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(54) Title: POLYETHERALKANOLAMINE DISPERSANTS

(57) Abstract: The present invention provides water-soluble products formed by reacting a monofunctional, amine-terminated polyether with a glycidyl ether of a polyol, which products are useful as dispersants in end uses and formulations known to employ dispersants. The invention also provides processes which comprises reacting a monofunctional, amine-terminated polyether with a glycidyl ether of a polyol.

POLYETHERALKANOLAMINE DISPERSANTS

Cross-references to Related Applications

This Application claims priority to US Provisional application serial number 60/570,600 filed May 13, 2004.

Background Information

The present invention relates generally to surfactants, and more particularly to polyetheralkanolamine surfactants that are derived from epoxy resins and monofunctional, amine-terminated polyethers.

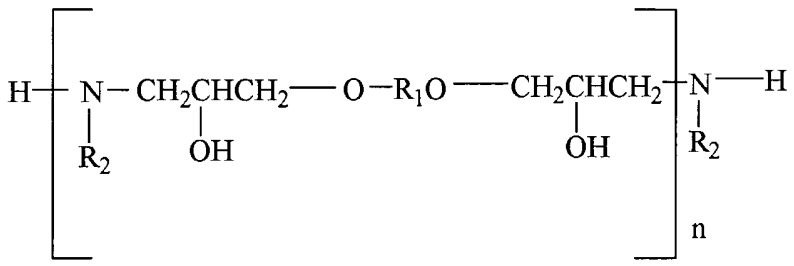
There is a class of polymers which are sometimes referred to by those skilled in the art as "comb polymers", because such polymers comprise a relatively long and hydrophobic or hydrophilic backbone having a plurality of branches appended to the backbone, wherein the branches resemble the teeth of a comb. The branches themselves may also be hydrophobic or hydrophilic. In these comb polymers, the chemical nature of the base of the comb is sometimes significantly different from the chemical nature of the branching teeth of the comb. In such instances, the polymers may be surface-active and hence useful as dispersive polymers in a wide variety of end uses.

U.S. Patent No. 6,506,821 B1 discloses epoxy resins obtained by reacting aromatic polyepoxides with polyoxyalkyleneamines in an equivalent ratio (epoxy equivalent : amine equivalent) of between 3.6 :1 and 10:1. Since the epoxide group content of these resins is bountiful, they are insoluble in water and are not suitable as pigment dispersants. U.S. Application No. 20050020735 discloses a dispersant prepared by reacting: 1) monofunctional or polyfunctional aromatic epoxides; with 2)

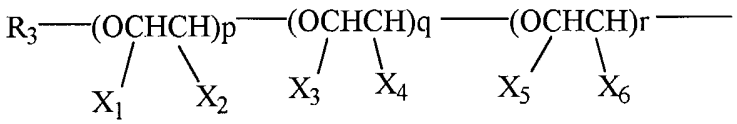
polyoxyalkylene monoamines, wherein from 90% to 100% of the epoxide groups are reacted. The polymers of the present invention are also obtained by reacting aliphatic polyepoxides with monofunctional amine-terminated polyethers. However, we have unexpectedly found that when an excess of epoxy resin is utilized that the viscosities of pigmented formulations are far lower than what one of ordinary skill in the art would expect.

SUMMARY OF INVENTION

One embodiment of the present invention provides dispersive polymers defined by the structure below, and including mixtures thereof:

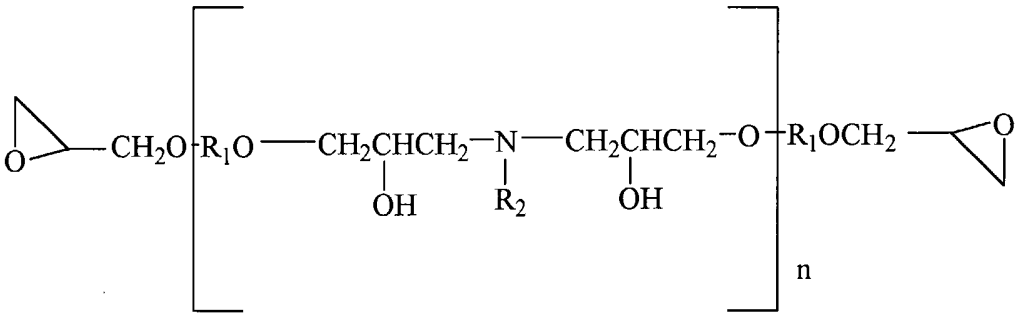


in which R_1 may be any C_1-C_{100} hydrocarbyl group; R_2 may be any alkoxylated hydrocarbyl group defined by the structure:

