

A PROCESS FOR PREPARING GLYCIDYL
DERIVATIVES OF COMPOUNDS HAVING AT LEAST
ONE AROMATIC HYDROXYL GROUP OR AROMATIC AMINE GROUP

The preparation of glycidyl ethers by the reaction of an aromatic hydroxyl-containing compound with epihalohydrin in the presence of a base is well known as disclosed by Lee and Neville in HANDBOOK OF
5 EPOXY RESINS, McGraw-Hill, 1967. Because of increased material costs and since in most instances, the reaction is conducted in excess epihalohydrin, any increase in epihalohydrin yields provide for a considerable economy in manufacturing costs. Also, particularly when the
10 epoxy resin is to be employed in electrical applications, it is desired that the epoxy resin have low hydrolyzable halide levels. The present invention provides a process for maximizing epihalohydrin yields and also produces epoxy resins low in hydrolyzable halide.

15 The present invention pertains to a process for preparing glycidyl derivatives of compounds having at least one aromatic hydroxyl group or aromatic amine group per molecule, (ie. a hydroxyl or amino group bound to an aromatic ring) by reacting at least one compound
20 having at least one aromatic hydroxyl group or aromatic amine group per molecule with an excess of at least one

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epihalohydrin in the presence of from 0.8 to 1.2 mole of an alkali metal hydroxide for each mole of aromatic hydroxyl group and aromatic amine hydrogen, and subsequently recovering the glycidyl derivatives; characterized by

5 (1) conducting the reaction in the presence of an organic solvent which is a primary or secondary alcohol, and which codistills with water and said epihalohydrin at a boiling point below the boiling point of the lowest boiling compound among the components in the reaction mixture;

10 (2) conducting the reaction at a temperature and a reduced pressure sufficient to provide a distillate with a boiling point of from 45°C to 80°C, preferably from 55°C to 70°C;

15 (3) employing said alkali metal hydroxide as an aqueous solution and adding said aqueous alkali metal hydroxide in a continuous or intermittent manner over a period of from 0.5 to 10, preferably from 1 to 5 hours;

20 (4) continuously removing water by means of codistillation at a rate such that the water content of the reaction mixture is less than 6 percent, preferably from 1.5 to 4 percent by weight; and

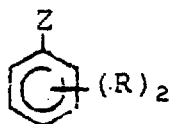
(5) separating the water from the distillate and returning the solvent and epihalohydrin to the reaction mixture.

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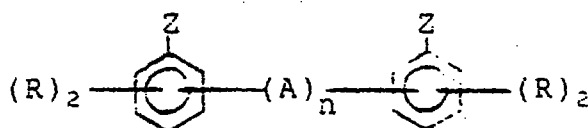
Suitable compounds having at least one aromatic hydroxyl group which can be employed herein include, for example, phenols, bisphenols, novolac

resins, polyvinyl phenols, and the corresponding amine compounds, such as those represented by the following formulas:

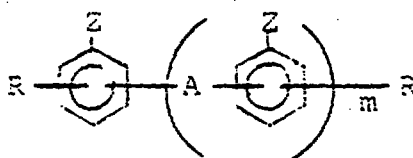
I.



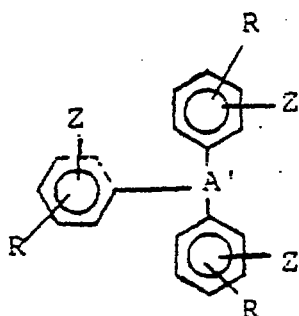
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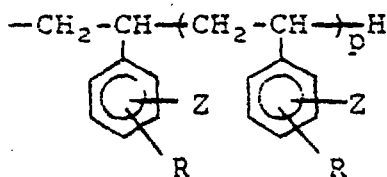
III.



IV.



