Preparation of Phenolic Resin Complexes

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Summary:

In this work, three types of complexed phenolic resins were prepared using various additives such as ($AlCl_3$, $FeCl_3$, $ZnCl_2$) and improving the aim of this work by modifying the phenol formaldehyde resins to high thermal resistance polymers and higher mechanical properties. This was attributed to chemical bonding between metal ions and polymeric phenol formaldehyde resins, the increasing in crosslinking which effects on thermal and mechanical properties of phenolic complexes as a function of temperature up to 1000 °C, the complexes could be used as insulators.

The complexes were characterized and tested by infra-red spectroscopy, thermogravimetry and mechanical properties for the phenolic resin complexes were measured the tensile strength, flexural strength, they were found that the higher thermal resistance and higher mechanical properties, therefore it was concluded that the phenolic complexes could be possibly used as insulation material and for other applications.

Introduction:

Phenols and oligomeric phenol compounds are weak acids and are able to form metal salts or complexes with metal ions. The reaction with Fe^{+3} ions, has been studied for analytical purposes with oligo (2-hydroxy-1,3-phenylene-methylene) [1].

The ability of p-tert-butyl alixarenes to transport metal ions through hydrophobic liquid membranes were reported by Izatt and coworkers [2].

Heat and flame resistant resins are obtained by the reaction of phenols and phenolic resins with metal halides (molybdenum trichloride, titanium trichloride, zirconium trichloride, tungsten trichloride), metal alcohols (aluminum trimethoxide, titanium tetramethoxide) or metal organic compounds (acetylacetones) [3]. If such metal containing resins are subjected to high temperature, the decompose considerably slower than conventional resins.

Further, it is assumed that metal carbides are formed complexes with carbon atom of the resin. The resins are deeply coloured and may contain up to 20% of ionic bond metals.

Otherwise [4], titanium tetrachloride is added to molten phenol, and the hydrogen chloride which is formed to remove by passing nitrogen through and raising the temperature up to the boiling point of phenol.

The esterification [5] of phenol novolak resins with inorganic polybasic such as phosphoric and boric acid or the reaction with phosphorus oxyhalides are a particular importance in increasing the heat or flame resistance of phenolic resins, because of high OH-functionality of novolaks.

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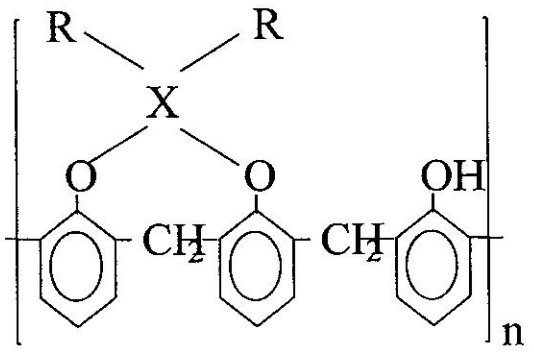
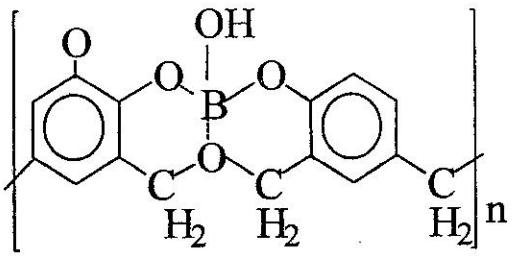


Scheme (1)

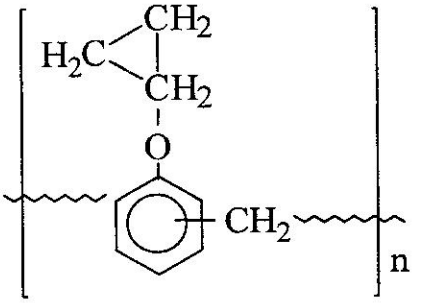
The intermolecular (crosslinking) reaction takes place predominately with ortho-novolaks, the intermolecular esterification [6] seems to be the preferred reaction yielding 8-membered rings as in scheme (1).

The increasing thermal resistance of phenolic resins, which modified with boron [7] is attributed to a structure as in scheme (2).



Scheme (2)

The addition of silicon compounds [8] for the improvement of the thermal resistance of phenol formaldehyde resin was recommended early, since then a series of HMTA to crosslink resins if the release of volatile compounds must be avoided epoxidized novolaks which are generally utilized as solid resins, these materials are readily obtained by the reaction of epichlorohydrine with novolak of sufficiently high M.W. as in scheme (3).

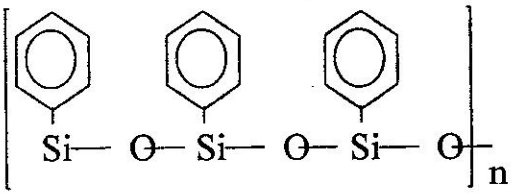


Scheme (3)

Phenolic composite [9] is that material which consists essentially of a thermosetting phenol formaldehyde resin as a binder matrix.

Amino phenols were allowed to react with maleic and phthalic anhydride [10] then the amic acid were dehydrated to the corresponding maleisomides and noval phenol formaldehyde resins, novolak like were prepared at 50 °C suffered rearrangement to corresponding phenol formaldehyde resins with pendant imide groups [7].

The reaction between phenol novolaks and methoxy phenyl poly silicoxanes as in scheme (4).



Scheme (4)

The incorporation of silicon atoms in the polymer chain instead of the methylene linkage is obtained by reaction of p-silyl phenols, which are available by hydrolysis of phenoxy silicones with formaldehyde [8].

The addition of silanes as adhesion promoters is widespread, for instance in the manufacturing of mineral wool mats, foundry sands, silicamicrosphere composites [9]. The