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REINFORCED COMPOSITES OF EPOXY RESINS

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Abstract

A wide variety of polymeric materials of many different types is discovered and that is still going on to facilitate our life with the countless technological, industrial and domestic applications of polymers. Bisphenols are important constituent or intermediates in dyes, drugs, paint and varnish, coating, pesticides, plasticizers, fertilizers, bactericides and in other applications. They are most widely used in manufacturing thermally stable polymers, epoxy and polyester resins. In order to convert the resins into cross-linked structures, it is essential to add a curing agent. Most of the curing agents in common use are classified into three groups, namely tertiary amines, polyfunctional amines and acid anhydrides.

Polysulphides and other types of curing agents are also used in specific compositions. The word polymer is derived from the Greek word 'poly '– many and 'meros'-part. The term 'resin' is frequently used to refer to any material whose molecules are polymer. Originally this term was restricted to natural secretions usually from coniferous and similar synthetic substances. Now the term is generally used to indicate a precursor of cross-linked polymeric materials such as epoxy and novolac resins. 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.

Keywords: *Polymeric Materials, Phenolic resins, Epoxy resins, Curing agents.*

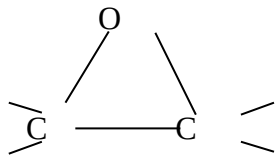
Experimental, Discussion and Findings:

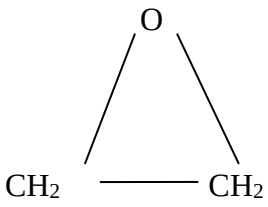
The development of synthetic polymeric materials has changed the human life style and helped to extend the range of activities in the field of science. A wide variety of polymeric materials of many different types is discovered and that is still going on to facilitate our life with the countless technological, industrial and domestic applications of polymers. The word polymer is derived from the Greek word 'poly '– many and 'meros'-part. The term 'resin' is frequently

used to refer to any material whose molecules are polymer. Originally this term was restricted to natural secretions usually from coniferous and similar synthetic substances. Now the term is generally used to indicate a precursor of cross-linked polymeric materials such as epoxy and novolac resins. 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 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.

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. 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 high cost.

There is a large range of composites available commercially, which include the phenolic, amino plastics, polyesters, epoxides, silicones and the furan resins reinforced with natural fibres like jute, hemp, cotton, sisal, banana and coir and also with man made fibers like carbon, aramid, paper asbestos and glass fibers.

The preparation of composite involves reinforcement of fibre matrix with a resin, a curing agent and a solvent in some cases under heat andpressure. The curing agent acts as a catalyst; fibre matrix enhances the strength and other properties of the composites. 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.

BISPHENOLS

Bisphenols are important constituent or intermediates in dyes, drugs, paint and varnish, coating, pesticides, plasticizers, fertilizers, bactericides and in other applications. They are most widely used in manufacturing thermally stable polymers, epoxy and polyester resins.

Rao et al [22] have reported a convenient method for the preparation of bisphenols. Cyclohexanone was treated with PhOH at 40^{o}C and with o-cresol at room temperature in the presence of HCl and AcOH to give 1, 1'-bis (4- hydroxy phenyl) cyclohexane and 1, 1'- bis (3-methyl-4-hydroxy phenyl) cyclohexane, respectively.

FORMALDEHYDE RESINS AND THEIR GLASS COMPOSITES

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

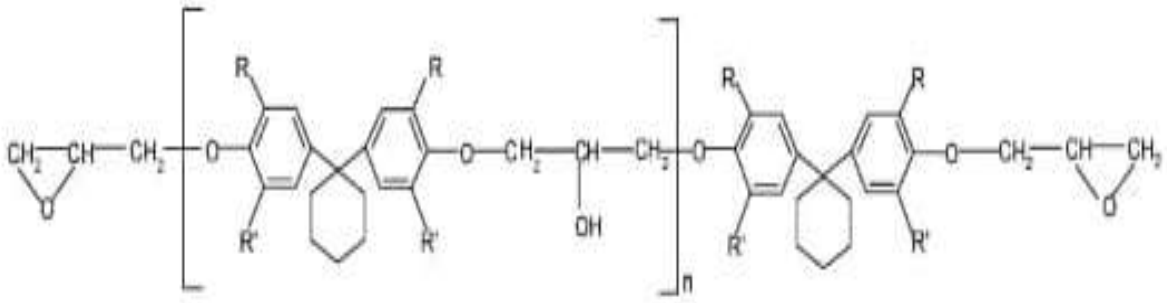
reinforced plastics (FRP) have started to challenge the most ubiquitous materials such as steel, aluminium alloys and metal-composite hybrids. Each type of composite brings its own performance characteristics that are typically suited for specific applications.

Joseph [33] has reported phenolic resin laminates with high flexural strength. Resin mixture of 200 g of epoxy resin, 50 g phenol-formaldehyde resin, 60 g of epoxy hardener (ethylene diamine), 1 ml linseed oil as a plasticizer, 1.5 ml concentrated HCl and 75 g acetone as a solvent impregnated on sheets of glass cloth to prepare a laminate with flexural strength of ~ 110 000 psi.

Venkov and Trostyanskaya [35] have reported curing of epoxide adhesive based on ED-6, and maleic anhydride used as a curing agent at

80^{o}C for 4 h in presence of catalyst diethylaniline to give adhesive of breaking strength 600 kg/cm^{2}. Epoxy resin containing 40 % phenol-formaldehyde resin was cured at 150-60^{o}C for 6 h to give adhesives of similar strength.

SYNTHESIS OF EPOXY RESINS BASED ON HALOGENATED BISPHENOL - C (V)



ECB: R=R'=Cl EBB: R=R'=Br

ECM: R=CH_3 and R'=Cl

Results: Epoxy resins of bisphenol-C derivatives were synthesized by condensing corresponding BC derivative (0.5mol) with epichlorohydrin (1.1mol) by using isopropanol (500 ml) as a solvent

and sodium hydroxide (1.0 mol in 40 ml water) as a catalyst. The reaction mixture was stirred at reflux temperature for 4 h. Then excess of solvent was distilled off and the viscous resins were isolated from distilled water. The resins were extracted in chloroform and evaporated to dryness to obtain pure resins. The yield was ~75-80%. The resins are soluble in common organic solvents like chloroform, 1,2-dichloro ethane, isopropanol, 1,4-dioxane, tetrahydrofuran, DMF, DMSO, etc.

In order to convert the resins into cross-linked structures, it is essential to add a curing agent. Most of the curing agents in common use are classified into three groups, namely tertiary amines, polyfunctional amines and acid anhydrides. Polysulphides and other types of curing agents are also used in specific compositions.

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