Young Scientist- Tomorrow's Science Begins Today
Vol. 4, Issue 1 – 2020
ISSN: 2581-4737

Physicochemical Analyses of White Emulsion and White Gloss Paints

Aborode Abdullahi Tunde[1], Baale Adebayo Tajudeen[2], Yekeen Iyabo Ajarat[2]

[1]*Department of Chemistry, Faculty of Physical Sciences, University of Ilorin, Ilorin, Nigeria.*
[2]*Department Industrial Chemistry, Faculty of Physical Science, Kwara State University' Ilorin, Nigeria.*
Correspondence E-mail Id: *editor@eurekajournals.com*

Abstract

White emulsion and white gloss paints were formulated using the basic paint ingredient such as polyvinyl acetate (binder), Solvent (water in the case of water-based paint and kerosene in the case of oil-based paint), Pigment and Additives. The physicochemical analyses (Viscosity, pH, Binding strength, Opacity, Specific gravity and Density) of the paints produced were carried out and results of the analyses were carefully recorded. The results revealed that the paints could be used as both indoor and outdoor coatings that could have good value for money and long durability.

Keyword: White emulsion, White gloss paint, Binder, Solvent; Addictive, Physicochemical.

Introduction

Paint is any liquid, or mastic composition which after application to a substance in a thin layer is converted to an opaque solid film (Abdul-salam and Maiwada, 2015).

The need and use of paint in the building industry cannot be over emphasized. It covers the block work and concrete rendering (plaster) with attractive and beautiful colors, giving the building a high aesthetic value that makes it decorative clean and habitable. Paint is indispensable in building construction all over the world (Ossi and Dilim, 2015).

Osemeahon *et al.,* (2013) lamented over the challenges facing the paint industry in Nigeria, the contribution of the sector to the gross domestic product (GDP) has dropped drastically. This is as a result of weakening infrastructure and the burden imposed on the manufacturing sector by the poor power supply, government policies on tariff and port operations. There is an astronomical rise in the cost of raw materials for paint making. This has also led to the high rate of contamination of paint products.

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 corroding air and also for beautification and protection (Crowley, 2008).

Paint is a term used to describe a number of substances that consist of a finely ground solid called pigment suspended in a liquid or paste called vehicle such as oil or water. It provides an economic protection, preservation, and decoration, aesthetic and adds functionality to structures (Abidalla, 2018).

Paints composition largely determines its characteristics, usage and shelf life. By suitable variation of the type of proportion of the various constituents, they can be made dry, glossy or flat as desired. Other properties such as permeability to water could be varied accordingly (Waldie, 1983).

Paints have been manufactured since ancient times, but until recently they were highly expensive and thus were mainly used for artwork. It is only since the 19th century that houses have commonly been painted. Today paints are used for coloring and protecting many surfaces, including houses, cars, road markings and underground storage vessels. Paint is essentially composed of a binder, pigment and solvent (Udell *et al.*, 2017).

Aim and Objectives

The aim of this research is to produce water and oil based paint for household and industrial use.

Objectives

i. To formulate white emulsion and white gloss paint
ii. To carryout physicochemical analysis of the formulated white emulsion and white gloss paint
iii. Application of the paint samples on suitable substrates

Material and Methods

Materials

The reagents and apparatus used are listed below which were used to perform the analysis studies without any further purification of this reagents after it has been bought.

The reagents used for the research studies of the production of white emulsion paints of 12 Liters are titanium dioxide (600g), calcium carbonate (4.2kg), aluminum silicate (600g), natrosol (120g), formalin (46mL), PVA (180mL), deformer (75mL), foaming agent (9g) and distilled water (7L).

The instruments and apparatus used during the research work analysis are analytical balance (weighing balance), mixer, measuring bowl, measuring cylinder, conical flask, stopwatch, density bottle, pH meter, viscometer, brush, beaker and plastic container.

The instruments and apparatus listed above are used during the research analysis which helps and speed up the rate of work that show the efficiency of the research work so as to get precise value of the analysis.

