INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

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Research Paper

Energy Efficient Approach for Alkyd Resin Manufacturing

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ARTICLE INFO

Published: 12 Sept 2026
Keywords:
Novel alkyd resin, renewable sources, conventional process
DOI:
10.5281/zenodo.22723420

ABSTRACT

Recently, the use of renewable sources in the preparation of various industrial materials has been revitalized because of the environmental concerns. Natural oils are considered to be the most important class of renewable sources. They can be obtained from naturally occurring plants, such as sunflower, cotton, linseed. Novel alkyd resins have been synthesized in a laboratory. Alkyd resins were investigated by selecting different compositions based on Linseed oil, glycerol, phthalic anhydride, maleic anhydride, rosin and benzoic acid. The sodium bisulphate and sodium bisulphite are taken as catalyst to enhance the rate of reaction. The time required in the process is about 7-8 Hrs. which is very less compared to the 12 hrs in conventional process. The temperature for the process is around 2000C compared to the 225-240 0C conventional.The method is developed in which risk of over polymerization has been avoided using chain stopper. Thus it saves the energy required for the process.The success rate of each batch is also low in conventional method because of over polymerization and gelation resulting in loss of energy and material. The cost of novel alkyd resin is less than the commercial, as it uses more agro base products and less energy.

INTRODUCTION

Alkyd resins[4] are the most important and most extensively used synthetic resin in the industries. They are classed as polyesters because the large molecules are building up as a result of esterification reaction. Alkyd resins are short branched polyester resin form by the polycondensation of dibasic and polyhydric alcohols in the presence of glyceride oil. The petrochemical based Surfactant has somewhat tarnished image because of their past association with environmental pollution, foaming river and eutrophication were often linked with surfactant. The new class of surfactant was introduced that is polymeric surfactant. Most of polymeric

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

surfactants are biodegradable in nature and prepared from renewable sources [1, 2]. The present work is attempt to synthesis short oil alkyd polymer.

In the present paper the preparation of Alkyd polymer and its characterization and usefulness in detergent formulation is discussed. The main aim of this paper is to focus on Preparation of Alkyd polymer based on short oil length. Alkyd resins are produce in closed kettle than the open kettles because in open kettle, there is a considerable loss of phthalic anhydride from sublimation. However this loss is not serious in a properly closed kettle and does not occur at all in the solvent method.

Manufacturing processes for alkyd [8, 9]

Alkyd resins are produce in closed kettle than the open kettle because in open kettle, there is a considerable loss of phthalic anhydride from sublimation. However this loss is not serious in a properly closed kettle and does not occur at all in the solvent method. The kettles are usually made of stainless steel. Since modified oils and some resins require cooking under vacuum, Kettle is made strong enough to prevent collapse when their air content is evacuated with vacuum pumps. They have variable speed mixing agitators, which operate at peripheral speeds of 400-1100 rpm. The principal heating and cooling of all-purpose closed kettles is generally done with heat transfer liquids pumped through jackets. The heat transfer liquids are non-flammable, non- corrosive chemical such as Therminol FR. These liquids are heated in oil or gas fired furnaces separated from the resin manufacturing plant by firewalls and pumped through the kettle jackets and baffles as desired. Resin plants require condenser or recover solvents and reaction components that might otherwise be lost. These condensers are also made of noncorrosive material such as a stainless steel to prevent contamination of recovered materials. A decanter is required to separate water, which is a reaction product in the manufacture of resin. Two general processes can make alkyd resin are:

a. The fatty acid process

b. The monoglyceride process (two stage process). These processes may be carried out by direct fusion of the materials (Fusion method), or by fusion in the presence of solvent (solvent method).

a. **In fatty acid process**, the ingredients are placed in the reaction kettle and heated at temperature ranging from 220°C to 300°C or higher. The batch is held at reaction temperature until the desire acid value and viscosity have been reached. In fatty acids process it is assumed that the free hydroxyl groups in a glycerol phthalate molecule can be used to esterifies drying oil fatty acid molecules.

