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AN INTRODUCTION TO EPOXY RESINS OF BISPHENOLS AND THEIR GLASS FIBRE REINFORCED COMPOSITES

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Abstract

We are now living in the age of plastic. Plastics have replaced the metallic and conventional materials used for the centuries. The phenolic resins are the first commercialized polymeric products from simple low molecular weight compounds. Phenolic resins are also widely termed as phenol formaldehyde resins, PF resins or phenoplasts. The condensation of an excess of phenol with formaldehyde under acidic condition results into resinous mass named novolac resins, while the condensation of phenol with an excess of formaldehyde under basic condition produces resol type resins. Soluble, fusible and low molecular weight resins (phenolic, amino plastics, epoxies, polyesters and furan resins) are converted into high molecular weight insoluble and infusible network structure by cross-linking. Resol type resins are cross-linked simply by heating and the conversion of novolac resins into network structure involves incorporation of cross-linking agents. The upcoming time is being supposed to be the era of Epoxy Resins. Modern composite materials, generally reinforcement of various resins with natural or man made synthetic fibers, are becoming a significant constituent of the engineered materials market ranging from everyday products of specified advanced applications.

Keywords: *Epoxy resins, Curing agent, Monomer, Halogenated Bisphenol.*

Discussion and Findings:

The phenolic resins are produced by condensation of a phenol or mixture of phenols with an aldehyde. Commercially available phenolic resins are commonly based on phenol itself and formaldehyde. Cresols, xylenols and resorcinol are used to a much less extent. Furfural is used as aldehyde exclusively in production of PF resins.

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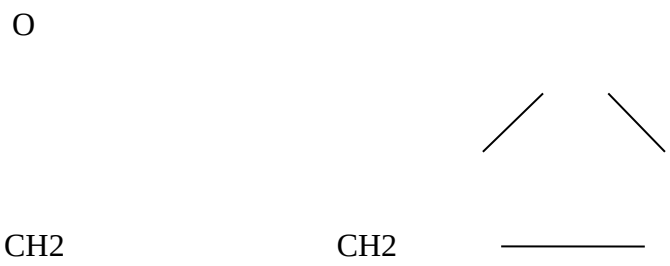
The mechanical properties of the network polymers are considerably influenced by adding fillers. Cured phenolic resins have good heat stability and high chemical resistance.

But they are applied adequately for insulation application since their electrical insulating properties are not outstanding. Phenolic resins have relatively poor tracking resistance under conditions of high humidity.

Phenolic resins are well known for two major applications in molding and laminates. They are also applied in other applications.

The term epoxy means a chemical functional group consisting of one oxygen atom and two carbon atoms are bonded to form a three membered ring. The simplest epoxy compound is ethylene oxide.