Methods

➢ Production of White Gloss Paint

The production of 4 liter of white gloss paint involves the mixture of these chemicals which are titanium dioxie (500g), silicon butadiene (500g), refined starch (one teaspoon), arcticide (% tomato tin container), Dryer Lotion (one milk tin) and Kerosene (2 Liter).

➢ Production of White Emulsion Paint Procedure

Aluminum silicate (an extender/Filter) and titanium dioxides (a pigment particle) were both dissolved partly in water. Water (solvent/thinner) were poured into a 20 Liter container, then add industrial soap (a foaming agent) to the water inside the container and lather after the industrial soap get dissolved, then add Defoamer so as to reducing foaming due to the addition of the industrial soap. Then, Formalin (preservatives) was added to the mixture and gets stirred vigorously for some time with local fabricated mixer.

After stirring for some minutes, then add Calcium carbonate (also an extender) which was dissolved inside the water and after the mixture then add their mixture to the former mixture that we stirred before.

Then the solution of Titanium dioxide and aluminum silicate was added to the stirred mixture to form a paste. After the formation of a paste from the mixture with stirred mixture then Natrosol solution (a thickener) were added to the paste and mixed thoroughly for about 30 minutes, After through mixing with PVA (The binder) that was added and stirred again for another 30 minutes.

➢ Procedure for Production of White Gloss Paint

Kerosene (the solvent) is poured into a 10L container and add titanium dioxide to the kerosene and then mixed the mixture thoroughly for at least 30 minutes, the silicon butadiene (the binder/resin) is added to the mixture as a dryer lotion).

Drying lotion (a drying agent) is added to the mixture. Arcticide (an anti-Skinning agent) is added to the mixture to prevent oxidation and skin formation on the same mixture. The refined starch (thickener) is added to the paste and mixed vigorously.

- **Physico-Chemical Analysis of White Emulsion Paint Procedure**

- **Viscosity Procedure**

Viscometer was used for viscosity measurement. The viscosity of the water was determined at particular temperature of about 32^{o}C and at a specified time by using stopwatch at an interval where Time is;

T_1 = 18.56, T_2 = 18.43, T_3 = 18.30. After the interval of the time known, 1 ml of paint was measured by using a measuring cylinder and dissolve in it 27 ml of water at a temperature of about 32^{o}C and the time of the viscosity were recorded. Where out T_1 = 38.56, T_2 =37.96, T_3 = 37.95 and T_4 = 37.98.

- **Kinematic Viscosity**

The liquid in a tube is immersed in a constant temperature medium is made to flow through a short capillary tube of A-B. Initially, the tube is kept fully and exit plugged. Whether the plug is removed, the time taken for the volume of the liquid which is usually 60cm^3 to flow through the capillary tube is recorded. Then the time is represented to as taking the readings.

The liquids of choice is drawn up the lens of the viscometer to fill the bulb up to the point mark, so we then set the stop clock to take the time taken by the liquid to flow through the tube. Then we repeat the experiment for the other liquid and this provides more information about the flow rate of the liquids in the tube.

- **Binding Strength/ Adhesive Ability**

The paint were painted into a back wall initially because of the primate with the white paint and also painted on a woolen wall to determine the binding strength or adhesive ability of the paint.

- **Opacity**

We measure 30cm^3 of the paint which were painted on the chair (Substrate). Then the length of the table is 29.5 while the breadth is 17.

- **pH**

We measured out 5 ml of the sample which were poured into a beaker and then take pH meter, which was switched on and the pH electrode and was standardized with a buffer solution of pH 7.0. The glass electrode was rinsed with distilled water and dried with tissue paper. It was then dipped into the emulsion paint and the pH reading taken.

- **Density**

The density of each of the paint solutions was obtained gravimetrically by using density bottle. The mass of the bottle was first determined as well as that of mass of the density bottle filled with the paint solution and when filled with water.

