PRODUCTION AND CHARACTERIZATION OF LIQUID DETERGENT USING POTASSIUM HYDROXIDE SOURCED FROM AN AGRICULTURAL PRODUCT IN NIGERIA

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Abstract

This paper deals with the production and characterization of liquid detergents using Potassium Hydroxide obtained from an agricultural product (ash from banana leave). Three Samples A, B and C of the detergent were produced. Sample A contains all the ingredients but no Sodium Silicate in its composition. Similarly, Sample B has all the ingredients but no Magnesium Sulphate while sample C contains all the ingredients including Sodium Silicate and Magnesium Sulphate. The characterization of the detergents was based on their detergency, foaming ability, pH, viscosity, hardness in well water and free oxide. The analysis of the results shows that Samples A, B and C have their active detergencies as 14.5, 13.82 and 13.95 % respectively. Sample A appears to have the highest quality while Samples B and C give close values of detergency.

Keywords: Detergency, hardness, free oxide, ingredients, viscosity

Introduction

Detergent is a substance used to enhance the cleaning action of water. A detergent can be viewed as an emulsifier that has the ability to penetrate and break up the film that binds dirt particles and a wetting agent. The dirt particles consequently float off (Abegunde, 2007). Emulsifier molecules have oil like non-polar portion which is drawn into the oil, and a polar group that is water-soluble, by bridging the oil-water interface (Bello, 2006). The oil is thereafter broken into dispersible droplets. Also, a detergent acts as surfactant by decreasing the surface tension of water and helps it penetrate the soil (Abegunde, 2007). The properties of surfactants and their intermediates were once studied by surface tension and conductivity measurements (Hujun, *et al.*, 2012). Biosurfactants are more environmentally friendly than their synthetic counterpart (Khajebafgra *et. al.*, 2012).

In view of the growing economic need of Nigeria, it has become necessary to produce liquid detergent using simple method. This can be achieved by using available raw materials which will be within the reach of the majority of the populace. Moreover, there has been an increase in consumer preference for liquid detergent over its powder counterpart over the last two decades (Caln and Lai, 2006). This is because liquid detergent is more convenient to use and it is easily soluble in places where washing is done at low temperatures (Lund *et al.*, 2011).

Detergents are used for cleaning purposes in a wide range of substances/surfaces. These include textiles, human skin, floors and walls, cooking utensils, glasses, sinks, baths and drainage surface (Bello, 2006). Generally, detergents can be in form of powder, tablets, liquids or flakes for all kinds of washing.

Detergency

Detergency or active detergent (AD) is used to measure the activity or quality of the sample. The measurement of detergency is necessary in studying the mechanism of detergency. Measurement of detergency can be achieved in two ways. The first one is measured by the relative quantity of soil

bound to the substrate prior to washing and after washing. In the second approach, major emphasis is placed on developing controllable laboratory. This second method is more reliable in assessing the performance of a detergent in water (Abegunde, 2007). Another measurement of detergency is by physical observation, which is cleaning result after inspection.

Detergent formulation and properties of detergents

The typical components of detergent formulae include surfactants, alkali, water, viscosity builders, EDTA, formalin, colour and perfume. Parameters for the characterization of detergent include the following: Active detergent, Lather Volume, Free oxide, Viscosity, Hardness and pH. The properties of detergent generally include wettability, surface tension, foaming actions, emulsifying activity and dispersing tendencies.

Experimental Work

Sample Preparation

The major raw material used in the production of the liquid detergents is potassium hydroxide (KOH) otherwise known as caustic potash. It is white in colour, highly deliquescent caustic solid and can be obtained in several form including pellets, flakes, lumps and powder. It can be produced from various agricultural products such as wood ash, cocoa pods, banana leaves, maize cobs and stalks etc. But for this work, banana leaves and husks were used.

Production of Potassium Hydroxide Using Banana Leaves and Husks

A reasonable amount of banana leaves and husks were gathered, dried and ashed in a furnace at a temperature range of 400^0C to 440^0C. The resulting ash is then retrieved and sieved through a mesh. The ash was then boiled with water to extract caustic potash in good concentration. Some quantities of the ashes were then packed in a porous container. Reasonable amount of water was heated to boiling and transferred into the ashes in the porous container to obtain slurry. A clean container was kept at the bottom of the porous container for the collection of the potassium hydroxide. The solution collected is then filtered off to remove unwanted materials.

