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REVIEW

Vegetable oil based eco-friendly coating materials: A review article

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Abstract Vegetable oils (VO) constitute the single, largest, easily available, low cost, non-toxic, non-depletable, biodegradable family yielding materials that are capable of competing with fossil fuel derived petro-based products. The outstanding feature of VO is their unique chemical structure with to 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 VO derived materials such as alkyds, polyesteramides, polyetheramides, polyurethanes, epoxies, polyols, along with their preparation and applications as protective coatings. A small portion of the review is also dedicated to the future perspectives in the field. Inspite of their extensive utilization

Abbreviations : ASO, *Annona squamosa*; BPA, bisphenol A; BMF, butylated melamine formaldehyde; CO, castor oil; CCO, coconut oil; DI, drying index; DSC, differential scanning calorimetry; FTIR, Fourier transform infrared; Tg, glass transition temperature; HYP, hyperbranched; IPN, interpenetrating polymer networks; IV, iodine value; LO, linseed oil; MFO, *Mesua ferrea* L. seed oil; MW, microwave; NMR, nuclear magnetic resonance; PAO, palm oil; PEA, polyesteramides; PEtA, polyetheramides; PU, polyurethanes; PGO, *Pongamia glabra*; RSO, rubber seed oil; SO, soybean oil; St, styrene; TDI, toluylene 2,4-diisocyanate; TGA, thermogravimetric analysis; VO, vegetable oils; VRO, vernonia; VOC, volatile organic contents; WB, waterborne.

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in the world of coatings, literature survey revealed that in the past (from 1990s to date) no review has come up describing the chemistry and applications of VO polymer based coating materials.

Contents

1. Introduction

The consumer and industrial interests in the development of eco-friendly materials have catapulted the environmentally benign agricultural resources as feedstocks of the polymer industry. Today, due to interdisciplinary approaches through research and technological innovations in oleo-chemistry, biosciences, biotechnology and engineering, it is possible to design eco-friendly specialty chemicals from nature's abundant renewable resources. Polymers are obtained from renewable resources 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, adhesives, 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 development of paints and coatings, besides their other industrial applications (Dutton and Scholfield, 1963; Wisniak, 1977; Baumann et al., 1988; Schuchardt et al., 1998; Lu and Larock, 2009; Xia and Larock, 2010; Salimon et al., 2012).

VO were used as the primary constituent in paints and coatings even during the days of cave paintings. Today, due to several environmental and health hazards cropping up from fossil fuel derived products, and fear of depletion of petroleum resources 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. Literature survey reveals that VO have enormous potential, significance and applications in the world of coatings. However, inspite of this, in the recent past no review has come up describing the chemistry and applications of VO and polymers based thereupon as coating materials. In the preceeding sections, we have described some important VO polymeric materials (alkyds, polyesteramides, polyetheramides, polyurethanes, epoxies and polyols) with special emphasis on their use as protective coatings.

2. VO in coatings

VO and their derivatives find applications in coatings owing to their unique structural attributes. The preceeding sections describe briefly the role of VO as corrosion inhibitors and polymeric binders in coatings.

2.1. VO as corrosion inhibitors

Besides their use in coatings and paints as binders, VO and plant extracts have also been used as *natural corrosion inhibitors*. An excellent review in this regard has been compiled by Raja and Sethuraman (2008). Srivastava and Sathiyanathan et al. have also reported the use of *Ricinus communis* or castor oil [CO] for corrosion inhibition of steel in acid media (Srivastava and Srivastava, 1981; Sathiyanathan et al., 2005). *Pongamia glabra* [PGO] and *Annona squamosa* [ASO] have shown corrosion inhibition for steel in acid media (Raja and Sethuraman, 2008). A recent review has also appeared on the use of VO and other extracts for corrosion inhibition (Dar, 2011). Extracts from leaves and VO from seeds of several edible and medicinal plants have also been employed for anticorrosion behavior against alkaline and acid media as well as chloride ions (Dar, 2011; Lahhit et al., 2011). Here, the anticorrosion activity is attributed to the presence of heterocyclic constituents such as alkaloids, flavonoids, tannins, cellulose, and others.