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PROPERTIES EVALUATION OF INTERIOR DECORATIVE EMULSION PAINTS PRODUCED USING LOCAL EXTENDERS OBTAINED FROM AKURE, ONDO STATE, NIGERIA

Ifeoma Janefrances UMUNAKWE[1], Reginald UMUNAKWE[2,4,*], Uzoma Samuel NWIGWE[3], Victor Adeola POPOOLA[1], Akinlabi OYETUNJI[4]

[1]Department of Chemistry, Federal University of Technology Akure, Ondo State, Nigeria.
[2]Department of Materials and Metallurgical Engineering, Federal University Oye-Ekiti, Ekiti State, Nigeria.
[3]Laboratory SYMME, University of Savoy Mont Blanc, Annecy, France.
[4]Department of Metallurgical and Materials Engineering, Federal University of Technology Akure, Ondo State, Nigeria.

Abstract

Three local extenders obtained from three different locations in the Akure area of Ondo State, Nigeria earlier processed, characterized and reported were used to produce interior decorative emulsion paints of Pigment Volume Concentration within the range of 74 – 76 %. Tests were carried out on the produced paint samples to ascertain their homogeneity, pH, specific gravity, viscosity, opacity, resistance to abrasion, resistance to external exposure, water dropping, dry times, fineness, temperature stability, colour, application properties, resistance to fungal and bacterial attack, application properties, re-coating properties, dry film resistance to fungal growth, adhesion to substrate, chalking, checking and cracking, flooding and floating and settling resistance. The properties of the paints produced with the local extenders were compared with those of the paint produced with commercial kaolin as extender and all properties of the paints were compared with the standard requirements stipulated by the NIS 269:2008 Standard. Results showed that the properties of the paints made with the local extenders met the required service requirements. The paints made with the local extenders offered better opacity on morest chart and substrate as well as higher abrasion resistance when compared with the paint made with commercial kaolin as extender.

Keywords*: paints, coatings, extenders, industrial applications, products testing.*

Introduction

The paint and surface coating industry in Nigeria is a key contributor to the economy with a range of products for diverse industrial and decorative applications. The Nigerian paints and coatings industry comprising the organized and unorganized sectors was estimated to worth about $ 200 million in 2012 with annual estimated sales of 128 million liters [1]. The decorative paints segment contributes about 71 % of the production volume and 60 % of the total revenue [1]. Some of the major players in the industry include Chemical and Allied Products (Cap) Plc., Chemstar Paints Industries Nigeria Limited, Berger Paints Nigeria Plc., Dn Mayer Plc., Apex Paints Limited, International Paints West Africa Plc., Eagle Paints, Paints and Coating Manufacturers Nigeria Plc., Premier Paints Plc., Portland Paints and Products Nigeria Plc., President Paints, and Prestige Paints Company Limited [2]. The Nigerian paint industry is currently facing the problem of scarcity and high cost of raw materials for paints production due to the dependence on the imported raw materials, and manufacturers are being encouraged to source for raw materials locally [3-5]. Earlier, some reports have been published on the suitablity of clays in various parts of Nigeria as extenders in the paints industry [6-13].

Corresponding author: reginald.umunakwe@fuoye.edu.ng; Phone:+234 8135504894

Umunakwe *et. al.,* (2019) characterized the calcined soils obtained from Ijapo, latitude 7^0 15' 37.8" N; longitude 5^0 13' 8.1" E; Ibule, latitude 7^0 18' 53.1" N; longitude 5^0 7' 20.4" E; and FUTA North Gate, latitude 7^0 18' 42.1" N; longitude 5^0 8' 6.2" E, in Akure, Nigeria and reported that they are suitable for application as extenders and pigments in the paints industry [14]. In this work, the local materials earlier characterized and reported [14] were used to produce interior decorative emuslions paints and the qualities of the paints produced were asssessed and compared to the service requirements.