Procedure for Liquid Detergent Production

About 80 % of water (80 % of 2 kg which is 1.6 kg) was measured into a reaction vessel with a stirrer. About 13 % sulphonic acid was measured and added to the water. It was followed by addition of about 3.7 % caustic potash. It was thoroughly stirred for about 5 to 10 minutes. Some sample was taken and checked for pH. The pH measurement was then repeated for between 5 to 7 minutes onward. The expected value for the pH was between 4 and 6 depending on the concentrations of acid and caustic potash in the mixture. Thus, the pH value was continuously readjusted using acid and caustic potash to obtain the desired pH range (4 to 6). When this range was obtained, other ingredients were added starting with Magnesium Sulphate ($MgSO_4$) of about 1.5 % with continuous stirring. About 0.1 % E.D.T.A , 0.002 % colour and 1 % formation were added while the reaction mixture was vigorously stirred. Finally, about 0.2 % perfume was added and stirred continuously for another 5 minutes. This procedure was repeated for two other samples with differences shown in Table 1 to obtain detergents A, B and C. Various properties of Detergents A, B and C as tested are as shown in Tables 2, 3 and 4.

Table 1: Detergent composition

Ingredients	Sample (Detergent) A	Sample (Detergent) B	Sample (Detergent) C
Water (g)	1600	1600	1600
H_2SO_4 (g)	260	260	260
KOH (g)	74	74	74
Silicate	-	30	30
$MgSO_4$(g)	30	-	30
E.D.T.A (g)	2	2	2
Colourant (g)	0.04	0.04	0.04
Formalin (g)	20	20	20
Perfume (g)	4	4	4

Results

Table 2: Sample (Formulation) A

Active Detergent value	14.50 %
Free oxide value	0.0209 %
Total hardness	115 ppm
Lather Volume	3.94 cm^3
Viscosity	280 cp
pH	10.60

Table 3: Sample (Formulation) B

Active Detergent value	13.82 %
Free oxide value	0.0419 %
Total hardness	60 ppm
Lather Volume	3.95 cm^3
Viscosity	300 cp
pH	10.70

Table 4: Sample (Formulation C)

Active Detergent value	13.95%
Free oxide value	0.0419%
Total hardness	110 ppm
Lather Volume	3.95cm^3
Viscosity	280 cp
pH	10.20

Discussion of Results

In the research carried out, Detergent A contains all the ingredients except Sodium Silicate while Detergent B has all other ingredients with the exception of Magnesium Sulphate. Detergent C contains all the ingredients including Sodium Silicate and Magnesium Sulphate.

From the results of active detergent (AD) titration, which is a measure of the activity of a detergent, it was observed that detergent A with (AD) 14.50 % is of highest quality of all the three detergent produced. Sample C is second with 13.95 % while sample B closely follows with AD (13.82 %).

Free oxide indicates the unreacted caustic or excess caustic in the detergent. Thus, the higher the free oxide in a detergent, the lower the quality of such a detergent. This is because free oxide if present in large quantity, can affect the skin of the user and even, the fabric. Since the free oxide of sample A is the least, detergent A appears to be of highest quality.

Lather volume determines the foaming ability of the samples. From the results, the foaming ability of the three samples is almost the same. Hardness determination is a measure of the detergent ability to function in hard water. From the result of the samples, detergent B appears to have the lowest total hardness based on the removal of Magnesium Sulphate that can easily react with calcium ion to form calcium sulphate (calcium hardness).

Conclusions

Liquid detergents have been successfully produced using ash from banana leave as the source of potassium hydroxide. The pH of the solutions of detergents A, B, and C were in good range (basic). The active detergent of detergents A, B, and C ranges between 13.82 % and 14.50 %. The total hardness of the solutions of detergent A, B and C were 115 ppm, 60 ppm and 110 ppm respectively. The foaming ability of the detergent solutions A, B, and C are also in close range. The detergents produced have viscosity values of 280 cps, 300 cps and 280 cps for Samples A, B and C respectively. The free oxide of the solution of detergent A was 0.0209 % while detergents B and C were 0.0419 %. The observed free oxide of solution of detergents A, B and C are 0.0209 %, 0.0419 % and 0.0419 % respectively.

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