ISSN 2229-5518

Quality Assessment and Characterization of Locally Made Ink

[1]Nwafulugo F. U , [2]Nwosibe P. O , [3] S . O. Omale,[4]F.Samuel, [5]M .Buhari

Department of Chemical Engineering, Kaduna Polytechnic, Kaduna, Nigeria
Corresponding Author: patnwosibe@gmail.com; Phone: +2348037710269

Abstract

The white board marker ink was formed by a homogeneous blend of dissolved fine particles of varnish, pigment and other additives. Thus Gum Arabic was dissolved in water and the resulting solution was mixed with ethanol to form a varnish. The pigments used were carbon soot from burnt Sodom apple stem, lamp black from burning of kerosene in a lantern and dye. The pH of the produced samples were 6.2, 4.8 7.6, viscosity were 1.11cp, 2.87cp, 1.32cp, and their drying time were 2.87s, 10.83s, 4.68s respectively. In comparison with a standard ink of pH of 5.5, viscosity of 1.05cp and drying rate of 2.21s, sample A stood out to be best with pH (6.2), viscosity (1.11cp) and drying time (2.87s).

Index Terms : Ink, white board, marker, pigment, additives, Gum Arabic, lamp black, soot, viscosity, Sodom apple stem, ethanol, viscosity, kerosene, drying, varnish

1.0 Introduction

Ink is a combination of a coloring agent or pigment and a liquid containing oils resins and additives (Cordova, 2008). According to Smolinske (1992), ink was initially fashioned from different colored juices and plant and animal extract. Today synthetic materials are used in addition to these natural resources (Palm, 2009). Research on the use of chalk has also shown that chalk has effect on the health of users especially those with weak respiratory system (Lyons, 2011). Thus the whiteboard is being used to replace blackboard and the chalks are being replaced with a non-toxic erasable whiteboard marker. But this efficiency is exchange with a non-affordable rate (Venise

2014).Whiteboard markers use an erasable ink, which are made to be used on a non-porous writing surface (Larrie and Deardruff , 2013). The ink for whiteboard markers are usually in fluid form, made on the basis of alcohol (e.g. 1-propanol 1-butanol di-acetone alcohol and cresols). The proposed ingredients for a locally produced whiteboard marker ink were dye, gum Arabic, spirit alcohol and distilled water etc(Cordova 1992). Though the formulations may differ from industries to industries and laboratories as well but the ink produced are expected to have the same characteristics like all other types of writing ink such as durability, toxicity, erase ability, viscosity, rate of drying etc. (Sunday, 2012)

Demands for whiteboard markers have risen ever since schools replaced their blackboard with whiteboard and chalk with whiteboard marker, which are easy to use, non-toxic and erasable (Kipphen, 2011). Nigeria is a good market for white board markers giving rise in the numbers of school (primary, secondary and tertiary) and other nonacademic users (Margaret, 2014). Thus this research was targeted on the need to flood the market with an affordable locally produced ink for whiteboard marker which can compete favorably with the ink of a standard existing whiteboard marker.

2.1 Materials and methodology

Table 1: Equipment used for the production

S/N	**Item**	**Manufacturer**
1.	Crushing mortar and pestle	-
2.	Stirrer	-
3.	Spatula	-
4.	Conical flask	Pyrex
5.	Beaker	Pyrex

6.	Weighing balance	Hanna
7. 8.	Sieve Measuring cylinder	-

Table2: Reagent used for the Production

S/N	Item	Manufacturer
1.	Sodom apple	Locally sourced
2.	green dye	Locally sourced
3.	Gum Arabic	-
4.	Distilled water	
5.	Ethanol	IMCO class3 India
6.	Magnesium sulfate	Sara Hk Ltd

2.2 Procedure for Making Ink

The carbon soot used was prepared by burning a dried stem of Sodom apple tree (calotropis procera) to obtain the soot which was further grinded and sieved to get fine particles similarly, the lamp block was gotten from burning kerosene in a lantern.

The gum Arabic was grinded using a mortar and pestle and was sieved. Then a gum Arabic solution was prepared by dissolving 20g of gum arabic in 10ml of distilled water.