Thus;

Mass of density bottle alone = W_0

Mass of density bottle with water = W_1

Mass of density bottle with paint solution = W_2

The equation is given below:

$$\text{Density of paint} = \frac{W_2 - W_0}{W_1 - W_0}$$

- **Specific Gravity**

The weight per liter cup was first weighed empty on a digital weighing scale. The value obtained was 'tarred'. The paint sample was poured into the cup and any excess paint cleaned off from the hole in the lid. The cup with the paint was weighed to obtain the weight per litre value of the paint.

The weight of a 100cc measuring cylinder was obtained. 10g of the extender was put into the cylinder and kerosene was poured into the cylinder until the 100cc mark was reached.

The weight of the empty cylinder was subtracted to obtain the weight of known volume of extender and kerosene (W_2).The weight of the extender (10g) was subtracted to give the weight of kerosene used (W_1).

The volume of kerosene (V_1) was obtained by dividing its specific gravity by its mass (W_1) and the volume of extender (V_2) was calculated by subtracting V_1 from 100cc. The S.G of extender was then calculated by expressing the mass (10g) over the volume (V_2).

- **Brushing Properties**

The ease of application of the paint (after thinning) was determined by using a brush. The brush was first wetted and excess water squeezed from it. It was then used to apply the paint on asbestos cement panels (300x100mm size) and the brushing/application properties observed.

Results and Discussion

Physico-Chemical Analysis on White Emulsion Paint Results

- **Density**

The densities of the formulated emulsion paints were obtained in the laboratory at room temperature and the results were presented below.

The calculation of how the result of the value of density and specific gravity is explained through calculation below:

5ml of density bottles was used

Weight of Empty density bottles = 6.386 g

Weight of Empty density bottles + Sample = 15

Since 1g = 1 ml

Weight of empty density bottle + 5 ml of water

= 6.386 + 5 = 11.386 g

$$\text{Density} = \frac{\text{Mass}}{}$$

$$\text{Volume} = \frac{W_2 - W_1}{V}$$

$$\text{Volume} = \frac{15.737 - 6.386}{5}$$

Volume = 1.870g/mol

Density of emulsion paint is due to the materials used in the production of the emulsion paint as can be seen above. Paint Sample has density of 1.870 g/mol which is higher than water.

- **Specific Gravity**

The specific gravity of paint determines the gravity of the texture of the paint and is the physical properties or feature that characterized the paint and the calculation on how the results is obtained is given below:

$$\text{Specific gravity} = \frac{W_2 - W_1}{W_2 - W_1}$$

$$\text{Specific gravity} = \frac{15.737 - 6.386}{11.386 - 6.386}$$

Specific gravity = 1.87

- **Viscosity**

This is defining as the resistance to flow. The calculation aspect is below:

Viscosity of Water at time (T) = $\frac{18.56 + 18.43 + 18.30}{3}$

= 18.43

Viscosity of Initial of paint that dissolve in water at a certain time

= $\frac{31.96 + 37.96 + 37.98}{3}$

= 37.96.

$V = C_1t$

Viscosity of the paint = (Viscosity of Paint +water) – Viscosity of water

= 37.96 – 18.43 = 19.53

$V - C_1 t$

C_1 = Co-efficient factor of path length (constant)

T = Varying Time

From the result above, it was observe that the formulated emulsion paint sample that was dissolved in water has a high viscosity when compared with samples that water was removed.

However, the entire sample paints shown a moderate viscosity which indicated good flow property.

The higher the pigment volume concentration (PVC), the higher the viscosity of the paint obtained. The low viscosity paint produced showed good leveling, with high opacity. The gloss of the paints was also higher. The paints were associated with having low spattering when coated on cardboard substrate. The low viscosity of the paints formulated accounts for high tendency of its movement and easy application. They also smooth out faster. These results compared revealed that the paint performance has influence on the value of viscosity. The formulated paint sample viscosity readings were taken at room temperature.

- **Kinematic Viscosity**

The main aim of this experiment is to determine the kinematic viscosity of different liquids at room temperature. The value of the results obtained during the calculation of kinematic viscosity of the paint is given below:

Viscosity of the Paint = C_1t where C = 0.3304 cm

Therefore, = 19.53 × 0.3304
= 6453 cm/sec.