V.



wherein each A is independently a divalent hydrocarbon group having from 1 to 12, preferably from 1 to

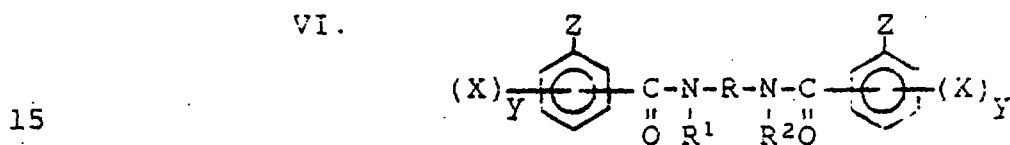
6 carbon atoms, ---O--- , ---S--- , ---S---S--- , $\text{---}\overset{\text{O}}{\underset{\text{O}}{\parallel}}\text{S---}$, $\text{---}\overset{\text{O}}{\parallel}\text{S---}$ or $\text{---}\overset{\text{O}}{\parallel}\text{C---}$

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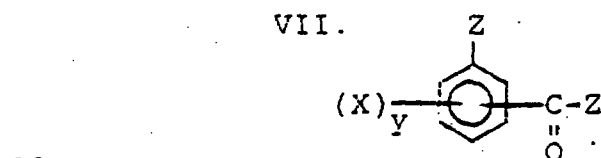
A' is a trivalent hydrocarbon group having from 1 to 12, preferably from 1 to 6, carbon atoms; each R is independently hydrogen, a hydrocarbyl group having from 1 to 10, preferably from 1 to 4, carbon atoms, a halogen atom, preferably chlorine or bromine or a hydroxyl group or an amino group; each Z is independently -OH or NH₂; p has a value of from 1 to 100, preferably from 2 to 50; m has a value from 1.00 to 6 and n has a value of zero or 1.

Also suitable as compounds having at least one aromatic hydroxyl or aromatic amine group per molecule are those represented by the formulas

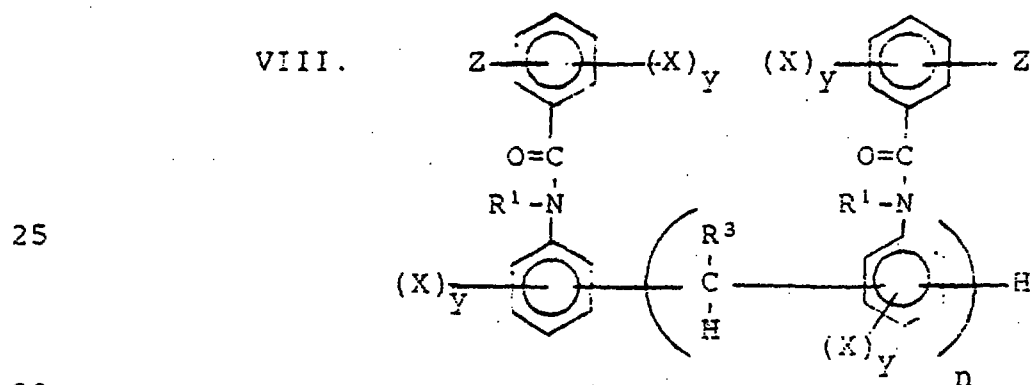
VI.



VII.



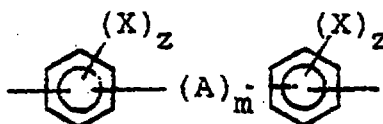
VIII.



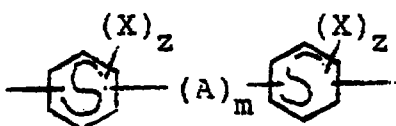
wherein each R is a divalent hydrocarbyl group having from 1 to 18, preferably from 2 to 12 and most preferably from 2 to 6 carbon atoms, a group represented by the following formulas IX, X, XI or XII

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IX.

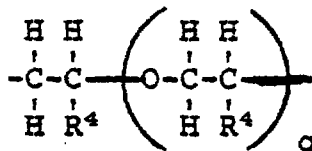


X.



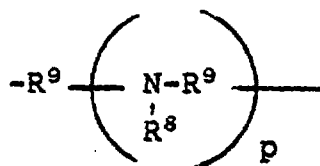
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XI.