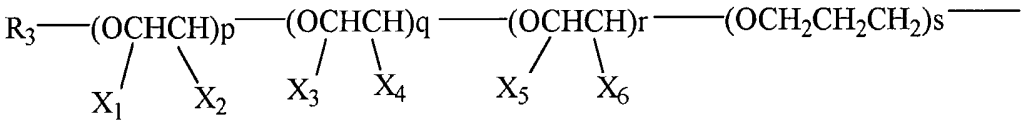


in which R_3 is any C_1 to about C_{24} hydrocarbyl group; X_1, X_2, X_3, X_4, X_5, and X_6 in each occurrence are independently selected from the group consisting of: hydrogen, methyl and ethyl, subject to the proviso that at least one of the two X groups that are attached to the same alkoxy unit are hydrogen, p, q, and r may each independently be any integer between zero and about 100, including zero, subject to the proviso that at least one of p, q, and r is not zero; and wherein n is any integer between 1 and about 50. In a preferred form of the invention, n is any integer between 1 and about 10 when the hydrocarbyl group is aromatic. In another embodiment, n is any integer between about 1 and 50 when the hydrocarbyl group is aliphatic.

In another embodiment, the present invention provides water-soluble dispersive polymers defined by the structure below, and including mixtures thereof:



in which R_1 may be any C_1-C_{100} aliphatic or aromatic hydrocarbyl group; R_2 may be any alkoxylated hydrocarbyl group defined by the structure:



in which R_3 is selected from the group consisting of: hydrogen, and any C_1 to about C_{24} hydrocarbyl group; X_1, X_2, X_3, X_4, X_5, and X_6 in each occurrence are independently selected from the group consisting of: hydrogen, methyl and ethyl, subject to the proviso that at least one of the two X groups that are attached to the same alkoxy unit are hydrogen, p, q, and r may each independently be any integer between zero and about 100, including zero, subject to the proviso that at least one of p, q, and r is not zero; and wherein n is any integer between 1 and about 50, and s is either 0 or 1. In a preferred form of the invention, n is any integer between 1 and about 10 when the hydrocarbyl group is aromatic. In another embodiment, n is any integer between about 1 and 20 when the hydrocarbyl group is aliphatic.

Detailed Description

A comb polymer may be prepared according to one embodiment of the present invention by reacting a monofunctional, amine-terminated polyether with a glycidyl ether of a polyol. The product resulting from such a process may be conveniently referred to as a polyetheralkanolamine. According to one preferred embodiment of the invention, the amine-terminated polyether (ATP) reactant is present in an amount sufficient to ensure that the total number of reactive hydrogen atoms on the nitrogen atom of the amine(s) present is at least stoichiometrically equal to the amount of epoxide groups present in all glycidyl ethers of a polyols present.

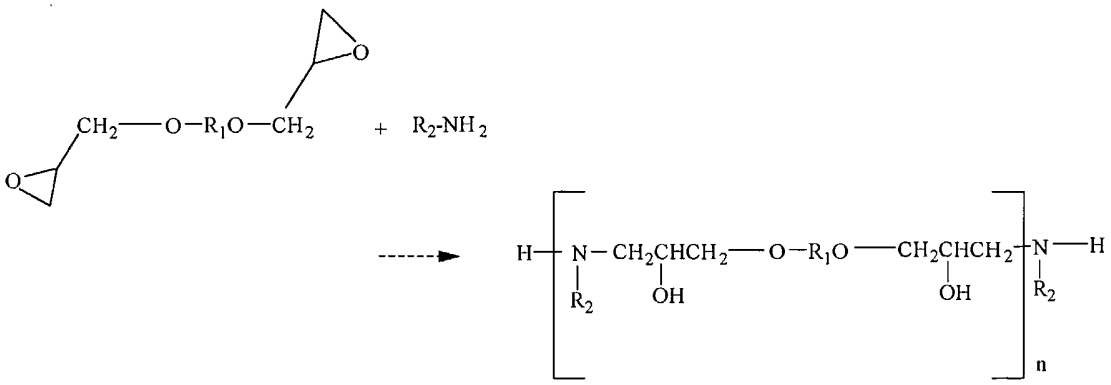
In another broad respect, the present invention provides a process that comprises reacting a monofunctional, amine-terminated polyether ("ATP") with a glycidyl ether of a polyol. A process according to another embodiment of the invention comprises reacting one or more epoxy resins with an ATP having a hydrophilic backbone at elevated temperature, to afford a thermoplastic polyethanolamine having many hydrophilic branches. The polymer molecular weight and physical properties of such products may be controlled by selection of raw materials, the ratio of the two starting materials, and the mixing temperature.

