay additives in order to enhance the paint thickness for economy and aesthetic purpose.

Optimum paint thickness was determined by testing 50 ml of each varied relative density paint samples on thirteen sample plates of 20 cm x 20 cm nothing the initial weight of each sample plate. The painted sample plates were allowed to dry at a sufficient time and reweighed thereby taking note of every weight of paint at each varied relative density. The thickness of each paint sample were determined by relating the weight with the density and surface area of the sample test plate. (see equation (1), (2) and (3))

$$\rho_p = \frac{\text{m (g)}}{\text{V (ml)}} \quad (1)$$

$$\text{V} = \text{At} \quad (2)$$

$$\text{R. D} = \frac{\rho_p \text{ (g/ml)}}{\rho_w \text{ (g/ml)}} \quad (3)$$

where ρ_p is density of paint (g/ml), ρ_w is density of water which equals 1 g/ml, V is volume, A is the coated area (area of sample plate), t is paint thickness (mm), m is weight of sample (g), and R. D is the relatuve density.

Result and Discussion

Table 1 shows the clay content variation, resultant weight and relative density variation for every 1000 ml of extract solution. It was found that both resultant weight and relative density increase as the clay additive in the paint increases. Table 2 indicate the weight of paint samples, densities of the samples and the thickness of the sample variations. Higher thicknesses were obtained as the paint relative density increases. Variation in thickness in relation to relative densities is illustrated in Figure 1. The graph affirmed significant variation in thickness of paint as the relative density varies. Equation (4) represents the general equation of relationship between paint relative density and paint thickness.

$$y = 1.3766x + 0.9902 \quad (4)$$

where "y" is paint relative density and "x" is paint thickness.

The association gave R^2 of 0.9784 which was relatively fit for a general equation.

Table 1: Relative Density of Paint at Varying Clay Content @ 1000 ml Extract Solution

Clay Content (g)	Resultant Weight (g)	Relative Density
10	1010	1.010
15	1015	1.015
20	1020	1.020
25	1025	1.025
30	1030	1.030
35	1035	1.035
40	1040	1.040
50	1050	1.050
60	1060	1.060

70	1070	1.070
80	1080	1.080
90	1090	1.090
100	1100	1.100

Table 2: Relative Density of Paint at Varying Clay Content @ 50 ml Extract Solution

Relative Density	Dry Weight of Sample (g)	Dry Density (g/ml)	Thickness (mm)
1.010	20.2	0.404	0.010
1.015	20.3	0.406	0.015
1.020	20.4	0.408	0.024
1.025	20.5	0.410	0.029
1.030	20.6	0.412	0.032
1.035	20.7	0.414	0.036
1.040	20.8	0.416	0.039
1.050	21.0	0.420	0.043
1.060	21.2	0.424	0.049
1.070	21.4	0.428	0.052
1.080	21.6	0.432	0.067
1.090	21.8	0.436	0.072
1.100	22.0	0.440	0.079