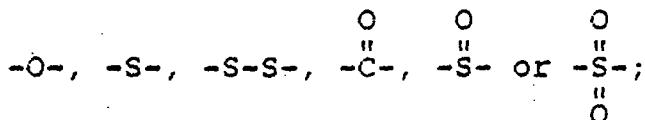
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XII.



20 or R can combine with R¹ so as to form a stable heterocyclic ring with the nitrogen atoms; each A is independently a divalent hydrocarbyl group having from 1 to 10, preferably from 1 to 4 carbon atoms,

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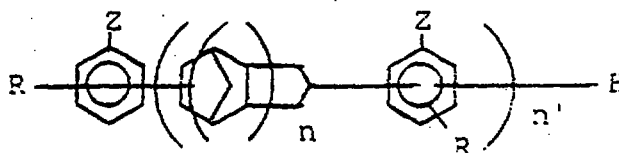
each R¹ is independently hydrogen, a 2,3,-epoxypropyl group, a 2-alkyl-2,3--epoxy-propyl group, a monovalent hydrocarbyl group or a hydroxyl substituted monovalent hydrocarbyl group, said hydrocarbyl groups having from 1 to 9 carbon atoms, said alkyl having from 1 to 4,

preferably 1 to 3 carbon atoms; each R^2 is independently hydrogen or an alkyl group having from 1 to 4, preferably 1 to 3 carbon atoms; each R^3 is independently hydrogen or an alkyl group having from 1 to 4 carbon atoms; each R^4 is independently hydrogen, a hydrocarbyl or halogen substituted hydrocarbyl group having from 1 to 9, preferably from 1 to 2 carbon atoms; each R^5 is independently selected from the group represented by formula XIV or the same groups as R^1 except that R^5 cannot be a hydrogen; each R^6 is independently a divalent hydrocarbyl group having from 2 to 4, preferably 2 carbon atoms; each Z is independently -OH or -NH₂; each X is independently hydrogen, chlorine, bromine or a hydrocarbyl or a hydrocarbyloxy group having from 1 to 9, preferably 1 to 6 carbon atoms; each m independently has a value of zero or 1; n has an average value of from 0.01 to 6, preferably 0.1 to 4; p has an average value of from 1 to 10, preferably from 1 to 3; q has an average value of at least 1, preferably from 1 to 150, most preferably from 1 to 100 and usually from 1 to 10 and each y and z independently has a value of 1 or 2.

Also suitable are polycyclopentadiene polyphenols or aromatic polyamines represented by the formula

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XIII



wherein Z is -OH or -NH₂ and n has a value from 1 to 5; n' has a value of from 1 to 10, preferably from 3 to 6; each R is independently hydrogen, a hydrocarbyl group having from 1 to 10, preferably from 1 to 4 carbon

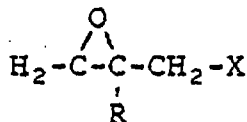
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atoms, a halogen atom, preferably chlorine or bromine or a hydroxyl group or an amino group.

Suitable such polycyclopentadiene polyphenols and methods for their preparation can be found in U.S. Patent 4,390,680, issued to Donald L. Nelson, on June 28, 1983. The polycyclopentadiene aromatic polyamines can be prepared in a similar manner by substituting an aromatic amine for the phenolic compound.

Also suitable are compounds containing both at least one aromatic hydroxyl group and at least one aromatic amine group such as, for example, hydroxy aniline, and aminoxyleneol.

Suitable epihalohydrins which can be employed herein include those represented by the following formula



wherein R is hydrogen or a hydrocarbyl group having from 1 to 4 carbon atoms and X is a halogen, preferably chlorine or bromine.

The epihalohydrin and the aromatic hydroxyl or aromatic amine compound are preferably employed in a molar ratio of from 2:1 to 10:1, more preferably from 2:1 to 6:1, respectively.

Suitable alkali metal hydroxides which can be employed herein include, for example, sodium hydroxide, potassium hydroxide, lithium hydroxide or mixtures

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thereof. The alkali metal hydroxide is employed as an aqueous solution, usually at a concentration of from 20 to 50, preferably from 40 to 50 percent by weight.