- **pH**

After taking the pH readings, the results of the value obtained are: 7.4, 7.5 and 7.6 at room temperature. The pH readings help to determine whether the paint is in basic or acidic form

Physicochemical Analysis of the white Emulsion Paint

Discussion

Table 1.Physicochemical parameters of the formulated paint

Parameters	Value/Units
Viscosity	6453 cm/sec
pH	7.6
Binding Strength	3 h 30 min
Specific Gravity	1.90
Opacity/Hiding Power	16.72 cm
Density	1.8702 g/mL

The paints mixed readily with a minimum amount of foaming to a smooth and homogeneous state. The pH values of the paints were also normal 7.6. This shows the pH measurement which is the amount of the relative acidity or alkalinity of the samples of emulsion paint produced, the pH is in the range of 7.0 - 9.0 which are in relation with the national institute of standard (NIS). The pH test was carried out at the laboratory under normal room temperature.

The binding strength of the paint show the strength and the ability of the clay to bind with other material with the time used for proper binding and the results above show that the binding strength of the paint takes up to 3 hours 3 minutes to bind perfectly.

The opacity/ hiding power of the paint show the 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 same surface. In the research results the opacity of the paint is 16.72cm.

There is higher value in the densities of the paint in each case. However, this may be due to the influence of the pigment, additive and other paint ingredients. However, the paint showed

a higher density, a small value-increase compared to all the formulated sample paints. The densities of the paint changed with the pigment mass concentration (PMC); such that the higher the PMC, the more the densities of the paint in each case. However, this may be due to the influence of the pigment, additive and other paint ingredients.

The viscosities of the formulated paints were obtained using the Ostwald viscometer at an ambient temperature. However, the paints showed moderate viscosity which indicated good flow property.

The viscosity of the paint produced showed good leveling. The gloss of the paints was also higher. The paints were associated with having low spattering when coated on cardboard substrate. The low viscosity of the paints formulated accounts for high tendency of its movement and easy application. They also smooth out faster.

This result had revealed that the paint performance is influenced by the molecular weight or viscosity as similarly revealed that the thicker the paint the more viscous paint it resist gravity better and doesn't slide down the canvas-it stays put. The individual small areas within a splotch of the thicker more viscous paint are also better at staying put.

Conclusion

The research analysis was able to achieve the property of a white emulsion paint which based on its feature and factors of the paint e.g. viscosity, binding strength and this gives more information that the type of chemical composition used will determine the physicochemical strength of the paint.

Acknowledgement

I want to appreciate Almighty God and the efforts of all the supervisors and reviewer of this research.

References

1. Abagale, S.A., Twumasi, S.K., and Awudza, J.M. Chemical studies on the Composition of Natural paint Pigment materials. *Chemistry and Materials Research* 3(1) (2013) 13-22.
2. Abdul-Salam, S., and Maiwada, D.Z. Effectiveness of Gum Arabic as a Binder in Emulsion House Paint. *International Journal of materials science and application* 4(5) (2015) 350-353.
3. Abidalla, M. Natural House Paint and Addictives usage. *Journal Science of Materials* 4 (2008) 18-27.
4. Akinterinwa, A., Osemeahon, S.A., Nkafamiya, I.I., and Dass, P.M. Formulation of Emulsion Paint from a Copolymer Composite of Dimethylol Urea Polystyrene. *Chemistry and Material Research* **7**(7) (2015) 20-26.