Materials and Method

Formulation and Production of the Emulsion Paints with the Calcined Extenders

The local extenders utilized for this work were calcined, sieved and characterized. Their properties and compositions have earlier been reported [14]. Three different emulsion paints were prepared with the three different calcined extenders from the three sources. A control sample of emulsion paint was prepared with kaolin as the reference extender. The other commercial chemicals used for the production of the paints were supplied by Motis Industries Limited, Akure, Ondo State, Nigeria. The formulation for the paints was tailored such that the Pigment Volume Concentration (PVC) of each of the produced paints was between 74 - 76 %. The formulations used for the production of four litres each of the paints with the different extenders is shown in Table 1. The materials for the production of the paints were meticulously weighed with an A&D digital weighing balance, model sk-1000. In order to ensure homogeneity and proper dispersion of the pigment and extenders in the binder, Hawing King Electric High Speed Mixer, model D8-16 was employed for mixing and dispersion.

The production process started by thoroughly mixing three quarter of the solvent (water) required in a mixing container with the wetting agent, dispersant and preservative. The weighed opacifier (titania), extenders and colourant were then added in the mixing container and they were thoroughly dispersed with the help of the high speed mixer. The remaining part of the solvent was used to dissolve the thickener before it was added to the mixing container. After two minutes of further mixing, the binder was added, followed by the coalescing agent and the buffer. The mixing continued until the paint built viscosity. The produced paint was checked for uniformity (homogeneity) in the mixing container before mixing was stopped. Each produced paint sample was packaged in air-tight container. Samples for the various tests were packaged.

Characterizations of the Produced Paints

Tests on the produced paints samples were carried out under standard laboratory conditions of temperature of $27 \pm 2\ ^0$C and relative humidity of 70 ± 5 % as stated by NIS 269: 2008 [15], except where another condition was required. The produced emulsion paints were subjected to in-can assessment [16], pH check with pH tester, specific gravity measurement in accordance with ASTM D 1475 – 13 [17], viscosity check as specified by NIS 269: 2008 [15] and ISO 2884-2:2003 [18], and opacity on morest chart in accordance with NIS 269:2008 [15] and ASTM D 2805 – 11(2018) [19]. The other tests carried out on the produced emulsion paints are resistance to wet abrasion using Sheen Wet Abrasion Scrub Tester; model REF 903 in line with ASTM D 3450 – 15 [20], water drop test as specified by NIS 269:2008 [15], resistance to external exposure as specified by NIS 269:1989 [21], and dry times with reference to NIS 269:1989 [21]. Also, fineness was determined following ASTM D 1210 – 05(2014) [22] with sheen fineness of grind gauge. Temperature stability of the paints and application properties were evaluated following NIS 269: 2008 [15] method. Re-coating properties were evaluated [16]. Finally, chalking, cracking and checking, flooding and floating, adhesion to substrate, settling resistance of the produce paints samples, as well as storage stability after twelve months were evaluated while their colours were matched with standard colours.

Table 1. Formulations for the emulsion paints samples

S/N	Ingredient	Wt% per gallon of paint			
		IJ	IB	FU	KA
1	Water	45.2	45.2	45.2	45.2
2	Genopur	0.11	0.11	0.11	0.11
3	Calgon PT	0.11	0.11	0.11	0.11
4	Biocide	0.24	0.24	0.24	0.24
5	Titania	1.2	1.2	1.2	1.2
6	Whiting	26.4	26.4	26.4	26.4
7	IJ_e	18.8	-	-	-
8	IB_e	-	18.8	-	-
9	FU_e	-	-	18.8	-
10	Kaolin	-	-	-	18.8
11	Natrosol	0.6	0.6	0.6	0.6
12	Poly(vinyl acetate)	7.2	7.2	7.2	7.2
13	Texanol	0.06	0.04	0.04	0.04
14	Soda	0.01	0.01	0.01	0.01

*IJ, IB, and FU represent the paints made with IJ_e, IB_e, and FU_e respectively.
KA represents the paint made with kaolin

Results and Discussion

The properties of the emulsion paints produced with the calcined local extenders and the one produced with kaolin are shown in Table 3. The emulsion paints are represented as KA, IJ, FU and IB for the paints produced with kaolin, Ijapo, FUTA North Gate and Ibule local extenders respectively.