b. The monoglyceride process

It is assumed that a drying oil is split into its two components, glycerol and fatty acids, then the glycerol portion is added to the glycerol used in the initial glycerol-phthalic anhydride formulation, while the drying oil fatty acid is cooked into the glyceryl phthalate resin at temperature of 180-250°C. In monoglyceride process, drying oil is first made to react with glycerol, and an intermediate product called a monoglyceride is obtained, which can then react with phthalic anhydride, to form a homogenous alkyd resin. By heating Coconut oil and the requisite amount of glycerol together at 250-280°C, monoglyceride is formed. The monoglyceride product contains two free hydroxyl groups and can regard as a derivative of glycerol. As such it reacts easily with phthalic anhydride at the usual esterifying temperatures of 180-250° C to give an alkyd resin.

Chemistry of alkyd formation[7]

Alkyd resins are essentially polyesters of polyhydroxyl alcohols and polycarboxyl acids

chemically combined with the acids of various drying, semidrying, non drying oils in different proportions. The chemical reactions that occur during preparation of alkyd resins are as follows:

1. Condensation reaction among alkyd ingredients or alkyd modifiers including esterification, ester alcohol or acid exchange and etherification.

$$RCOOH + ROH \longrightarrow RCOOR + H_2O$$

2. Addition reactions of the unsaturated hydrocarbon portion of the monobasic fatty acids, including free radical or Diels alder reactions with other alkyd ingredients, modifiers or oxygen.
3. Addition reactions, especially free radical types with other unsaturated alkyd ingredients.
4. Side reactions such as decarboxylation.

The proposed Process

For preparation of alkyd resin, mixture given was charged and reacted in a standard glass reactor. Xylene, butanol and toluene (1:1:1) were used as solvent. The order of addition of raw material and heating schedule for making eco-friendly resin was standardized. The reaction temperature was around 200^0C. Heating was done for 6.30 hrs and product was cooled to 80^0C. Also the solvent was removed from the product.

Reaction Programming of proposed process

Cooking Schedule for the preparation of Novel alkyd Resin

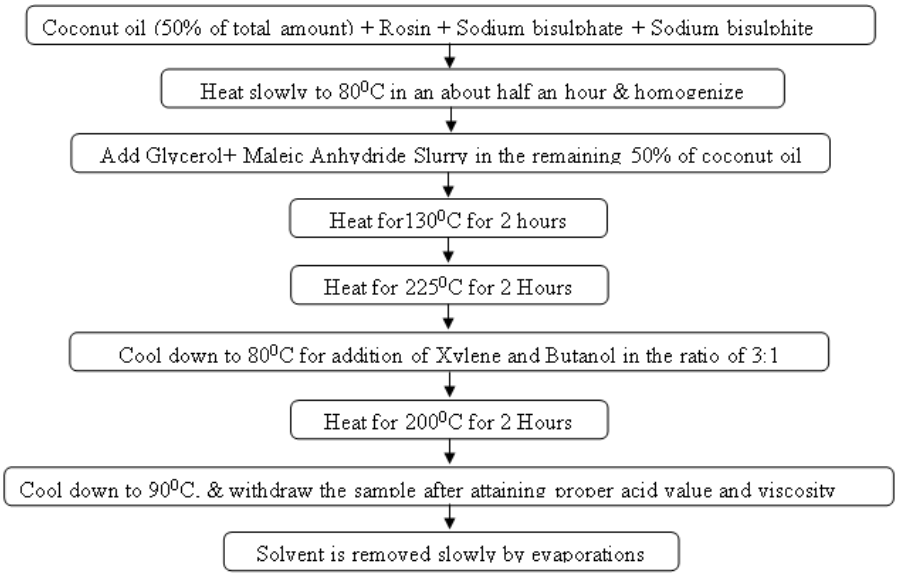
First Step- The reaction was carried out in a 2 liter capacity glass reactor with four opening, condenser and controlled heating of $\pm 2^0$C. At first 50% of total amount of coconut oil, rosin and catalysts were heated slowly at $80^0 \pm 2^0$C for half an hour's then slurry of remaining 50% coconut oil and maleic anhydride with glycerol were added in about 15 minutes.