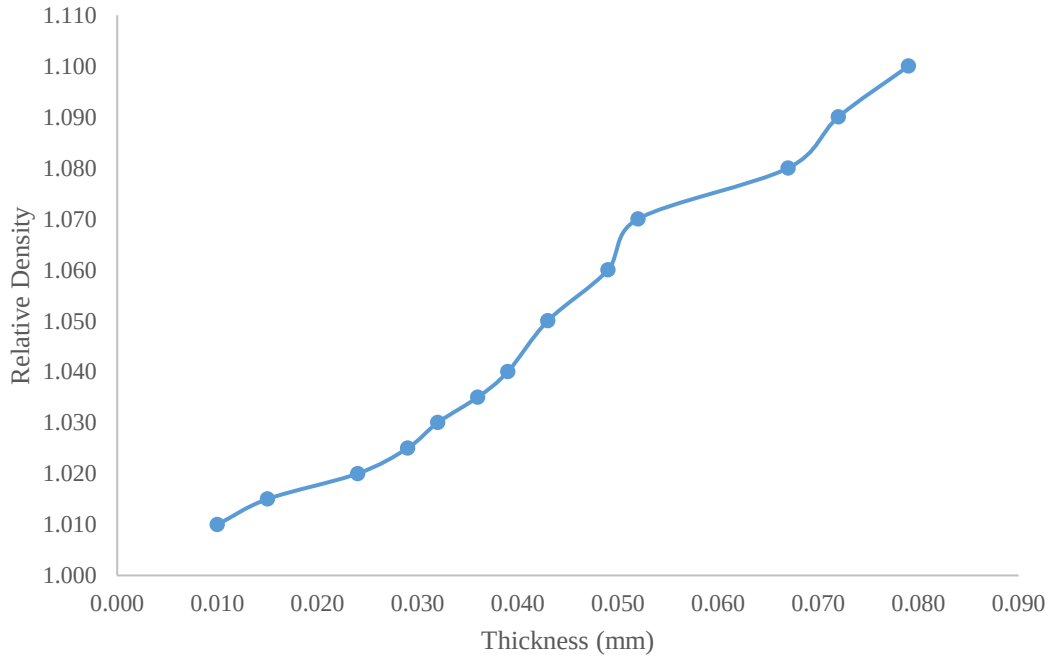


Figure 1: Thickness Variation in Relation to Relative Density

Validation of Result

The result was validated by relating the density and thickness of the paint. The association gave $R^2 = 0.9784$ which correlate with the R^2 value in the relationship between the relative density and thickness of the paint under examination (see Figure 2).

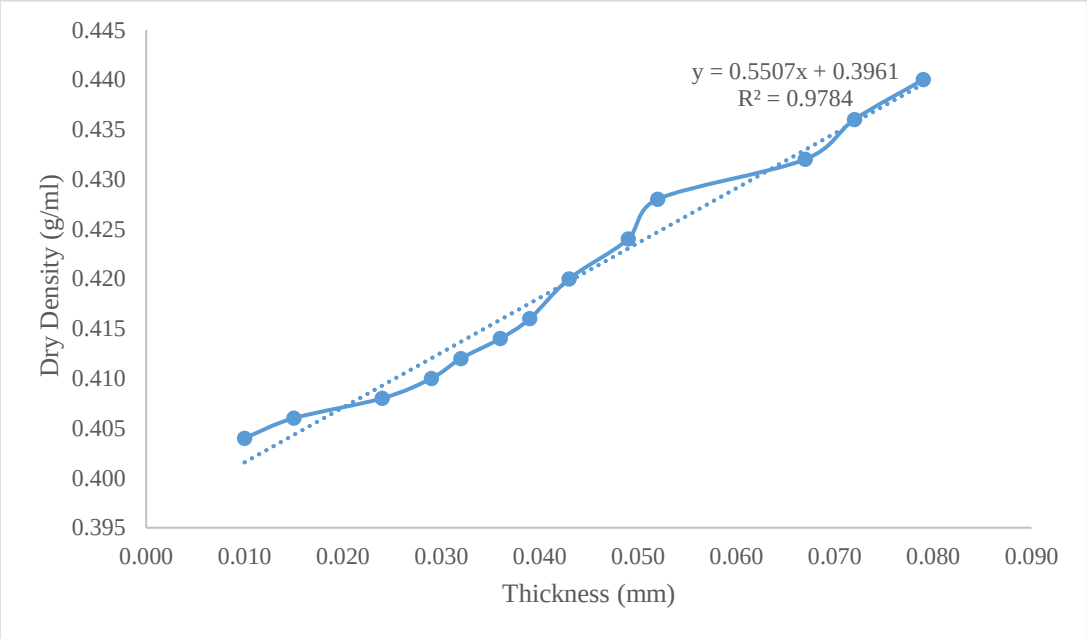


Figure 2: Thickness Variation in Relation to Paint Density

Conclusion and Recommendation

It was a point to note that the density and relative density of paint increases proportionally as its thickness. Optimum thickness of the paint was discovered to be in the range proportional to 1.04 and 1.05 relative density and 0.416 g/ml and 0.420 g/ml. It is a point to note that the weight of the paint drastically reduced by over 60% after drying. This inferably affected the dry density of the paint as inflected from the obtained results. The relationship between the dry density of the paint and paint thickness was established to be "y = 0.5507x + 0.3961". where in this context, y is the paint dry density and x is the paint thickness. Further research on clay additive analysis at it varies in moisture content during process of drying with time factor is encouraged.

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