A polyethanolamine composition of the present invention may be prepared by reaction of a diglycidyl ether of Bisphenol A (or Bisphenol F) with a mono-functional polyetheramine having a molecular weight of 250 to 3500. The polyether (i.e., polyoxyalkylene) chain may be based on a polymer of ethylene oxide, propylene oxide, butylene oxide, or any combination of these materials, and may also include materials derived from cyanoethylated polyoxyalkylene glycols.

A reaction according to the invention, for forming the water-soluble comb materials herein described is preferably conducted at any temperature in the range of between about 50°C and 150° C. Reaction times vary independently, depending upon the nature of the reactants (i.e., degree of steric hindrance present) and may be any time between about 2 and about 10 hours, with the preferred reaction time being dependent on the nature of the starting materials as well.

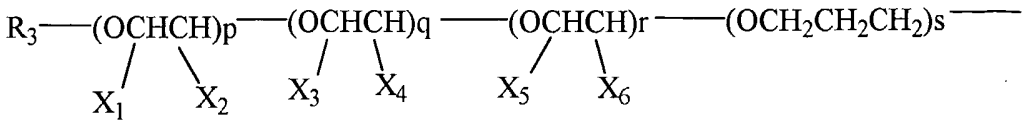
A comb polymer prepared in accordance with one preferred embodiment of the invention is water-soluble to a degree of at least 5% by weight of the polymer in water. A comb polymer in another embodiment is preferably soluble in water to a degree of at least 10 % by weight of the polymer in water. A comb polymer in one embodiment is preferably soluble in water to a degree of at least 15% by weight of the polymer in water. A comb polymer in another embodiment is preferably soluble in water to a degree of at least 20 % by weight of the polymer in water. A comb polymer in one embodiment is preferably soluble in water to a degree of at least 25% by weight of the polymer in water. A comb polymer in another embodiment is preferably soluble in water to a degree of at least 30 % by weight of the polymer in water. A comb polymer in one embodiment is preferably soluble in water to a degree of at least 35% by weight of the polymer in water. A comb polymer in another embodiment is preferably soluble in water to a degree of at least 40 % by weight of the polymer in water. A comb polymer in one embodiment is preferably soluble in water to a degree of at least 45% by weight of the polymer in water. A comb polymer in another embodiment is preferably soluble in water to a degree of at least 50 % by weight of the polymer in water. A comb polymer in yet a further embodiment is miscible with water in all proportions.

A general reaction scheme for the preparation of a comb polymer according to one embodiment of the present invention is:



in which an epoxy resin containing at least two epoxy functional end groups is reacted with a primary amine. R_1 in the above reaction may be any C_1-C_{100} hydrocarbyl group; thus the epoxy reactant may be any epoxy resin of at least a functionality of two, and includes without limitation the materials listed under the glycidyl ethers section of this specification. Further, it is easy for one of ordinary skill in the art to control the relative amounts of the raw materials used in forming a dispersant according to the present invention. In one embodiment, there is an excess of epoxy resin present, which results in dispersant molecules which are end-capped with epoxy groups. In another embodiment, there is excess amine used in forming the dispersants, which results in dispersant molecules which are end-capped with amine groups.

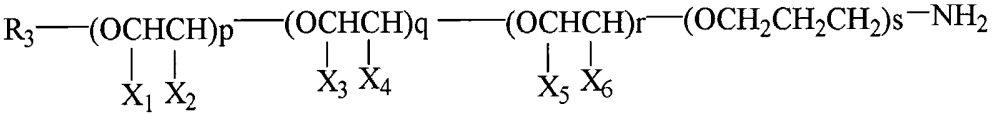
In the above equation, n is any integer between about 1 and about 50; R_2 may be any hydrocarbyl group which includes as a part of its molecular structure a portion containing at least two alkoxy groups linked to one another, i.e., the group R_2 may be a group:



in which R_3 is any C_1 to about C_{24} hydrocarbyl group; X_1, X_2, X_3, X_4, X_5, and X_6 in each occurrence are independently selected from the group consisting of: hydrogen, methyl and ethyl, subject to the proviso that at least one of the two X groups that are attached to the same alkoxy unit are hydrogen, p, q, and r may each independently be any integer between zero and about 100, including zero, subject to the proviso that at least one of p, q, and r is not zero, and s = 0 or 1.