Second step- First the contents were heated at 130^0C for two hours. This initial heating allows maleic anhydride to sublime and reacts with rosin and oil. Then the temperature was raised to 225^0C and heated the contents for 2 hours. If the heating continue at this temperature, there is a chance of getting gelation and charging.

Third Step- Now the temperatures was brought to 80^0C and Xylene: butanol solvent (3:1 by weight) was added. Now the temperature as raised slowly to 200^0C. Then the reaction was continued for 2 hours. At the end all the solvents were completely eliminated by slowly evaporation at 90^0C. Acid value and viscosity was observed periodically.

Fourth Step: The reaction was terminated when desired acid value and viscosity had attained. Total water removed was measured. Batch was withdrawn and weighted to find out % yield.

Flow sheet of heating schedule and order of addition of reactants of proposed process

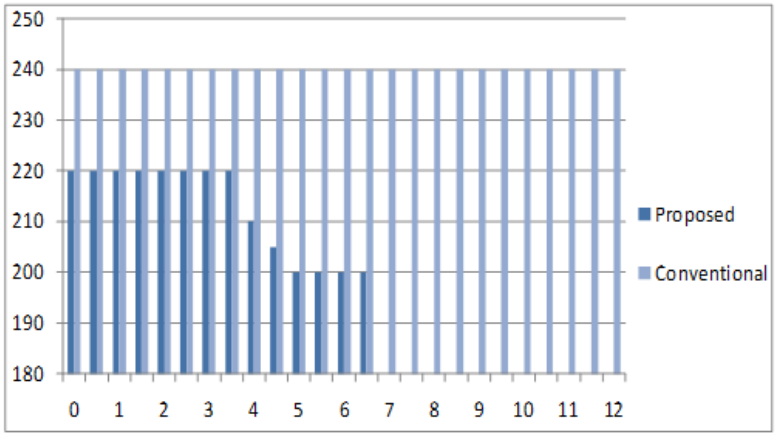


Composition of Alkyd Resin

Ingredients	Composition (by wt %)
Linseed oil	20.0
Glycerol	15.0
Maleic anhydride	10.0
Benzoic acid	1.0
Rosin	53.0

Sodium bisulphite (0.5%) and sodium bisulphate (1.5%) have been used as catalysts. The solvent Xylene and Butanol in the ratio 3:1 has been used in the second phase of reaction (3 to 5% by weight).

Energy Graph



Salient features of proposed process

1. The time required in the process is abt. 7-8 Hrs. which is very less compared to the 12 hrs in conventional process.
2. The temperature for the process is around 200^{0}C compared to the 225-240 ^{0}C conventional.
3. The method is developed in which risk of over polymerization has been avoided using chain stopper.

4. Thus it saves the energy required for the process.
5. The success rate of each batch is also low in conventional method because of over polymerization and gelation resulting in loss of energy and material.

Comparative study

1. Alkyd resin contains agro (50-70%) and petroleum(25%) base raw materials as compared to conventional resin containing 50-70% petroleum based products, which is to be imported. The agro products used are non edible oil and rosin.
2. Rosin imparts the mechanical strength, helps in smooth propogation of polymerization and gives high molecular weight polymer (higher the molecular stronger the polymer).
3. Volatile organic compounds (VOC) content of conventional alkyd resin is 40% while the new alkyd resin was 14%.
4. The alkyd resin produce is highly hydrophilic.
5. Hence it can be used in emulsion polymer.
6. The cost of novel alkyd resin is less than the commercial, as it uses more agro base products and less energy.

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HOW TO CITE: Pravin Dhakite, Energy Efficient Approach for Alkyd Resin Manufacturing, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 9, 1535-1540, https://doi.org/10.5281/zenodo.22723420