The gum Arabic solution was measured and then mixed with ethanol and other additives to form the varnish in which the pigment/dye will be dispersed.

The pigment was dispersed into the varnish and stirred thoroughly for homogenous mixing and then filtered to remove any suspended pigment. The final homogenous solution after filtration is the ink solution. This was further subjected to XRF analysis to determine the chemical constituents.

Table 3: Formulation for Locally Produced Ink

pigment/dye	weight of pigment/dye (g)	distilled water (ml)	gum Arabic solution (ml)	polyvinyl acetate (g)	colorant (ml)	ethanol
Carbon soot :Sodom Apple (Sample A)	30	10	20	6	5	30
Lamp black (Sample B)	30	10	20	6	5	30
Dye(Sample C)	10	10	20	6	-	30

2.3 Quality Assessment Test

The following qualities were tested for: color, drying time, pH value and viscosity in comparison with standard.

Drying time determination

At room temperature (28^0C) the ink was used to write on a whiteboard and the approximate time it took to dry up was measured and recorded.

Determination of Viscosity

A volume of water was allowed to flow freely from a flow cup and the time was noted. Equal volume of the ink was also allowed to flow freely and the time noted. This relationship was used to determine the viscosity of the ink, where time = t and viscosity = μ

$$\frac{time\ of\ flow\ of\ water\ (t)}{time\ of\ flow\ of\ ink\ (t)}\frac{time\ of\ flow\ of\ water\ (t)}{time\ of\ flow\ of\ ink\ (t)} = \frac{viscosity\ of\ water\ (\mu)}{viscosity\ of\ ink\ (\mu)}\frac{viscosity\ of\ water\ (\mu)}{viscosity\ of\ ink\ (\mu)}$$

(McCabe et al, 1986)

Determination of the pH

The pH values of the various samples of ink produced were determined using a pH meter

Erasability

The ink was used to write on a white board allowed to dry then erased to determine the eras-ability, whether it was easily erased or not.

Table4: Physical observations made on test

sample	Eras ability	eligibility	color	Drying times (s)	pHvalue	Viscosity (cps)
Standard ink	Easily erased	Clearly visible	Blue	2.21	5.5	1.05
A	Easily erased	Clearly visible	blue	2.87	6.2	1.11
B	Not Easily erased	Clearly visible	black	10.83	4.8	2.87

C	Easily erased	Not clearly visible	green	4.68	7.6	1.32

Table 5: Chemical Composition of the Ink Samples from XRF analysis

Element	Standard ink	Sample A	Sample B	Sample C
Na_2O	0.000	0.000	0.192	0.000
MgO	0.102	0.059	0.000	0.000
AL_2O_3	3.394	1.698	2.083	1.576
SiO_2	40.463	52.926	49.385	43.953
P_2O_5	3.857	17.101	19.768	26.566
SO_3	16.517	5.506	7.235	4.137
Cl	10.675	2.895	4.905	2.282
K_2O	0.242	10.724	15.188	1.572
CaO	0.000	80763	0.965	19.111
TiO_2	23.437	0.021	0.040	0.090
Cr_2O_3	0.792	0.011	0.012	0.006
Mn_2O_3	0.399	0.033	0.012	0.073
Fe_2O_3	0.054	0.166	0.069	0.514

ZnO	0.000	0.063	0.146	0.070
SrO	0.067	0.034	0.000	0.049

3.1 Discussion of result

The formulation as presented in Table 3 shows uniform constituents. The only variables were the pigments which were locally sourced. Physical and chemical analysis was carried on the resulting products, thus Table 4shows the result of the physical test carried out on the ink samples in comparison to a standard ink. . Standard ink refers to ink sample from imported brands currently available in the market which stands as the comparative ink, while samples A, B and C are the ink samples produced from carbon soot, lamp soot, and dye respectively. The colour of the standard ink is blue while the colours of the samples are blue, black and green for samples A, B, and C respectively. The color of the ink sample is a derivative of the dye/colorant used.

The viscosity of the ink affects the drying time, therefore, the more viscous the ink, the longer the drying time. The viscosities of standard ink 1is 1.05cp. The viscosities of samples A,B and C were 1.11cp 2.87cp and 1.32cprespectively. The viscosities of samples A and C are closer to that of the standard than sample B.

