

STATISTICAL DESIGN OF POLYVINYL ACETATE

EMULSION PAINT

BY

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FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG (E))
DEGREE IN CHEMICAL ENGINEERING.**

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DECLARATION

I AYENERO, GLORIA OLAMIDE with matric no: 2004/20849EH declares that this research project report is my original work and has not been presented elsewhere to the best of my knowledge.

Ayenero Gloria Olamide

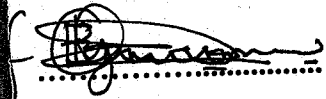
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Ayenero Gloria Olamide

Date

CERTIFICATION

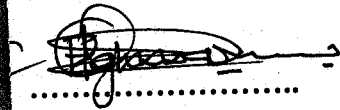
This research project by Ayenero Gloria Olamide (2004/20849EH) has been examined and certified under the supervision of Dr.M.O EDOGA to the adequate in scope and quality for the partial fulfillment of the requirement for the award of Bachelor of Engineering (B.ENG) in chemical Engineering.



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EXTERNAL EXAMINER

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DATE

DEDICATION

This research project work is dedicated to the Almighty God, the creation of heaven and earth, the tribe of the Lion of Judah, the King of Kings, for his greatness, power, glory, majesty, splendor, righteousness and for his love for me and the salvation of my soul.

I also appreciate the efforts of my beloved friend Oni Tony Uwadiale, for his support, knowledge, motivating, encouragement over this research work, I wish him good in all his endeavours, may he see dreams come true.

My appreciation goes to others who have contributed one way or the other to the success of this project.

Finally, I appreciate the efforts of my dear friends, Senu Priscilla, Iperin peace, Muzee Simon, Momoh Emmanuel. For contributing immensely to the successful completion of this project. May God bestow them with long life.

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1.3 Justification

The justification of this research work is to improve the quality of polyvinyl acetate to ascertain its conformity to standard value.

1.4 Limitation

In the course of this study the limitation encountered are lack of materials ,equipment and source of fund.

2.1 Properties of Polyvinyl acetate

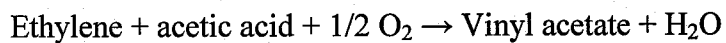
1. It is a colorless liquid.
2. It has a boiling point of 72.7°C, 346K, 163°F.
3. It has a molar mass of 86.09g/mol.
4. It has a melting point of -93°C, 180K, -135°F.
5. It has a molecular formula of C₄H₆O₂.

2.1.1 Uses of polyvinyl acetate

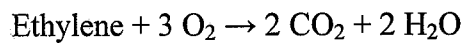
1. It is used as water based paints
2. It is used for paper coatings
3. It is used as an adhesive.

2.1.2 Preparation of vinyl acetate

The major industrial route involves the reaction of ethylene and acetic acid with oxygen in the presence of a palladium catalyst.



But also byproducts are also generated:



Vinyl acetate is also prepared by the gas-phase addition of acetic acid to acetylene.

3. Since polymer molecules are contained within the particles, viscosity remains close to that of water and is not dependent on molecular weight.
4. The final product can be used as is and does not generally need to be altered or processed.

2.2.2 Disadvantages of emulsion polymerization include:

1. Surfactants and other polymerization adjuvant remain in the polymer or are difficult to remove.
2. For dry (isolated) polymers, water removal is an energy-intensive process.
3. Emulsion polymerizations are usually designed to operate at high conversion of monomer to polymer. This can result in significant chain transfer to polymer.

2.3 History

The early history of emulsion polymerization is connected with the field of synthetic rubber. The idea of using an emulsified monomer in an aqueous suspension or emulsion was first conceived by workers at Bayer, before World War I, in an attempt to prepare synthetic rubber. The impetus for this development was the observation that natural rubber is produced at room temperature in dispersed particles stabilized by colloidal polymers, so the industrial chemists simply tried to duplicate these conditions. The Bayer workers used naturally occurring polymers such as gelatin, egg albumin, and starch to stabilize their dispersion. By today's definition these were not true emulsion polymerizations, but suspension polymerizations.

The first "true" emulsion polymerizations, which used a surface-active agent and polymerization initiator, were conducted in the 1920s to polymerize isoprene. Over the next twenty years, through the end of World War II, efficient methods for production of

several forms of synthetic rubber by emulsion polymerization were developed, but relatively few publications in the scientific literature appeared: most disclosures were confined to patents or were kept secret due to wartime needs.