5 The amount of alkali metal hydroxide which is employed in the process of the present invention is from 0.80 mole to 1.2 mole of alkali metal hydroxide, preferably from 0.90 mole to 1.0 mole for each mole of aromatic hydroxyl group and aromatic amine hydrogen.

10 The alkali metal hydroxide can be added either continuously or incrementally, but never is all of the alkali metal hydroxide added in one increment.

15 Suitable solvents which can be employed herein include any primary or secondary alcohol which does not react with any component in the reaction mixture, is partially or wholly miscible with water, forms a co-distillate with the epihalohydrin and water and the distillate has a boiling point below that of the lowest boiling component of the reaction mixture at the pressure employed. Suitable such solvents include, for example,
20 1-methoxy-2-propanol, 1-butoxy phenol and cyclohexanol. The secondary alcohols are preferred.

25 The amount of solvent which is employed will depend on the particular solvent and hydroxyl or amino compound being employed. The amount of solvent generally ranges from 5 to 50 weight percent, preferably from 10 to 40 weight percent based on the total weight of reactants.

Suitable temperatures and pressures which are employed in the process of the present invention are those which will provide the codistillate with a boiling point of from 45°C to 80°C, preferably from 55°C to 70°C. Advantageously, the reaction is conducted at a temperature of from 45°C to 80°C, preferably from 55°C to 70°C, and at a reduced pressure of from 150 to 230 mm of Hg (20.0 to 30.7 kPa), preferably from 160 to 220 mm of Hg (21.3 to 29.3 kPa).

10 The reaction is preferably conducted for a length of time such that the quantity of phenolic hydroxyl groups remaining in the reaction mixture is not greater than 0.5, preferably not greater than 0.2 percent by weight.

15 Upon completion of the reaction, the resultant epoxy resin is finished in any of the methods normally employed. The excess epihalohydrin is usually removed by distillation and the salt removed by filtration, centrifugation and/or water washing.

20 The following examples are illustrative of the present invention, but are not to be construed as to limiting the scope thereof in any manner.

The following components were employed in the examples and comparative experiments.

25 PHENOLIC COMPOUND A was a phenol-formaldehyde novolac resin having an average hydroxyl equivalent weight of 104.5 and an average phenolic hydroxyl functionality of 5.7.

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PHENOLIC COMPOUND B was a phenol-formaldehyde novolac resin having an average hydroxyl equivalent weight of 101 and an average phenolic hydroxy functionality of 3.6.

5 PHENOLIC COMPOUND C was bisphenol A.

PHENOLIC COMPOUND D was 4,4'-dihydroxybiphenyl.

PHENOLIC COMPOUND E was a cresol-formaldehyde novolac resin having an average hydroxyl equivalent weight of 118.5 and an average phenolic hydroxyl functionality of 5.7.

PHENOLIC COMPOUND F was a composition containing between 60 and 70 weight percent of tris(hydroxyphenyl)methane, the remaining 30 to 40 weight percent being higher homologs thereof.

15 PHENOLIC COMPOUND G was a polycyclopentadiene polyphenol resin having an average hydroxyl equivalent weight of 180 and an average phenolic hydroxyl functionality of 3.2.

20 PHENOLIC COMPOUND H was polycyclopentadiene polyresorcinol resin having an average hydroxyl equivalent weight of 93 and an average phenolic hydroxyl functionality of 5.5.

EXAMPLE 1

25 Into a one liter reaction vessel equipped with temperature and pressure control and indicating means, a means for the continuous or intermittent addition of aqueous sodium hydroxide, a means for