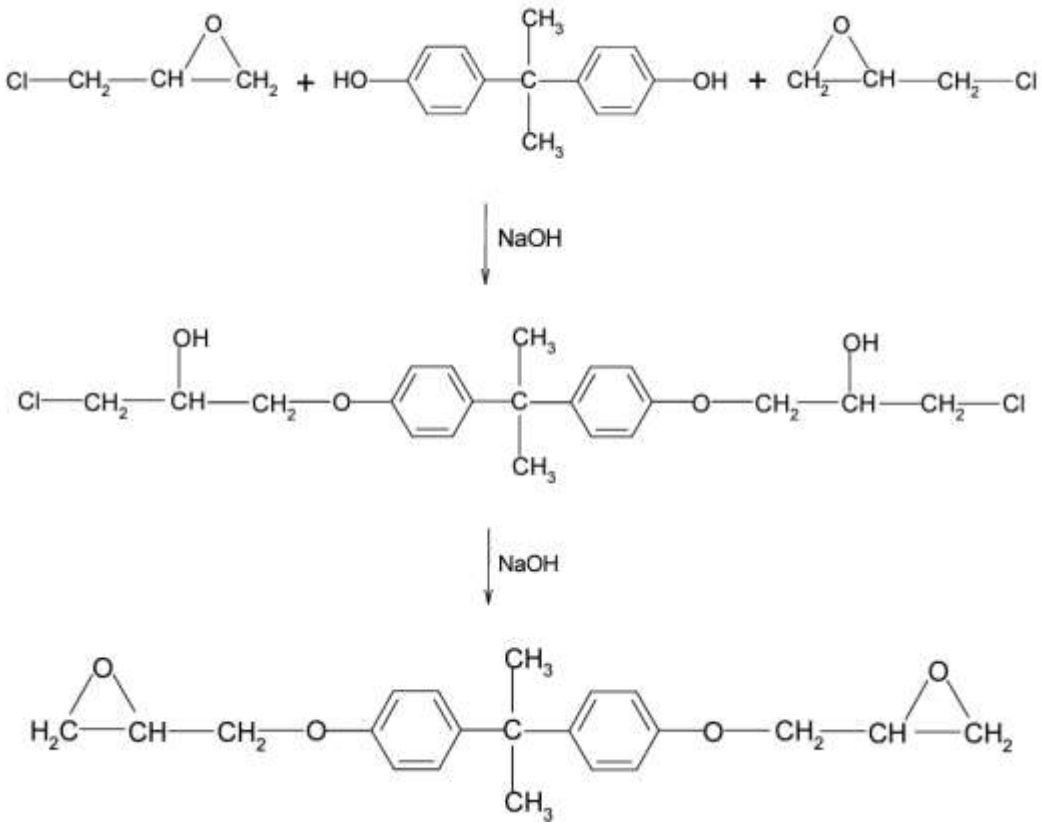


Epoxy group is also called epoxide or oxirane group, while the terms epoxies, epoxy resins or epoxides are practiced to refer cross-linked polymers or low molecular weight resin precursors. Epoxy resins are the condensation products of epichlorohydrin and various bisphenols. At present bisphenol-A is commercially applied to produce epoxy resins of different viscosities for wide field of applications.

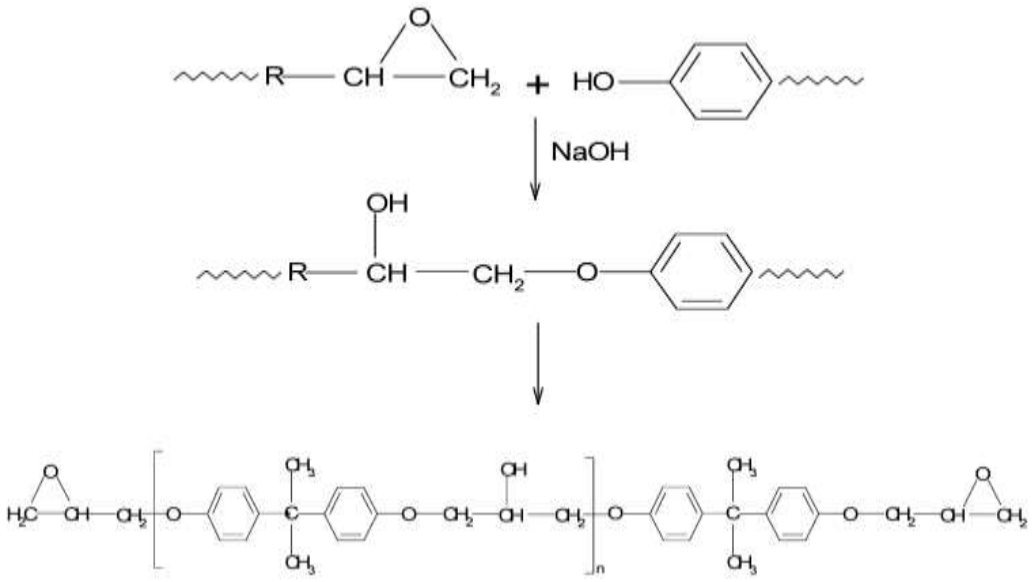
Epoxy resins are firmly established in number of important applications like surface coatings, encapsulation of electronic components, other applications include adhesives, castings and laminates though they are relatively costly

Epoxy resins are characterized by viscosity, colour, hydroxyl equivalent, epoxide equivalent, average molecular weight and molecular weight distribution, melting point of solid resin and heat distortion temperature of cured resin by standard analytical procedure.

Commercial liquid epoxy resins are essentially of low molecular weight diglycidyl ether of bisphenol-A and small quantities of higher molecular weight polymers. The preparation of diglycidyl ether of bisphenol-A is described below-



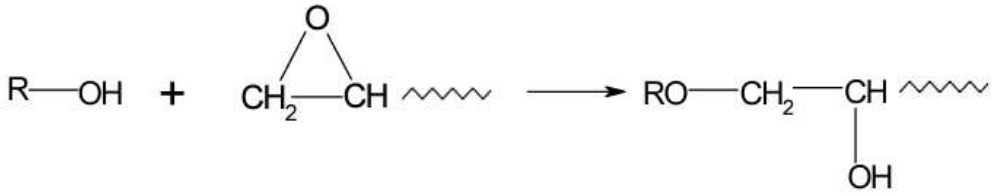
If diglycidyl ether is considered as a diepoxide; it will further react with hydroxyl groups to form high molecular weight epoxy resin as shown below-