The properties of the produced paints listed in Table 2 met the requirements stated by NIS 269: 2008 standard. The pH values of the paints were okay as NIS 269: 2008 requires emulsion paints to have pH values range 7 – 9 to ensure adhesion to walls that are mostly acidic. pH of paints are usually controlled during production with the aid of some ingredients such as ammonia solution and soda. The drying time is a very important parameter as paints are not required to take very long time to dry. The produced paints samples meet the required dry time as shown in Table 3. The uniformity, fineness and less coarse particle obtained in the produced paint samples were due to the proper grinding, sieving and good dispersion of the extenders in the paints. The paints produced with calcined local extenders offered more resistance to wet abrasion due to the good interaction and bonding of the extenders with the binder and also the presence of silica which is a hard material in the local extenders. All the paints samples exceeded the minimum cycles required for surfaces to show substantive damage during abrasive condition. The worn surfaces are shown in Fig. 1. The opacity of the paints produced with the calcined local extenders shown in the hiding power (morest) charts in Fig. 2 were better than the opacity of the paint produced with kaolin. This is due to the presence of opacifiers like anatase, red oxide, and orthoclase in the calcined local extenders. The opacity in paints made with kaolin is always enhanced by the addition of titania. The colours imparted in the paints by the calcined local extenders conform to some of the standard colours of paints marketed in the industry as checked through colour matching. The local extenders imparted beautiful colours due to their compositions. Earlier, it was reported that the extenders used have are kaolinite in nature due to their high content of Silica (SiO_2) and alumina (Al_2O_3) [14], and this is responsible for the quality obtained in the produced paints.

The results of the other tests carried on the paints are as follows:

Resistance to External Exposure

The painted surfaces exposed to external environment for thirty days showed no paint defects such as cracking, flaking, blistering or colour fading.

Water Drop Test

After 24 hours of drying on the glass panel, there was no blistering, cracking and swelling of any of the paints films when tested with distilled water. All the paints samples passed the water drop test.

Temperature Stability

The results showed that the paints did not develop offensive odour and any form of paint degradation after undergoing the tests. They met the required standard. The calcined extender materials being ceramic in nature are not easily degraded by temperature [6].

Application Properties

The paints samples were brushed and were rolled satisfactorily after thinning down with water.

Re-coating Properties

Successive coats were applied without difficulty and without lifting of the undercoat. The brush marks during the application of the successive coats were not visible on the first coats.

Dry Film Resistance to Fungal Growth and Bacterial Attack

Both the surfaces painted outside and inside observed after thirty days showed neither fungal growth nor any form of degradation from bacterial attack.

Table 2. Properties of the produced emulsion paints

S/N	Parameter	IJ	FU	IB	KA	NIS 269:2008 Standard
1	Viscosity at 27 ^{0}C (Poise)	10.5	9.5	11.5	10.5	6 minimum
2	pH value	8	8	8	8	7 - 9
3	Specific gravity	1.37	1.34	1.38	1.35	-
4	Opacity after 2 coats	Good	Good	Good	Fair	Good coverage
5	Colour	Standard	Standard	Standard	Standard	Standard
6	Resistance to wet abrasion (Cycles)	112	147	118	102	50 minimum for IEP 101 minimum EEP
7	Uniformity	Smooth and homogenous	Smooth and homogenous	Smooth and homogenous	Smooth and homogenous	Smooth and homogenous
8	Fineness	Finely ground	Finely ground	Finely ground	Finely ground	Finely ground
9	Coarse particle content (%)	Less than 1	Less than 1	Less than 1	Less than 1	Less than 1
10	Surface dry time (mins)	20	17	20	17	20
11	Had dry time (mins)	Less than 120	Less than 120	Less than 120	Less than 120	Less than 120

*IEP: Interior emulsion paint. *EEP: Economy emulsion paint.