After World War II, emulsion polymerization was extended to production of plastics. Manufacture of dispersions to be used in latex paints and other products sold as liquid dispersions commenced. Ever more sophisticated processes were devised to prepare products that replaced solvent-based materials. Ironically, synthetic rubber manufacture turned more and more away from emulsion polymerization as new organometallic catalysts were developed that allowed much better control of polymer architecture. [Witby and Katz, 1933]

2.4 Theory

The first successful theory to explain the distinct features of emulsion polymerization was largely developed by Smith and Ewart, and Hawkins in the 1940s, based on their studies of polystyrene. Smith and Ewart arbitrarily divided the mechanism of emulsion polymerization into three stages or intervals. Subsequently it has been recognized that not all monomers or systems undergo these particular three intervals. Nevertheless, the Smith-Ewart description is a useful starting point to analyze emulsion polymerizations.

The Smith-Ewart-Harkins theory for the mechanism of free-radical emulsion polymerization is summarized by the following steps:

- A monomer is dispersed or emulsified in a solution of surfactant and water forming relatively large droplets of monomer in water.
- Excess surfactant creates micelles in the water.
- Small amounts of monomer diffuse through the water to the micelle.
- A water-soluble initiator is introduced into the water phase where it reacts with monomer in the micelles. (This characteristic differs from suspension polymerization

Dispersions prepared with such stabilizers typically exhibit excellent colloidal stability (for example, dry powders may be mixed into the dispersion without causing coagulation). However, they often result in products that are very water sensitive due to the presence of the water soluble polymer. [Odian, 1991]

2.6.6 Others

Other ingredients found in emulsion polymerization include chain transfer agents, buffering agents, and inert salts. Preservatives are added to products sold as liquid dispersions to retard bacterial growth. These are usually added after polymerization, however. [Odian, 1991]

2.7 Applications

Polymers produced by emulsion polymerization can be divided into three rough categories.

- **Synthetic rubber**
 - Some grades of styrene-butadiene (SBR)
 - Some grades of Polybutadiene
 - Polychloroprene (Neoprene)
 - Nitrile rubber
 - Acrylic rubber
 - Fluoroelastomer (FKM)

- **Plastics**
 - Some grades of PVC
 - Some grades of polystyrene
 - Some grades of PMMA
 - Acrylonitrile-butadiene-styrene terpolymer (ABS)
 - Polyvinylidene fluoride

CHAPTER THREE

3.0 METHODOLOGY

In to carryout this research project work, the equipment and raw materials used are:

3.1 Materials and Equipment

The equipment and raw materials used in carrying out this research work is:

Table 3.1 List of Materials Used

MATERIALS	SOURCE	COMMENT
VAM(vinyl acetate monomers)	China	A colorless liquid with sweet smell in small quantities, pleasant fruity, characteristic odor.
Potassium persulphate($K_2S_2O_8$)	Germany	In powdery form
Vinyl alcohol(PVOH)	China	A colourless liquid
Sodium larry sulphate (SLS)	Germany	In powdery form
Gohesenol	Germany	In powdery form
Sodium benzoate	England	In powdery form
De-ionized water	England	A colourless liquid

3.3 Characterization of Sample

3.3.1 Determination of pH test.

8ml of the sample was weighed and put into the beaker.

3ml of distilled water was also weighed and poured into the beaker.

The contents of the beaker were stirred to have uniformity of solution.

The pH of the resulting solution was determined by immersing the pH electrode into the solution in the beaker.

3.3.2 Determination of viscosity

50ml volumetric flask was used to dilution 0.75wt%, of the sample.

Viscometer was place in temperature bath of 20⁰C

The sample 0.75wt% was apply to suction A while holding finger over tube B

The sample was brought above C into bulb D.

Efflux time was measured by allowing the sample to flow freely through bulb F.

The flow was stop when the meniscus reaches mark E

Viscosity value was taken at mark

react due to the fact that vinyl acetate monomer is an excellent conductor of heat which at this point removes heat from the system. This temperature continues to decrease until growing chain of the monomer terminates and reaction is complete.

The pH test carried out was confirmed to be 7.9 and viscosity value is 0.2 which is appropriate equal to the standards value.

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APPENDIX

All conversion made on a basis of 50ml Erlenmeyer flask.

Total monomer added= $0.49 \times 50\text{ml} = 25\text{ml}$.

* Initial addition of 5ml and total intermittent addition of 20ml.

Volume of emulsifier used= $0.2 \times 50\text{ml} = 10\text{ml}$

Total volume of Initiator used= $0.00147 \times 50\text{ml} = 0.0735$.

Buffer is added intermittently to regulate the p H but the total amount added 0.0735.

Constituent	Proportion(Parts)	Volume(ml)
Vinyl acetate monomer	0.4900	25
Emulsifier(PVOH)	0.2000	10
Initiator	0.00147	0.0735