condensing and separating water from a codistillate mixture of water, solvent and epichlorohydrin and a means for returning the solvent and epichlorohydrin to the reaction vessel was added 104.5 grams (1 equivalent) of phenolic compound A, 370 grams (4 equivalents) of epichlorohydrin and 247 grams of the methyl ether of propylene glycol (1-methoxy-2-propanol) as a solvent. After stirring at room temperature and atmospheric pressure to thoroughly mix the contents, the temperature was raised to 65°C and the pressure was reduced to 160 mm Hg (21.3 kPa) absolute. To the resultant solution was continuously added 76 grams, 0.95 equivalent of a 50 percent aqueous sodium hydroxide solution at a constant rate over a period of 1 hour (3600 s). During the addition of the sodium hydroxide, the water was removed by codistilling with epichlorohydrin and solvent. The water content of the reaction mixture was less than 6 percent by weight. The distillate was condensed thereby forming two distinct phases, an aqueous phase (top) and an organic epichlorohydrin-solvent phase (bottom). The organic phase was continuously returned to the reactor. After completion of the sodium hydroxide addition, the reaction mixture was maintained at a temperature of 65°C and a pressure of 160 mm Hg (21.3 kPa) absolute for an additional 30 minutes (1800 s). A sample of the reaction mixture was washed to remove salt and subsequently distilled resulting in an epoxidized novolac resin having a hydrolyzable chloride content of 0.02 percent and an epoxide content of 23.5 percent which corresponds to an epoxide equivalent weight of 183. The epichlorohydrin yield (calculated as the yield of the desired product as a preparation of total yield including by-products such as glycidol, glycerine monochlorohydrin and glycerine diglycidylether, based on an analysis of the reaction mixture for formation of by-products) was 99 percent.

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COMPARATIVE EXPERIMENT A (No solvent)

In a manner similar to Example 1, the following components and reaction conditions were employed.

- 104.5 grams (1 equiv.) of phenolic compound A
- 5 462.5 grams (5 equiv.) of epichlorohydrin
- 76 grams (0.95 equiv.) of 50 percent aqueous sodium hydroxide

- The reaction temperature was 65°C and the reaction pressure was 160 mm Hg (21.3 kPa) absolute.
- 10 The sodium hydroxide was added over a period of 1 hour (3600 s) and the reaction continued thereafter for a period of 5 hours (18,000 s). During the addition of the sodium hydroxide, the water and epichlorohydrin formed a binary azeotrope which was condensed to form
 - 15 two distinct phases. The organic, epichlorohydrin, (bottom) phase was continuously returned to the reaction mixture.

- Even after the 5 hours of additional reaction, only 80 percent of the phenol-formaldehyde novolac had
- 20 reacted and the epichlorohydrin yield was only about 80 percent.

COMPARATIVE EXPERIMENT B (105° reaction at atmospheric pressure)

- In a manner similar to Example 1, the following components and reaction conditions were employed.
- 25

- 104.5 g (1 equiv.) phenolic compound A
- 370 g (4 equiv.) epichlorohydrin
- 247 g propylene glycol methylether (1-methoxy-2-propanol)
- 30 76 g (0.95 equiv.) 50 percent aqueous sodium hydroxide

The reaction temperature was 105°C, the reaction pressure was atmospheric (101 kPa); and the sodium hydroxide was added continuously over a period of 1 hour (3600 s). During the addition of sodium hydroxide, the water, epichlorohydrin and propylene glycol methyl ether formed a codistillate which was condensed. The epichlorohydrin and propylene glycol methyl ether from overhead was recycled to the reaction mixture while the aqueous phase was discarded. After the completion of sodium hydroxide addition, the reaction mixture was further stirred at 105° until all of the caustic has been used up (10-15 minutes, 600-900 s). A sample was taken and analyzed for by-product formation (glycidol, glycerine monochlorohydrin, glycerine and glycerine diglycidyl ether). Besides 5 percent epichlorohydrin hydrolysis product, approximately 6 percent of epichlorohydrin polymers were observed which indicated a yield on epichlorohydrin of 89 percent. A sample of the reaction mixture was washed to remove salt and then distilled to give an epoxy novolac with a hydrolyzable chloride content of 0.2 percent (10 times higher than the one under a reduced pressure) and an epoxide content of 21.6 percent.

COMPARATIVE EXPERIMENT C (solvent present, but no codistillation)

The procedure of Comparative Experiment B was followed except that the reaction was carried out at 65°C, but no water was removed by codistillation. The water from the sodium hydroxide addition and the water of reaction remained in the reaction mixture. The yield of epichlorohydrin was 92 percent. A sample of the reaction mixture was washed to remove salt and then distilled thereby resulting in an epoxidized novolac

having a hydrolyzable chloride content of 0.1 percent (5 times that produced in Example 1).