The Amine Component

Such a group R_2 as specified above may be incorporated into a polymeric dispersant of the invention by reaction of an amine having the structure:



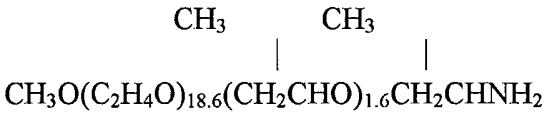
in which the variables are as defined above, with an epoxy resin having at least di-functionality, as previously specified. Thus, the above structures include R_2 groups that include, without limitation, both random and block polymers and co-polymers of any one or more of the following, either alone or mixed with one another in any proportion: ethylene oxide, propylene oxide, and butylene oxide. According to one preferred form of the invention, the molecular weight of the amine reactant is any molecular weight between about 100 and 12,000. In one preferred embodiment, amine-terminated

polyethers have a molecular weight of from about 1,000 to about 3,000. In another embodiment, the amine-terminated polyethers have a molecular weight in the range from about 250 to about 3500. In a further embodiment, the molecular weight is from about 1500 to about 2000.

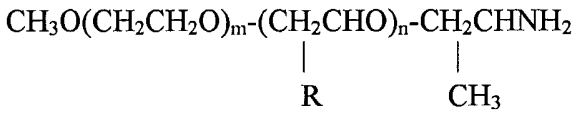
In cases where mixtures of such amines are employed to produce a polymer provided herein, the preferred molecular weight will in reality be an average molecular weight of all amines present, as it is recognized by those skilled in the art that the production of such alkoxylated amines inherently results in the production of a mixture of amines, by the nature of the process.

Thus, the mono-amine-functional, amine-terminated polyethers used in this invention include without limitation, those marketed by Huntsman LLC of The Woodlands, Texas under the trademarks JEFFAMINE® and SURFONAMINE®, as well as analogous compounds offered by other companies comprising polyoxyalkylenated primary amines. Suitable monoamines include JEFFAMINE® M-1000, JEFFAMINE® M-500, JEFFAMINE® M-600, JEFFAMINE® M-2070, and JEFFAMINE® M-2005. JEFFAMINE® M-1000, M-2070, and M-2005 have the following structures:

JEFFAMINE® M-1000



JEFFAMINE® M-2070 and JEFFAMINE® M-2005



where R = H or CH_3, m is from about 3 to 32, and n is from about 10 to 32. While these compounds are methoxy terminated, the amine-terminated polyethers used in the practice of this invention can be capped with other groups where the methyl group of the methoxy group is replaced with a higher hydrocarbon such as ethyl, propyl, butyl or any substituent up to about 18 carbons, including substituents. The amine termination is typically a primary amine group. Additional representative non-limiting examples of suitable amine-terminated polyethers for use in the practice of this invention include SURFONAMINE® B-60, a 600 molecular weight methyl capped amine having a PO/EO ratio of 9/1; SURFONAMINE® L-100, a 1000 molecular weight methyl capped amine having a PO/EO ratio of 3/19; SURFONAMINE® B-200, a 2000 molecular weight methyl capped amine having a PO/EO ratio of 29/6; SURFONAMINE® L-207, a 2000 molecular weight methyl capped amine having a PO/EO ratio of 10/31; SURFONAMINE® L-300, a 3000 molecular weight methyl capped amine having a PO/EO ratio of 8/58; SURFONAMINE® B-30, a 325 molecular weight C_{13} alkyl capped amine having two to three PO groups; and SURFONAMINE® B-100, a 1004 molecular weight nonyl phenyl capped amine having 13.5 parts PO.

