Thermophysical Properties of Shoe Polish Manufactured from Pure Water Sachet

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Abstract

The thermophysical properties of shoe polish manufactured from wastewater sachet was investigated. Wastewater sachet was pyrolyzed at various temperatures to obtain wax yield. The other types of wax obtainable were discussed. A formulation is developed with the wax generated. Shoe polish is made from the paraffin wax obtained from the thermal decomposition of pure water sachet in a reactor. This recovery process helps in the disposing of what was hitherto a waste thereby reducing environmental pollution. The recovered product is tested for its thermophysical properties such as density, viscosity pour point and melting point. These properties were compared with a foreign manufactured shoe polish. The highest wax yield was obtained at a temperature of 160°C yielding 59.8g in 12 min.

Keywords: *Paraffin wax, pyrolysis, paraffin, reactor, environmental pollution.*

Introduction

Raw material is essential in any manufacturing industry. Pure water sachet is one of the most endemic pollutants in Nigeria. Why not convert waste to wealth?

In the manufacture of shoe polish, wax is reacted with resins which provide the thin film on the shoe after polish has been applied and shined. Volatile solvents are also used to give it a quick drying effect. Water acts as a solvent while different dyes can be used to give it the coloration (De Bussy 1972).

The wax used in this project is a readily available raw material. This can be used to replace the foreign waxes used in the manufacture of polish. General properties of polish include glossiness, quick-drying, thin layer formation and being decorative.

Polish and its Functions

This is a substance which could either be liquid or pasty and which is used to restore the original luster and finish of a smooth surface. In this instance, the surface we have considered is that of a shoe. It is expected also that a polish will clean the surface and prevent deterioration.

Due to surface tension forces, a glossy surface is created after polishing. This will dry to give the object the required luster. The polish has to be resistant to corrosion, smooth, transparent, uniform in color, be adhesive, glossy and also thin. Most polishes depend on wax or oil for their polishing properties. Wax polishes are however more long lasting (Okanlawon 2005).

Types of Polish

Basically there exist two types of polish. (1) Waterless - this is clear or translucent. (2) Water based - this is milky in appearance.

General Properties of Polish

i. Gloss: forms the basis for the decorative and protective properties of polish.
ii. Quick-Drying: the precipitation of dust on the polished surface occurs when there is low drying rate.
iii. Thin-Layer formation: this serves as a barrier between the polished surface and the moisture filled environment. This inhibits corrosion.
iv. Decorative: The polish must look smart and nice (Hans-George 1977).

Purpose of Work

This project is aimed at establishing that useful products can be obtained from what is known as a major environmental waste product in Nigeria. The pure water sachet is a non-biodegradable waste and poses great threat to man and the environment.

Motivation

In Nigeria, we see pure water sachet littering everywhere on the streets. It forms about 50% of most of the domestic waste generated due to the relevance of drinking water to humanity and existence. These sachets are non-biodegradable and are harmful if left in the soil for years. Out water table also stands the risk of pollution by this waste.

The most common method of disposing this waste present is by burning. This has its own harmful impact on the air as it releases CO, CO_2, SO_2, etc., into the atmosphere. CO_2 and SO_2 dissolve in the atmosphere and form weak acids that fall back to the earth as acid rain. Carbon monoxide causes heart diseases and also affects man's central nervous system leading to death.

Objectives

The objective of this project is the sanitization of the environment and also developing a long term solution for waste conversion and environmental friendliness. It also looks at developing capacity of industries in the country using raw materials obtained from this country instead of foreign wax importation. There is also economic advantage as wealth will be generated and employment created.

Scope of Work

This work covers the pyrolysis of waste pure water sachet to get wax. The wax is then tested for properties like melting point, pour point, viscosity and density. The wax is used alone and then also in addition to paraffin wax to manufacture shoe polish. The properties of these polishes are compared with two standard foreign polishes viz Kiwi and Lude.

Literature Review

The physical definition of wax comes from a substance between resins and fats and chemically it is defined as "an ester of a long chain aliphatic acid with a long chain aliphatic alcohol (Chalmers 1979).

A better definition also states that wax is the collective name for a series of natural or synthetically produced substances that possess the following properties; kneadable at 20°C, brittle to solid, coarse to finely crystalline, translucent to opaque but not glass like, melts at about 40°C without decomposition, of relatively low viscosity even slightly above melting point, not tending to stringiness, consistency and solubility depending on the temperature and capable of being polished by slight pressure (Perry and Chilton 1973).

Both natural and manufactured waxes are finding application in the manufacture of polish. Natural waxes which have general importance in this field are paraffin and microcrystalline waxes, waxes of vegetable oil origin such as carnauba and waxes of animal origin such as spermaceti (Perry and Chilton 1973).

Materials and Methods

Experimental Procedure

Waste pure water sachets were collected, washed and dried to make them clean. They were weighed into samples of 100g each. Each of these samples was charged into a reactor. The reactor was placed on a heat source and the outlet immersed in water. For each sample, the temperature and reaction time is noted. This was to enable the determination of temperature and time at which highest yield was obtained.

The procedure below outlines the manufacturing process of the shoe polish using wax generated above.