EXAMPLE 2

5 In a manner similar to Example 1, the following components and conditions were employed.

51 grams (0.5 equiv.) of phenolic hydroxyl compound B
231.5 grams (2.5 equiv.) of epichlorohydrin
75 grams cyclohexanol
38 grams (0.475 equiv.) of 50 percent aqueous sodium
10 hydroxide

The reaction temperature was 60°C and the reaction pressure was 155 mm Hg (20.7 pKa). The sodium hydroxide was added over a period of 1 hour (3600 s) and the reaction continued for an additional 15 minutes
15 (900 s). The product had an epoxide content of 24.51 percent which corresponds to an equivalent weight of 175 and a hydrolyzable chloride content of 0.02 percent. The epichlorohydrin yield was 98 percent.

EXAMPLE 3

20 In a manner similar to Example 1, the following components and conditions were employed.

114 grams (1 equiv.) of phenolic compound C
370 grams (4 equiv.) of epichlorohydrin
247 grams of propylene glycol methyl ether
25 (1-methoxy-propanol)
80 grams (1 equiv.) of 50 percent aqueous sodium hydroxide

The reaction temperature was 65°C and the reaction pressure was about 160 mm Hg (21.3 kPa)
30 absolute. The sodium hydroxide was added over a

period of one hour (3600 s) and the reaction was continued for an additional 15 minutes (900 s).

The product had an epoxide content of 24 percent corresponding to an epoxide equivalent weight of 179 and a hydrolyzable chloride content of 0.02 percent. The epichlorohydrin yield was 99 percent.

EXAMPLE 4

In a manner similar to Example 1, except where noted, the following components and conditions were employed.

93 grams (1 equiv.) of phenolic compound D
370 grams (4 equiv.) of epichlorohydrin
330 grams of propylene glycol methyl ether
(1-methoxypropanol)
80 grams (1 equiv.) 50 percent aqueous sodium hydroxide

The reaction temperature was 70°C and the reaction pressure was 190 mm Hg (25.3 kPa) absolute. The sodium hydroxide was added over a period of 1 hour (3600 s). The reaction was continued for an additional 15 minutes (900 s). The product was insoluble, and precipitated from the reaction mixture; therefore, 330 grams of water was added to the reaction mixture to facilitate the precipitation thereof and the mixture was cooled to 30°C. The solid was suction filtered, washed on the filter with water and methanol and then dried in a vacuum oven thereby producing a white solid having a softening point of 155°C, an epoxide content of 26.4 percent corresponding to an epoxide equivalent weight of 163. The hydrolyzable chloride content was 0.02 percent. The epichlorohydrin yield was 98 percent.

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EXAMPLE 5

4,4'-Methylenedianiline (99.2 g, 0.5 mole),
epichlorohydrin (370 g, 4 eq.) and 1-methoxy-2-propanol
(92.5 g) were stirred under atmospheric pressure to
5 achieve a complete solution. The solution was heated
to 80° and maintained at that temperature for 3 hours
(10800 s). The reaction was then cooled to 65°C and
under a reduced pressure of 160 mm Hg (21.3 kPa) absolute.
Aqueous sodium hydroxide (50 percent concentration, 176
10 g, 2.2 eq.) was added to the reaction mixture at a
constant rate over a period of 1 hour (3600 s). During
the addition of caustic, the water was removed in
accordance with the invention by codistilling with epi-
chlorohydrin and 1-methoxy-2-propanol. The distillate was
15 condensed and the organic phase was continuously returned to
the reaction mixture. After the addition of caustic was
completed, the reaction mixture was further stirred at
65°C, 160 mm Hg (21.3 kPa) for another 15 minutes. Work-up
of product as in Example 1 gave a product with 34.8
percent epoxide.

20 EXAMPLE 6

In a manner similar to Example 1, the following
components and conditions were employed.

