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Utilization of Minor Seed Oils for Eco Friendly Coatings

Dr. Prashant. B. Shingwekar, A.L.Rathod
University Deptt. Of Chemical Technology, S.G.B. Amravati University, Amravati

ABSTRACT

Over the years efforts have been made to design eco-friendly specialty chemicals from natural renewable resources. Among different renewable resources like vegetable oils obtained from various seeds spotted largely due to their unique properties, functionalities and worldwide abundant availability. Minor seed oils constitute the single, largest, easily available, low cost, non-toxic,biodegradable family yielding materials that are capable of competing with fossil fuel derived petro-based products. The outstanding feature of minor seed oils is their unique chemical structure with unsaturation sites, epoxies, hydroxyls, esters and other functional groups along with inherent fluidity characteristics. These enable them to undergo various chemical transformations producing low molecular weight polymeric materials with versatile applications, particularly as chief ingredients in paints and coatings. In this manuscript, we have briefly described important vegetable oils derived materials such as alkyds, polyester amides, polyether amides, polyurethanes, epoxies, polyol, along with their preparation and applications as protective coatings.

KEYWORDS: ***Minor seed oils, Eco-friendly, Coatings, Renewable resources.***

1. INTRODUCTION

The consumer and industrial interests in the development of eco-friendly materials have catapulted the environmentally agricultural resources as feed stocks of the polymer indus-try. Today, due to interdisciplinary approaches through research and technological innovations in oleo-chemistry, bio-sciences, biotechnology and engineering, it is possible to design eco-friendly specialty chemicals from nature's abundant renew-able resources. Polymers are obtained from renewable re-sources such as starch, lignin, protein, cellulose, chitosan, shellac, rosin, polyhydroxyalkanoates, furanone, alginate, wool fibres and vegetable oils [VO]. They find innumerable industrial applications such as plasticizers, biodiesel, lubricants, adhe-sives, biodegradable packaging materials, printing inks, paints and coatings. VO are non-toxic, non-depletable, domestically abundant, non-volatile and biodegradable resource. They yield polymers capable of competing with fossil fuel derived petro-based products. Such polymers find applications in the develop-ment of paints and coatings, besides their other industrial appli-cations. Today, due to several environmental and health hazards cropping up from fossil fuel derived products, and fear of depletion of petroleum re-sources by the end of 21st century, the polymer chemists and technologists have reverted to the extensive utilization of VO derived materials in paints and coatings. Several VO based materials have been developed and are tailor made for various end use applications. The area holds immense potential and significance globally.

1.1 Vegetable oils as polymeric coating materials:

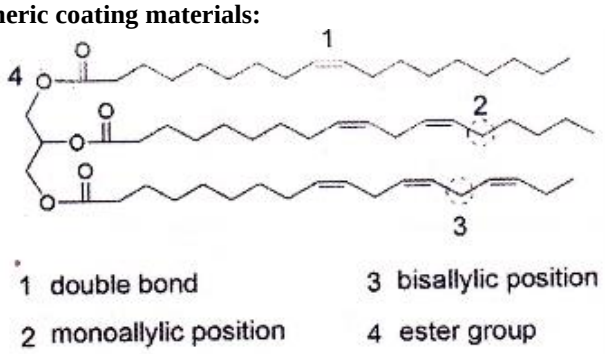

Fig.1: Demonstration of the structure of triglyceride and reactive sites

Vegetable oils (VO) are triglycerides – esters of glycerol with three long-chain depending on the source of oil. A fatty acids with varying compositions general molecular structure of triglycerides is demonstrated in *Fig.1* . They contain suitable functionalities in their backbone such as double bonds, epoxies, hydroxyls, esters and other functional groups that can undergo several chemical reactions. Vegetable oils have the tendency to dry or form films in their virgin forms. Drying is an inherent characteristic of VO and depends upon their unsaturated portion, their conjugation or nonconjugation and the geometrical arrangement of the substituent's

about the double bonds, i.e., Cis or Trans. The physical and chemical properties of vegetable oils are mainly determined by the fatty acid compositions, i.e., the fatty acid chain length and the numbers and locations of double bonds in the fatty acid chains. Usually, the length of the fatty chain is between C12 and C20, with oleic acid (C18:1), linoleic acid (C18:2) and linolenic acid (C18:3) being the most common.