The drying time of the standard ink is 2.21 seconds; this is due to the low viscosity of the ink. As a result of this quick drying time and low viscosity, the ink erases quickly. The drying time of samples A, B and C are 2.87, 10.83 and 4.68 seconds respectively. The drying time of the ink is a function of the viscosity. The drying time of samples A and C are closer to standard than sample B; this is because they have lower viscosities. Low drying time is necessary for easy erasability so that the ink components will stick to the surface instead of being absorbed. The erasability of standard ink is high; the ink samples A and C are easily erased while sample B is not easily erased. This is because of the relatively low viscosities and drying time. Sample B does not erase easily because the drying time is long; the quicker the drying time, the easier the erasability.

The pH of standard ink is 5.5 making it slightly acidic. This is due to the presence of Sulphur (VI) Oxide SO_3, an acidic gas which is a precursor of H_2SO_4. The ink is not highly acidic due to the presence of other basic substances shown in Table 4such as chlorine and magnesium oxide. The pH of sample A is 6.2 making it slightly acidic, pH of sample B is 4.8 which is acidic and pH of sample C is 7.6 which is alkaline. The difference in pH is as a result of the polyvinyl acetate and the type of pigment used. Samples A and C are closer to neutrality than sample B but can also be used since the ink does not come in bodily contact with the user.

The standard ink and sample A, B, C as could be seen in Table 5, contains the following elements in concentration (wt %) as the active ingredient Al_2O_3, SiO_2, Cl and TiO. They also contain the following in minute concentration K_2O, MgO, Cr_2O_3, Mn_2O_3, Fe_2O_3 as depicted in Table 5.SiO_2 has the highest percentage in both the standard ink and the three samples, this is because silicone serves as an antifoaming agent to regulate foam efficiency, an anti-caking agent to prevent the ink from solidifying, and also makes the ink slippery ink order to prevent the ink from reacting with the surface in contact. Chromium and manganese are heavy metals which accounts for the toxicity, their percentage being low makes the standard ink and the samples non-toxic and also eco-friendly.SO_3 and Cl_2 accounts for the acidic level but the acidity of the ink can be also b as a result of the materials being used.

4.0 Conclusion and Recommendations

4.1 Conclusion

Sample A stood out as the best in quality with the following; pH (6.2), viscosity (1.11cp), and drying time (2.87), which compared favorably with the standard ink with pH of 5.5, viscosity of 1.05cp, and a drying time of 2.21s. The locally produced ink would as much as possible create much market at an affordable cost.

4.2 Recommendations

More research would be necessary in the area of producing the felt tip marker and also a locally sourced drying agent would be required.

Acknowledgments

The authors wish to acknowledge the TETFUND institutional based fund for their financial support in this research work.

References

Cordova A (2008). washable marker ink composition retrieved 4th nov 2013 from http://wwww.google/patent/us7455725

Kipphan, Helmut(2011). Handbook of print media :technologies and production methods (illustrated ed.)springer pp.130-144

Larrie R.A and Deardruff A. erasable inkjet composition retrieved 6th December 2013 from http://www.google.com.ng/patent/wo1993024565a|?cl=en

Lyons M (2011). books:a living history los Angeles: J. Paul Getty museum

Magaret A.E (2014). production of quick drying erasable and nontoxic ink as a refiller for white board marker from locally available raw material unpublished ND dissertation chemical engineering department Kaduna polytechnic.

McCabe et al, (1986). Momentum, Heat, and Mass Transfer Fundamentals edited by

Robert Greenkorn.

Palm K (2009). How product are made , marker forum retrieved 7th july 2014 from http://www.madehow.com/volume-3/marker.htm

Sunday C, (2012). Production of quick drying erasable and non toxic ink as a refiller for white board marker from locally available raw material unpublished ND dissertation chemical engineering department Kaduna polytechnic.

Smolinske Susan (1992). handbook of food drug and cosmetic excipient p.7 isbn 0-8493-3585-x

Venise C.(2014). feasibility of charcoal and used engine oil as an alternative retrieved 4th july from http://prezi.com/q_oggtveeecw/feasibility-of-charcoal-and-used-engine-oil-as-an-alternative/