59.3 grams (0.5 equiv.) of cresol-formaldehyde
novolac (phenolic compound E)
25 185 grams (2.0 equiv.) of epichlorohydrin
46 grams 1-methoxy-2-propanol
38 grams (0.475 equiv.) of 50 percent aqueous
sodium hydroxide

The reaction temperature was 65°C and the
30 reaction pressure was 180 mm Hg (24.0 kPa). The sodium
hydroxide was added over a period of 1 hour (3600 s)

and the reaction continued for an additional 15 minutes (900 s). The water content of the reaction mixture was found to be 1.3 percent.

5 The product had an epoxide content of 20.5 percent corresponding to an epoxide equivalent weight of 210 and a hydrolyzable chloride content of 0.02 percent. The epichlorohydrin yield was 98 percent.

EXAMPLE 7

10 In a manner similar to Example 1, the following components and conditions were employed.

97.3 grams (1.0 equiv.) of tris(hydroxyphenyl)-methane (phenolic compound F)
555 grams (6.0 equiv.) of epichlorohydrin
139 grams 1-methoxy-2-propanol
15 76 grams (0.95 equiv.) of 50 percent aqueous sodium hydroxide.

The reaction temperature was 65°C and the reaction pressure was 195 mm Hg (26.0 kPa). The sodium hydroxide was added over a period of 1 hour (3600 s)
20 and the reaction continued for an additional 30 minutes (1800 s). The water content of the reaction mixture was found to be 1.9 percent.

The product had an epoxide content of 26.5 percent corresponding to an epoxide equivalent weight
25 of 162 and a hydrolyzable chloride content of 0.02 percent. The epichlorohydrin yield was 98 percent.

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EXAMPLE 8

In a manner similar to Example 1, except where noted, the following components and conditions were employed.

- 5 90 grams (0.5 equiv.) of polycyclopentadiene polyphenol
 (phenolic compound G)
- 185 grams (2.0 equiv.) of epichlorohydrin
- 46 grams 1-methoxy-2-propanol
- 38 grams (0.475 equiv.) of 50 percent aqueous sodium
- 10 hydroxide

The reaction temperature was 65°C and the reaction pressure was about 180 mm Hg (24.0 kPa). The sodium hydroxide was added over a period of 1 hour (3600 s) and the reaction continued for an additional
15 30 minutes (1800 s). The product had a softening point of 85°C with an epoxide content of 15.8 percent and a hydrolyzable chloride content of 0.02 percent. The epichlorohydrin yield was 98 percent.

EXAMPLE 9

- 20 In a manner similar to Example 1, except where noted, the following components and conditions were employed.

- 93 grams (1.0 equiv.) of polycyclopentadiene polyresorcinol (phenolic compound H)
- 25 370 grams (4.0 equiv.) epichlorohydrin
- 92 grams 1-methoxy-2-propanol
- 76 grams (0.95 equiv.) of 50 percent aqueous sodium
- hydroxide

The reaction temperature was 65°C and the
30 reaction pressure was about 180 mm Hg (24.0 kPa). The

sodium hydroxide was added over a period of 1 hour (3600 s) and the reaction continued for an additional 30 minutes (1800 s). The product had a softening point of 89° with an epoxide content of 24.7 percent and a hydrolyzable chloride content of 0.02 percent. The epichlorohydrin yield was 98 percent.

EXAMPLES 10 THROUGH 14 AND COMPARATIVE EXPERIMENT D -

(Effect of water content in the reaction mixture on the yield and insoluble polymer formation)

10 A series of experiments were conducted in a manner similar to Example 1 except that the amount of water in the reaction vessel was varied. The following components and reaction conditions were employed.

15 104.5 grams (1 equiv.) of phenolic compound A
370 grams (4 equiv.) of epichlorohydrin
92.5 grams of the methyl ether of propylene glycol (1-methoxy-2-propanol) as a solvent

After stirring at room temperature and atmospheric pressure (101 kPa) to thoroughly mix the components, 20 the temperature was raised to 65°C and the pressure was reduced to a predetermined value. To the resultant solution was continuously added 76 grams, 0.95 equivalent, of a 50 percent aqueous sodium hydroxide solution at a constant rate over a period of two hours 25 (7200 s). During the addition of the sodium hydroxide, the water was removed by codistilling with epichlorohydrin and solvent. The distillate was condensed thereby forming two distinct phases. The organic phase (bottom) was continuously returned to the reactor. 30 After completion of the sodium hydroxide addition, the reaction mixture was maintained at a temperature of 65°C for an additional 30 minutes (1800 s). A sample