Paraffin wax was melted along with the wax obtained from the above experiment. The melting of the wax was done in a double boiler (the water in the outer container must be at a boil). I ensure a proper mix of both waxes and then introduced stearic acid and stirred the dissolved mixture. Thereafter, turpentine was introduced while still stirring to ensure a proper mix with all flame removed. The mixture was allowed to cool to 41°C and poured into a container for storage. The polish was allowed to stay undisturbed for the night.

Polish Formulations

Three different formulations of polish were prepared and labeled samples A, B and C. the three samples were also compared with the two standard polishes labeled D (Kiwi) and E (Lude).

In Table 1, sample B had the highest percentage of wax from the pure water sachet followed by sample C, and then sample A.

Table 1. Percentage of ingredients in the formulations.

Constituent	A (%)	B (%)	C (%)
Sachet wax	11.9	33.3	21.4
Paraffin wax	21.4	-	11.9
Stearic acid	12.1	12.1	12.1
Turpentine	54.5	54.5	54.5

Laboratory Measurements

The following properties of the wax obtained above were determined using laboratory experimental procedures; density, melting point and relative density.

Melting Point

A quantity of wax was put in a dish and placed on an electric heater. A thermometer was placed in the dish to monitor the temperature. The wax melted at 45°C.

Density

Using a digital weighing balance, a quantity of the wax was put into a beaker and weighed. The same quantity of wax was put in a measuring cylinder containing a known volume of water. The change in volume was noted and recorded. The density of wax was calculated to be as follows:

$$Density = Mass/Volume = 60.30 \text{ g}/ 80 \text{ ml} = 0.754 \text{ g/ml}.$$

Relative Density

This refers to the density of the wax with reference to the density of water at 4°C:

$$R.D. = 0.754 \text{ g/ml} / 1.0 \text{ g/ml} = 0.754.$$

Flow Diagram

The flow diagram of polish manufacture is shown in Fig. 1.

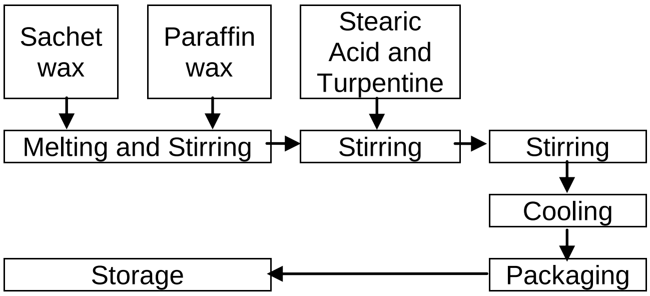

Fig. 1. Flow diagram of polish manufacture.

Results and Discussions

Table 2 below shows the reaction time, temperature and yield of wax during the pyrolysis of waste water sachet. The highest yield of 59.8% was obtained at 160°C in 12 minutes. Above 160°C, the sachets melted into fuel oil.

Table 2. Reaction time, temperature and wax yield.

Sample	Temp. (°C)	Wax yield (%)	Rxn time (min)
1	120	8	13
2	130	10	15
3	140	10	14
4	150	31.64	20
5	150	22.9	20
6	150	57.5	60
7	160	59.8	12

Properties of Wax after Pyrolysis

Table 3 shows the properties of the sachet wax after pyrolysis.

Table 3. Properties of wax after pyrolysis.

Properties	Values
Melting point	45°C
Density @ room temperature	0.754 g/ml
Relative density	0.754

Thermophysical Properties of Manufactured Polish

Table 4 shows the thermophysical properties of polish produced from waste water sachet and other known standard polish.

Samples A, B and C were prepared using the formulation as discussed earlier while samples D and E are the control samples which are Kiwi and Lude, respectively.

In analysis, sample E had the highest melting point followed by D, A and then B/C which had the same melting point. There are evident differences in the pour point of all samples. There are also significant differences in the density and relative density of the samples with exception of sample B which was too hard to melt even at 60°C. Sample A compares favorably with the control polish used for comparison.

Table 4. Comparison table.

Properties	A	B	C	D	E
Melting point (°C)	28	26	26	32	39
Pour point (°C)	-8	-18	-12	-7	-5
Density (g/ml)	0.63	Too hard	0.68	0.62	0.62
Relative density	0.63	Too hard	0.68	0.62	0.62

Viscosity of Polishes at Different Temperatures

Table 5 shows that increase in temperature affects the viscosity of the samples. Viscosity value decreased with increase in temperature for all samples. Sample B was too hard to melt. This could be attributed to its composition having 33% of the pure water sachet wax.

Table 5. Viscosity values.

Temp. (°C)	A	B	C	D	E
40	2.39	Too hard	0.57	Too viscous	8.24
50	2.03	Too hard	0.33	Too viscous	3.67
60	0.35	Too hard	0.19	0.69	3.14

Conclusion

1. Shoe polish can be produced from pure water sachet.
2. One of the economic advantages of the project is in the use of 12% sachet wax which is a waste product in addition to paraffin wax to produce the shoe polish.
3. Shoe polish produced from pure water sachet when compared with foreign shoe polish has a slight difference on all properties except the viscosity.
4. The other economic advantage of this project is that wealth generation and employment opportunity can be created.

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