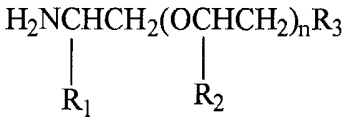
Suitable polyether blocks from which amine-terminated polyethers may be made from include polyethylene glycol, polypropylene glycol, copolymers of polyethylene glycol and polypropylene glycol, poly(1,2-butylene glycol), and poly(tetramethylene glycol). The glycols can be aminated using well known methods to produce the amine-terminated polyethers. Generally, the glycols are prepared from ethylene oxide, propylene oxide or combination thereof using well known methods such as by a methoxy or hydroxy initiated reaction. By varying the amounts of EO and/or PO, the hydrophilicity of the resulting products can be varied. When both ethylene oxide and

propylene oxide are used, the oxides can be reacted simultaneously when a random polyether is desired, or reacted sequentially when a block polyether is desired.

In one embodiment of the present invention, the amine-terminated polyethers are prepared from ethylene oxide, propylene oxide or combinations thereof. Generally, when the amine-terminated polyether is prepared from ethylene oxide, propylene oxide or combinations thereof, the amount of ethylene oxide on a molar basis is greater than about 50 percent of the amine-terminated polyether, preferably greater than about 75 percent and more preferably greater than about 90 percent. Diamines and triamines may, in one embodiment of this invention, be excluded from the composition. Similarly, functional groups, such as hydroxy groups, other than ether linkages and amine groups may be absent from the amine-terminated polyethers. The monofunctional amine-terminated amines used in the practice of this invention can be prepared using well known amination techniques such as described in U.S. 3,654,370; U.S. 4,152,353; U.S. 4,618,717; U.S. 4,766,245; U.S. 4,960,942; U.S. 4,973,761; U.S. 5,003,107; U.S. 5,352,835; U.S. 5,422,042; and U.S. 5,457,147. Generally, the monofunctional amine-terminated amines are made by aminating a polyether monol with ammonia in the presence of a catalyst such as a nickel containing catalyst such as a Ni/Cu/Cr catalyst.

Especially preferred amine-terminated polyethers have a molecular weight of from about 1,000 to about 3,000. (Unless otherwise specified herein, all molecular weights are expressed in atomic mass units ("a.m.u.")). While these particular materials are methoxy terminated, the amine-terminated polyethers used in practice of this invention can be capped with any other groups in which the methyl group of the methoxy group is replaced with a hydrogen or higher hydrocarbon such as ethyl, propyl, butyl, etc., including any hydrocarbyl substituent which comprises up to about 18 carbons. It is

especially preferred that the amine termination is a primary amine group. Thus, mono-functional amine-terminated polyethers useful in accordance with one embodiment of the present invention may have the general structure:



in which R_1 and R_2 are each independently selected from the group consisting of: hydrogen and any C_1 to C_4 hydrocarbyl group; R_3 is independently selected from the group consisting of: hydrogen, methyl, methoxy, ethoxy, and hydroxy; and wherein n is any integer in the range of between about 5 and 100, and including mixtures of isomers thereof. Such materials are available from Huntsman LLC of Houston, Texas in the highest quality and batch-to-batch consistency available in the marketplace.

The Glycidyl Ether Component

The glycidyl ethers of polyols useful in providing a composition according to the present invention are generally known as "epoxy resins" which include various epoxy resins including conventional, commercially-available epoxy resins. In addition, mixtures including any two or more epoxy resins may be employed in any ratio of combination with one another to provide a mixture with which a primary amine as set forth herein may be reacted. In general, the epoxy resins can be glycidated resins, cycloaliphatic resins, epoxidized oils and so forth. The glycidated resins are frequently formed as the reaction product of a glycidyl ether, such as epichlorohydrin, and a bisphenol compound such as bisphenol A. C_2-C_{28} alkyl glycidyl ethers; C_2-C_{28} alkyl-and-alkenyl-glycidyl esters; C_1-C_{28} alkyl-, mono- and poly-phenol glycidyl ethers; polyglycidyl ethers of pyrocatechol, resorcinol, hydroquinone, 4-4'-dihydroxydiphenyl methane (or bisphenol F), 4,4'-