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was taken for analysis of by-products to determine the epichlorohydrin yield and the rest of reaction mixture was washed to remove salt and subsequently distilled resulting in an epoxidized novolac resin. Results of
5 experiments were as follows:



Examples and Comparative Experiment	Reaction Pressure, mm Hg (kPa)	H ₂ O Content in Reactor (%)	Hydrolyzable Chloride (%)	Insoluble Polymer (%)	Epi- chloro- hydrin Yield (%)
10	180 (24.0)	1.2	0.02	1.6	98
11	185 (24.7)	1.56	0.02	0.6	99
12	195 (26.0)	2.0	0.02	0.76	99
13	215 (28.7)	3.5	0.05	<0.1	98.5
14	220 (29.3)	4.0	0.05	<0.1	98
D	240 (32.0)	6.0	0.80	<0.1	94

At too low a water content, epichlorohydrin yield is high but insoluble polymer formation requires filtration in order to remove the polymer. At water contents of between 1.5 and 4.0 percent, the epichloro-
5 hydrin yields are 98 percent or above and insoluble polymer formation is less than 1 percent. A water content of 6 percent and above in the reaction mixture resulted in reduced epichlorohydrin yield and also increased the hydrolyzable chloride content of the
10 resultant product.



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CLAIMS

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1. A process for preparing a glycidyl derivative of a compound having at least one aromatic hydroxyl group or aromatic amine group per molecule by
05 reacting at least one compound having at least one aromatic hydroxyl group or aromatic amine group per molecule with an excess of at least one epihalohydrin in the presence of from 0.8 mole to 1.2 mole of an alkali metal hydroxide for each mole of aromatic
10 hydroxyl group and aromatic amine hydrogen, and subsequently recovering the glycidyl derivative product; characterized by

(1) conducting the reaction in the presence of a primary or secondary alcohol which codistills with
15 water and said epihalohydrin at a boiling point below the boiling point of the lowest boiling compound among the components in the reaction mixture;

(2) conducting the reaction at a temperature and a reduced pressure sufficient to provide a distillate
20 with a boiling point of from 45°C to 80°C;

(3) employing said alkali metal hydroxide as an aqueous solution and adding said aqueous alkali metal hydroxide in a continuous or intermittent manner over a period of from 0.5 to 10 hours;

25 (4) continuously removing water by means of codistillation at a rate such that the water content of the reaction mixture is less than 6 percent by weight and



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(5) separating the water from the codistillate and returning the solvent and epihalohydrin to the reaction mixture.

2. The process as claimed in Claim 1, wherein
05 the reaction temperature is from 55°C to 70°C.

3. A process as claimed in Claim 1 or Claim 2, wherein the aqueous alkali metal hydroxide is added over a period of from 1 to 5 hours.

4. A process as claimed in any one of the
10 preceding claims, wherein water is removed at a rate such that the water content in the reaction mixture is from 1.5 percent to 4 percent by weight.

5. A process as claimed in any one of the preceding claims, wherein the alcohol is a secondary
15 alcohol.

6. A process as claimed in Claim 3, wherein the secondary alcohol is cyclohexanol, 1-methoxy-2-propanol or a mixture thereof.

7. A process as claimed in any one of the
20 preceding claims, wherein the compound having an aromatic hydroxyl group is a phenol, bisphenol, a novolac resin, a polyvinyl phenol, or a compound of the formula, I, II, III, IV, V, VI, VII, VIII, or XIII as defined herein.

25 8. A process for the preparation of a glycidyl derivative of a compound having at least one aromatic



- 25 -

hydroxyl group or amine group, substantially as
hereinbefore described in any one of Examples 1 to
14.

9. A glycidyl derivative of a compound having
05 at least an aromatic hydroxyl group or amine group,
produced by a process as claimed in any one of the
preceding claims.