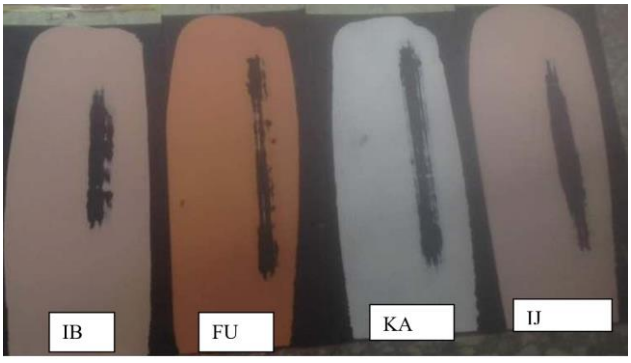

Fig. 1. The worn surfaces after wet abrasion testing on the paints samples

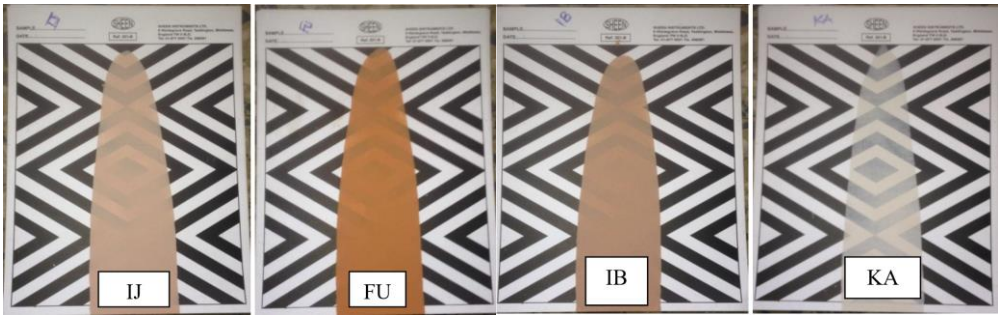

Fig. 2. The opacity of the paints samples on morest chart

Chalking, Cracking and Checking

The paints passed these tests as such defects were not observed on the painted surface. The binder offered good binding strength in the paints formulated.

Adhesion to Substrate

All the paints samples passed the adhesion test as the removal of paint films from each painted surface was less than 50 % of the square line in glass panel as required by NIS 269: 2008.

Flooding and Floating

The dry films on glass panel observed for separation of colours and streaks did not exhibit such defects. All the paints samples passed the test.

Settling Resistance

After observing the paints for twelve months, no form of separation or lumps was observed in the paints. This was due to the low specific gravity of the extender materials and their good compatibility with the binder.

Conclusions

From the results, it can be concluded that the interior decorative emulsion paints made with the calcined local extender materials obtained from Ijapo, FUTA North Gate and Ibule areas of Akure, Ondo State, Nigeria met the required standard, passed the quality assessments tests and will compete effectively with the other commercial products in the market. The suitability of the calcined local materials for the production of paints was due to the fact that their phase compositions were majorly commercial pigments and extenders. The process of calcinations, milling and sieving of the materials to fine particles (below 75 μm) as well as proper formulation, dispersion and mixing during paints production ensured that the quality of the paints met the service and specified requirements.