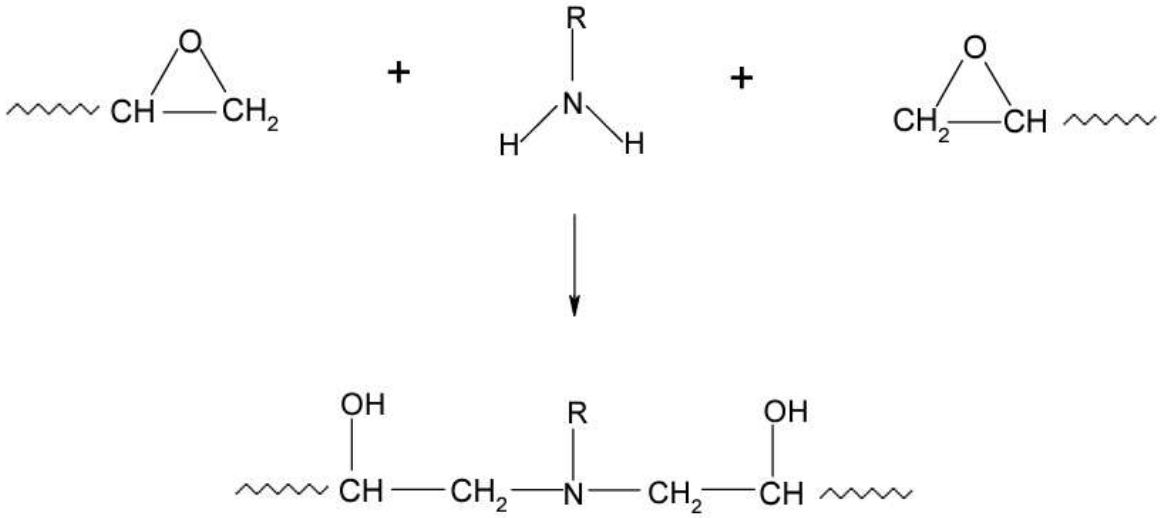
Curing of epoxy resins takes place either through epoxy group or hydroxyl group involves two types of curing agents, catalytic system and polyfunctional cross-linking agents. The catalytic cross-linking occurs in presence of hydroxyl group, which may be present due to the following circumstances:

1. They will be present in the higher molecular weight homologues of the diglycidyl ether of bisphenol A.
2. They may be introduced by the curing agent or modifier.
3. They will be formed as epoxy rings are opened during cure.
4. In unreacted phenol type materials they are present as impurities.

The epoxy-hydroxyl reaction is given below:



The epoxy resins can also be cross-linked by polyfunctional amines, acids and acid anhydrides, which link across the epoxy molecules. The reaction is as follows:



Resins applied in preparation of composites are of two types:

(1) Thermosetting resins

(2) Thermoplastic resins

Thermosetting resins are widely applied than thermoplastic resins. Some of the more common thermosetting resins used in the preparation of composites are epoxies, polyurethanes, phenolic, polyamides, and polyimides. Of these, epoxies are the most

commonly used in plastic molded composites (PMC) industries ranging from low viscosity liquids to high molecular weight solids for over 40 years.

Phenolic and amino resins are another group of PMC resins. Other areas of applications of epoxy and phenolic reinforced glass fibre composites are in aerospace, marine, electrical encapsulation, coating application, building material and bio medical applications.

EPOXY AND FORMALDEHYDE RESINS AND THEIR GLASS COMPOSITES

In early stage of their development, epoxy resins were used almost entirely for surface coating, while phenolic resins were used widely in molded articles, encapsulation, adhesives and binders. Now a days epoxy resins are increasingly used as contemporary plastics in a wide variety of applied areas. Thermosetting epoxy resins possess improved thermal and mechanical properties and can be prepared of different viscosities, which facilitate their applications. The newer polymer resin matrix material and high performance reinforcement fibers of glass, carbon and aramid are introduced in the field of diverse applications viz: composite designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of high way bridges and even paper making roller. Epoxy and phenolic resins reinforced with glass fibers result into composite materials offering great thermal and mechanical stability, good chemical resistance and sound and electrical insulation.

Certainly, this evaluation of the thin film spectra has to account for the optical situation, which is significantly different from bulk measurements. Spectra calculation provides the essential tool for a reasonable comparison between bulk and thin film spectra, thus allowing for a detailed quantitative analysis. Thickness and substrate effects on the interphase can then be separated from the optical situation of the measurement. The results reveal very specific features caused by adhesive interactions and different cure behavior in the interphase on different metal surfaces. Modern composite materials, generally reinforcement of various resins with natural or man made synthetic fibers, are becoming a significant constituent of the engineered materials market ranging from everyday products of specified advanced applications. Such high performance fibre reinforced plastics (FRP) have started to challenge the most ubiquitous materials such as steel, aluminium alloys and metal-composite hybrids. Each type of composite brings its own performance characteristics that are typically suited for specific applications.

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