2. ALKYD RESINS

Alkyd resins are the main product of poly (condensation) reaction between polyalcohols, polycarboxylic acids or their anhydrides in presence of fatty acids or vegetable oils. The systematic scheme for formulation of alkyd resin is illustrated by the general formula (Figure 1). Properties of the alkyd resins are governed by constituting materials and their proportions. The two most common methods are used for the synthesis of alkyds; i.e. monoglyceride process and fatty acid process. In the monoglyceride process; alcoholysis of vegetable oil with polyol followed by esterification with polyacids, whereas in fatty acid process polyacids, polyalcohol and fatty acids are added collectively in the reaction vessel and allow to the heat, no intermediate step involve in latter process. Alkyd resin classified on the basis percentage of oil in alkyds referred as oil length. The alkyd resins with oil content less than 40% refers to short oil alkyds, oil contents in between 40-60% medium oil alkyds, whereas, oil contents above than 60% are called long oil alkyds. Oil length is an important factor which governs the properties of final products. Short chain alkyds are useful for baking finishes on washing machine, refrigerator, automobiles, architectural equipments and many others .Medium oil alkyds are normally synthesized from drying and semi drying oils. These resins are used in both airs drying and baking metallic primers and topcoats formulations. Such formulations are extensively used in industrial finishes, house hold articles, wooden and metallic furniture's, electric fans, railways cars, engineering equipments. Long oil alkyds are mainly used in brushing enamels for both external and internal finishes

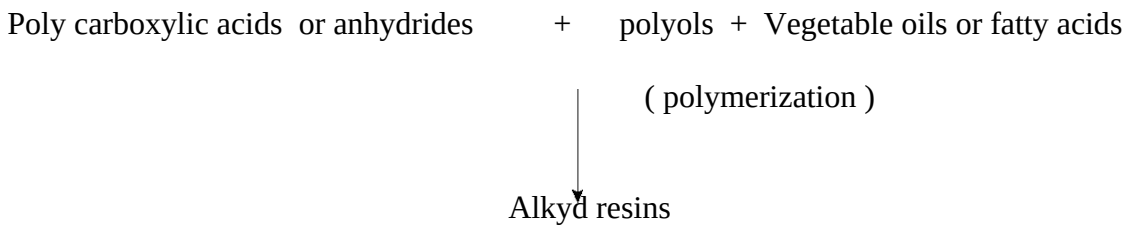

Figure 2: A systematic scheme for synthesis of alkyd resin.

Numerous aliphatic and aromatic polyacids or their anhydrides are used in alkyd resin preparations, like succinic anhydride, maleic anhydride, glutaric anhydride, phthalic anhydride etc. Alkyds of aromatic anhydrides known for better heat and moisture resistance performances as compare to alkyds of aliphatic anhydrides due to presence of benzene rings. The film forming time of the alkyds reduces on increasing the anhydride contents Furthermore, alkyd resin of maleic anhydride shows comparatively shorter time than the alkyds of other anhydride in same proportions Careful selection of the type of polyacids or anhydrides and polyalcohols may help in hampering the gelation of alkyd resin of choice and offers easy control of the process of polymerization for the alkyd resins.

2.1 Modified Alkyds

Alkyd resins of different vegetable oil extensively used as coatings and binder for making paints. However, these coatings and paints show inferior performance when expose to UV radiation, thermal fluctuation, high humid and salty conditions. Under these conditions paints show considerable chalking, colour fading and loss of gloss within few months of exposures. In view to provide more practical and viable utility to the alkyds, several chemical modifications were performed . Modifications of alkyd resins with acrylic monomers offer the possibility of hybrid desirable application and film forming properties of the alkyd with the weathering resistance properties of acrylic systems. The modifications by acrylization have been extensively investigated for different vegetable oil based alkyds.Acrylation performed either by post-acrylation or by monoglyceride methods. The developed acrylated alkyd resin with copolymer of n-butylmethacrylate and maleic anhydride (n-BMA-CO-MA) reported for improve performances in terms drying time, resistance to scratch, adhesion and chemical resistance ability in many corrosive environments

2.2 Water Soluble Alkyd Resins

Water based organic coating materials are eco-friendly and more economical than solvents based coating materials. Furthermore, environmental legislation on volatile organic solvents utilization directed the attention of researchers to developed water based organic coating materials. Alkyd resins of high acid values were prepared for water soluble.

3. DISCUSSION & CONCLUSION

Alkyd resins, derived from different seed oils, extensively used as protective coatings and paints are discussed. The performances of the final resins mainly govern with constituting poly acids and fatty acid compositions of the vegetable oils used as well as their compositions. Careful selections of these materials are required for the syntheses of alkyds of different usages and also to complete the process without any technical difficulties such gelation and charring. Numerous modifications on vegetable oil based alkyds were performed in view to make the polymeric resin more fruitful. VO are abundantly available, easy to procure and cost effective sources of nature. VO have found practical applications as biodiesel, lubricants, cutting fluids , coatings and paints along with other applications. Although the use of VO in paints and coatings is decades old and well studied, today emphasis is being laid on research pertaining to the modifications of these materials to introduce novel properties, improved performance coupled with environment friendliness at affordable costs. With persistent and extensive research efforts, VO coatings may compete well with their petro based counterparts in performance and applications and may establish themselves as ‘‘greener’’ precursors to environment friendly coatings.

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