dihydroxy-3,3'-dimethyldiphenyl methane, 4,4'-dihydroxydiphenyl dimethyl methane (or bisphenol A), 4,4'-dihydroxy-3,3'-dimethyldiphenyl propane, 4,4'-dihydroxydiphenyl sulfone, and tris (4-hydroxyphenyl) methane; polyglycidyl ethers of NOVOLAC® resins; polyglycidyl ethers of diphenols obtained by esterifying ethers of di-phenols obtained by esterifying salts of an aromatic hydrocarboxylic acid with a dihaloalkane or dihalogen dialkyl ether; polyglycidyl ethers of polyphenols obtained by condensing phenols and long chain halogen paraffins containing at least two halogen atoms; N,N'-diglycidyl-aniline; 4-glycidyloxy-N,N'-diglycidyl aniline; N,N'-dimethyl-N,N'-diglycidyl-4,4'-diaminodiphenyl methane; N,N,N',N'-tetraglycidyl-4,4'-diaminodiphenyl methane; N,N'-diglycidyl-4-aminophenyl glycidyl ether; and combination thereof. Commercially-available epoxy resins that can be used in the practice of this invention include but are not limited to ARALDITE® GY6010 resin (Huntsman Advanced Materials), ARALDITE® 6010 resin (Huntsman Advanced Materials), EPON® 828 resin (Resolution Polymers), and DER® 331 resin (the Dow Chemical Co.). Heloxy™ 68, Eponex™ 1510, and ARALDITE® MV 0500.

The Comb Polymers

In general the polymers of the present invention are obtainable by reacting aromatic polyepoxides with monofunctional amine-terminated polyethers in excess of aromatic polyepoxides based on equivalence, wherein from about 40% to about 75% of the epoxide groups of the starting material are reacted and the epoxy-to-amine equivalent ratio is any ratio between 1.10:1 to 2.5:1. In one preferred embodiment the ratio of epoxy groups to amino hydrogen atoms (hydrogens attached to a nitrogen atom of a primary amine) in a reactant mixture used to form a dispersant according to the present invention

is in the range of between about 1.1 : 1 to 2.5 : 1. Such a provision ensures that less than 90% of the epoxy groups in the reactive mixture are reacted, which is especially beneficial when the epoxy component is aromatic to produce a material within this invention.

Thus, it will be seen and recognized by one of ordinary skill in the art that the R_1 group of a dispersant according to the present invention is a hydrocarbyl residue derived from a material as described above.

It is generally preferred that the amine-terminated polyether and glycidyl ether of a polyol are present in such amounts that the amine group of the polyether is able to be consumed by reacting with essentially all of the epoxide functionality of the glycidyl ether. Thus, during the reaction, the amount of amine-terminated polyether is stoichiometrically equal to or greater than the amount of epoxide in the glycidyl ether of a polyol. The resulting product has little if any unreacted epoxide functionality left after the reaction.

Depending on the starting amount used of a primary amine, it is possible to form either a secondary or tertiary amine in the final product. It is therefore possible to form products which contain repeating units where an ATP has reacted with two epoxide groups to form a tertiary amine. This result can be depicted by the following representative formula:

$$RNHCH_2CHOHCH_2\text{-}[\text{-}O\text{-}A\text{-}O\text{-}CH_2CHOHCH_2NRCH_2CHOHCH_2\text{-}O\text{-}]_x\text{-}A\text{-}O\text{-}CH_2CHOHCH_2\text{-}NRH$$

in which R represents the capped polyether portion of the ATP; A represents a hydrocarbyl radical, such as the hydrocarbon portion of bisphenol A; and x can vary from

0 (if no tertiary amine present) to about 100. The reaction that forms such products is preferably conducted at any temperature in the range of between about 80°C to about 150°C, under ambient pressure.

Thus it is seen that in one broad respect, this invention is a product formed by reacting a monofunctional, amine-terminated polyether with a glycidyl ether of a polyol. The amine component and the glycidyl ether component may each comprise mixtures of amines and glycidyl ethers, respectively. The amine-terminated polyether provided is generally preferred to be provided in an amount stoichiometrically equal to or greater than the amount of epoxide in the glycidyl ether of a polyol. In one embodiment, up to about 10 percent excess glycidyl ether of a polyol is used.

In another broad respect, this invention comprises a process which comprises contacting a monofunctional, amine-terminated polyether with a glycidyl ether of a polyol. The amine-terminated polyether is used in a stoichiometrically-equivalent or greater amount than the amount of epoxide in the glycidyl ether of a polyol. Likewise, in one embodiment, up to about 10 percent excess glycidyl ether of a polyol is used.

The adduct polymers provided by the present invention can be used as surface active agents in aqueous solutions, hydrocarbons and other organic solvents, depending on which possible composition is used. They are useful in all end use applications and formulations which are known to contain a dispersant as a component.