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References

[1] "*Analysis of the industrial paints and coatings marketin South Africa, Nigeria, and Kenya"*, Frost and Sullivan, http://www.frost.com/sublib/display-report.do?id=M960-01-00-00-00

[2] "*Nigeria's chemical and paints industry (an analytical view)",* LeadCapital Limited, https://www.proshareng.com/admin/upload/reports/Report%20on%20the%20Chemical%20%20Paints%20Sector.pdf

[3] P. N. Opara, *Production of textcoat and emulsion paints stainless for youth skill and entrepreneurship empowerment program*, **Journal of Educational Policy and Entrepreneurial Research, 1(1),** 2014, pp. 96-102.
[4] C. Iwelunmo, *Paint manufacturers decry high cost, scarcity of raw materials,* **The Daily Times,** (2017, September 30), p. 25
[5] A. Okon, *Paint manufacturers lament high cost, raw materials scarcity,* **The Punch,** (29, September 2017), p. 22.
[6] I. O. Igwe, G. Osuoha, C. Nwapa, *Characterization and utilization of Eziulo clay as an extender in emulsion paint formulations,* **Journal of Minerals and Materials Characterization and Engineering, 5**, 2017, pp. 174-184.
[7] C. M. Ewulonu, I. O. Igwe, G. N. Onyeagoro, G. N., *Performance of local clay-titanuim dioxide core-shell extender pigments in alkyd paints,* **Advances in Nanoparticles**, **5**, 2016, pp. 90-102.
[8] I. C. Chukwujike, I. O. Igwe, *Extender properties of some nigerian clays,* **Journal of Minerals and Materials Characterization and Engineering, 4**, 2016, pp. 297-291.
[9] I. C. Chukwujike, I. O. Igwe, G. N. Onyeagoro, *Performance evaluation of local clay-extender pigment on alkyd paint formulations,* **International Journal of Modern Research in Engineering and Technology, 3(3)**, 2016, pp. 30-41.
[10] I. C. Chukwujike, J. L. Chukwuneke, S.C. Nwanonenyi, I. E. Digitemie, *Effect of particle sized clay extender pigment on alkyd paint formulations,* **Covenant Journal of Engineering Technology, 1(1)**, 2018, pp. 31-46.
[11] I. O. Igwe, C. M. Ewulonu, A. I. Chikei, B. Nicholas, *Performance evaluation of Aro-ndizuogu local clay in alkyd paint production,* **International Journal of Engineering and Technologies, 7**, 2016, pp. 87-93.
[12] A. A. Raheem, O. A. Olowu, *Production of household paint using clay materials,* **International Journal of Engineering Research and Applications**, **3(2)**, 2013, pp. 85-93.
[13] T. O. Odozi, R. Dore, C. O. Onu, *Paint extenders based upon an indigenous clay,* **Journal of Nigerian Society of Chemical Engineers,** 5, 1986, pp. 34-40.
[14] I. J. Umunakwe, R. Umunakwe, V. A. Popoola, U. S. Nwigwe, A. Oyetunji, *Evaluating the extender characteristics of some local materials in Akure, Ondo State, Nigeria for applications in the paints industry,* **MRS Advances, 5**, 2019, In Press.
[15] NIS 269: 2008, *Specifications for emulsion paints for decorative purposes*. 2008.
[16] C. D. Igwebike-Ossi, *Pigment extender properties of rice husk ash in emulsion paint,* **International Journal of Innovative Research in Science Engineering and Technology**, **4(8)**, 2015, pp. 6821-6829.
[17] ASTM D 1475 – 13, *Standard test method for density of liquid coatings, inks, and related products.* 2013.
[18] ISO 2884-2:2003, *Paints and varnishes -- Determination of viscosity using rotary viscometers -- part 2: disc or ball viscometer operated at a specified speed*. 2003.
[19] ASTM D2805-11(2018), *Standard test method for hiding power of paints by reflectometry.* 2018.
[20] ASTM D 3450 – 15, *Standard test method for washability properties of interior architectural coatings*. 2015.
[21] NIS 269: 1989: *Standard for paints and varnishes; part 5: specifications for emulsion paints for decorative purposes.* 1989.
[22] ASTM D1210 – 05, *Standard test method for fineness of dispersion of pigment-vehicle systems by Hegman-type gage*. 2014.

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