5. Athawale, V.D., and Nimbalkar, R.V. Waterborne coatings based on renewable oil resources: An Overview. *Journal of the American Oil Chemists' Society* 88 (2011) 159-185.
6. Barletta, M., Gisario, A., Rubino, G., and Tagliaferri, V. Electrostatic spray deposition (ESD) of "self organizing" TiO_2-epoxy powder paints: Experimental analysis and numerical modeling. *Surface and Coatings Technology* 201 (2006) 3212-3228.
7. Crespi, M.S., Hikosaka, M.Y., Do Amaral, G.C.A., and Ribeiro, C.A. Kinetic parameters obtained for thermal decomposition of acrylic resins present in commercial paint emulsions. *Journal of Thermal Analysis and Calorimetry* 88 (2007) 669-672.
8. Crowley, J.D., League, J.R., Jack, W., and Lowe, J.R. A three Dimensional Approach to Solubility. *Journal of Paint Technology* 38(2) (2008) 20 – 28.
9. Cyprian, O., and Eneh, J. Introduction to Paint Technology. *Journal of Paint Technology* 2(20) (1986) 20-15.
10. De Mariz, F.A. I., Millichamp, I.S., and Reiza, J.R. High performance water-borne paints with high volume solids based on bimodal latexes. *Progress in Organic Coatings* 68 (2010) 225-233.
11. Dyer, P.J., and Cummings, P.T. Hydrogen bonding and induced dipole moments in water: Predictions from the Gaussian charge polarizable model and Car-Parrinello molecular dynamics. *The Journal of Chemical Physics* 125 (2006) 1-6.
12. Elhalawany, N., Saleeb, M.M., and Zahran, M.K. Novel anticorrosive emulsion-type paints containing organic/inorganic nano hybrid particles. *Progress in Organic Coatings* 77 (2014) 548-556.
13. Hofland, A. Alkyd resins: From down and out to alive and kicking. *Progress in Organic Coatings* 73 (2012) 274-282.
14. Idris, M.N., and Rashan, J.A. Laboratory studies on small scale production of three different Grades of Paints. *Research Journal of Pure Science and Technology* 1(1) (2017) 23-35.
15. Kowalczyk, K., Luczka, K., Grzmil, B., and Spychaj, T. Anticorrosive 2K polyurethane paints based on nano and micro phosphates with high dispersing additive content. *Progress in Organic Coatings* 76 (2013) 1088- 1094.
16. Kumar, A., and Gottesfeld, P. Lead Content in Household Paints. *Science of the Total Environment* 407(1) (2008) 333-337.
17. Michael, D.T., and Clark, J. The Paint Research Association, Nigerian Industrial Standard: Specifications for Emulsion Paints for Decorative Purposes. *Standards Organization of Nigeria* 2(1) (2008) 87-94.
18. Osemeahon, S.A., Hotton, A.J., and Fadawa, F.G. Development of Mosquito Repellent Emulsion Paint from Neem Seed Oil. *International Journal of Green and Herbal Chemistry* 2(3) (2013) 641-650.
19. Ossi, I., and Dilim, C. Comparative Evaluation of Pigment Extender of Calcium carbonate and Kaolin in Emulsion Paints. *International Journal of Science and technology* 4(12) (2015) 570-577.

20. Raheem, A., and Olowu, O.A. Production of Household Paint Using Clay Materials. *International Journal of Engineering research and Application* 3(2) (2013) 85-93.
21. Rusu, A.O., and Dumitriu, E. Destruction of volatile organic compounds by catalytic oxidation. *Environmental Engineering and Management Journal* 2 (2003) 273-302.
22. Salleh, N.G., Alias, M.S., Glasel, H.J., and Mehnert, R., High performance radiation curable hybrid coatings. *Radiation Physics and Chemistry* 84 (2013) 70-73.
23. Traumann, A., Reinhold, K., and Tint, P. Environmental and occupational impact on human health of dust and chemicals from modern technologies. *Environmental Engineering and Management Journal* 13 (2014) 2233- 2241.
24. Tucaliuc, O.M., Cretescu, I., Nemtoi, G., Breaban, I.G., Soreanu, G., and Iancu O.G. Monitoring of mercury from air and urban dust in the industrial area of Iasi municipality. *Environmental Engineering and Management Journal* 13 (2014) 2051-2061.
25. Udell, A.N., Hodglans, E.R., Berrie, B.H., and Meldrum, T. Physical and Chemical Properties of Traditional and Water-Mixable Oil Paints Assed Using Single Sided NMR. *Micro chemical Journal* 4 (2017) 31-36.
26. Waldie, D., and John M. Surface Coatings: Raw Materials and Their Usage. *Journal Oil and Color* 1(20) (1983) 57-89.