The reaction of the amine-terminated polyether with the glycidyl ether of a polyol can be conducted with, or without, one or more solvents. In general, the reaction may be conducted with one or both reactants in neat form, in the absence of solvents. If a solvent is used, the solvent should be non-reactive with the amine-terminated polyether, the epoxy resin, or the reaction product of the amine-terminated polyether and the epoxy resin.

Representative, non-limiting examples of such solvents include alcohols such as isopropanol, ketones such as methyl isobutyl ketone, and aromatic hydrocarbons such as toluene, and other alcohols, ketones, ethers and hydrocarbons. Water may be also used as a solvent.

The following examples are illustrative of this invention and shall not be construed as being delimitive hereof in any manner. Unless otherwise denoted all parts and percentages are on a weight basis.

Example 1

A mixture of standard epoxy resin, such as EPON™ 828, available from Resolution Polymers, Inc. or ARALDITE™ 6010, a product of Huntsman Advanced Materials, is mixed with slight molar excess of the ATP, such as JEFFAMINE® M-2070. The resulting mixture is of very low viscosity, forming a clear solution, which is heated up to 100°C for three to four hours. During this time the resulting polymerization of occurs, forming the polyetheralkanolamine and increasing the viscosity build with time. The resulting polymer is a clear, viscous liquid, which dissolves in water. When the solution is agitated, foaming occurs, and remains stable.

Other monofunctional ATP products, such as JEFFAMINE® M-1000 (XTJ-506) and an experimental product, XTJ-580 (500 MW), produce similar products when reacted in similar fashion with the epoxy resins in the above example.

Example 2

To a small sample vial is added 10 g. (0.04 equivalent mole (amount divided by equivalent weight)) of XTJ-580 (an ATP of 500 MW and having 250 equivalent weight)

and 5 g (0.0266 equivalent mole) of EPON 828 (a diglycidyl ether of bisphenol A, having 188 equivalent weight). Equivalent weight for an amine is calculated by dividing the number of active amine hydrogens. This example used a 1.5 ratio of equivalent moles of XTJ-580 to EPON 828. The resulting mixture was mixed to a clear solution, then put in a 50°C oven for 1 hour. After that time, the mixture was still clear and mobile, so was placed in a 100°C oven for 5 hours. A comb-like polyethanolamine formed which was a clear viscous liquid that was soluble in water. The water solution foams slightly on shaking.

Example 3

To a small vial was added 10 g (0.040 equivalent mole) of XTJ-580 and 6 g (0.0319 equivalent mole) of EPON 828. Upon shaking the two layers went into a clear, water-white solution which was placed in a 100°C oven for three hours. This example used a 1.25 ratio of equivalent moles of XTJ-580 to EPON 828. A comb-like polyethanolamine formed which was completely soluble in water, and which foams slightly on shaking.

Example 4

To a small vial was added 9 g (0.036 equivalent mole) of XTJ-580 and 6.4 g (0.034 equivalent mole) of EPON 828. Upon shaking the two layers went into a clear, water-white solution which was placed in a 100°C oven for three hours. This example used a 1.06 ratio of equivalent moles of XTJ-580 to EPON 828. The resulting mixture was mixed to a clear solution, and then put in a 100°C oven for 2.5 hours. The product was mostly soluble in water. The mixture was returned to the 100°C oven for an

additional 15 hours. The comb-like polyethanolamine was viscous, movable at 100°C, not movable at 20°C, water soluble and produces foaming on shaking.

Example 5

To a one pint wide-mouth glass container was added 200 g (0.2 equivalent mole) of JEFFAMINE™ M-2070 at 50°C. EPON 828 (30 g, 0.16 equivalent mole) was added at 50°C. The resulting mixture was shaken until homogenous and allowed to heat at 100°C for about six hours, then cooled to room temperature. The resulting polyethanolamine product had total acetylatables of 1.28 milliequivalents/gram, total amine of 0.379 milliequivalents/gram, and a molecular weight of 2009.

Example 6

To a 500 mL wide mouth bottle was added XTJ-580 (200 g, 0.4 mole equivalent) and HELOXY 65 (184 g, 0.89 mole equivalent) which is a p-tert-butylphenylglycidyl ether. The resulting mixture was stirred into a clear homogeneous solution, tightly capped, and placed in a 50°C oven for one hour. The solution was placed in a 100°C oven for 3.5 hours and then cooled to 85°C for about one hour, before removing from the oven and allowed to cool to room temperature. Analysis of the product showed the following: total acetylatables, 2.29 milliequivalents/gram; total amine, 1.046 milliequivalents/gram; secondary amine, 0.0474 milliequivalents/gram; tertiary amine, 0.9965 milliequivalents/gram; primary amine, 0.003 milliequivalents/gram; viscosity of 1959 cps at 25°C, and an epoxide equivalent weight of 0.0130.

Example 7

To a small, wide mouth glass bottle was added JEFFAMINE™ M-1000 (XTJ-506, 50 g, 0.1 mole equivalent) and EPON 828 (15 g, 0.08 mole equivalent). The mixture is swirled to a homogeneous off-white solution and placed in a 100°C oven for five hours. The product at 25°C was a soft, waxy semisolid. Analysis of the product showed: total acetylatables, 1.79 milliequivalents/gram; total amine, 0.75 milliequivalents/gram; secondary and tertiary amines, 0.3759 milliequivalents/gram; and tertiary amine, 0.770 milliequivalents/gram. The product was completely water soluble. When shaken the water solution produced a stable foam.

Example 8

To a small wide mouth bottle was added XTJ-534 (a tert-butyl capped polyether monoamine, 50 g, 0.2 mole equivalent) and EPON 828 (30 g, 0.161 mole equivalent). The resulting mixture was shaken until homogeneous and clear, then placed with a cap into a 100°C oven for four hours. The product is believed to include predominantly molecules composed of 5 parts of epoxy and 6 parts of XTJ-534 (2 parts secondary amine and 4 parts tertiary amine). Analysis of the product showed the following: total acetylatables, 2.44 milliequivalents/gram and total amine, 1.15 milliequivalents/gram.

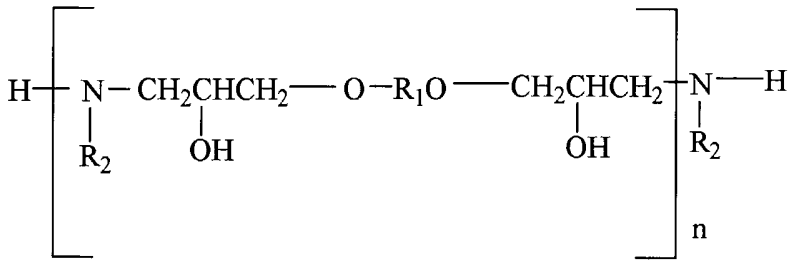
Example 9

To a one pint, wide mouth jar was added XTJ-580 (100 g) and EPON 828 (60 g, 0.319 mole equivalent). The resulting mixture is mixed until homogeneous, then placed in a 100°C oven for four hours, then allowed to cool to room temperature. Analysis of the

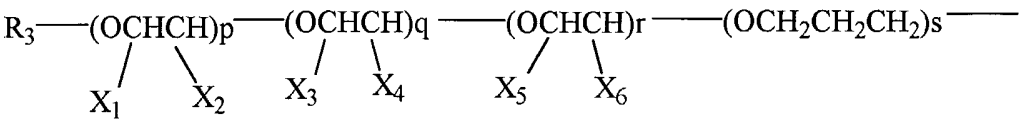
product shows: total acetylatables, 2.4 milliequivalents/gram; hydroxyl number, 137.5; and total amine, and 1.25 milliequivalents/gram.

What is claimed is:

1) A composition of matter useful as an dispersing agent, which composition comprises a water-soluble dispersant having the structure:



in which R_1 may be any C_1-C_{100} aliphatic hydrocarbyl group; R_2 may independently be any alkoxylated hydrocarbyl group defined by the structure:



in which R_3 is independently selected from the group consisting of: hydrogen, and any C_1 to about C_{24} hydrocarbyl group; X_1, X_2, X_3, X_4, X_5, and X_6 in each occurrence are independently selected from the group consisting of: hydrogen, methyl and ethyl, subject to the proviso that at least one of the two X groups that are attached to the same alkoxy unit are hydrogen, p, q, and r may each independently be any integer between zero and about 100, including zero, subject to the proviso that at least one of p, q, and r is not zero; n is any integer between 1 and about 50; and s may be either 0 or 1.

2) A composition according to claim 1 further comprising a solvent.

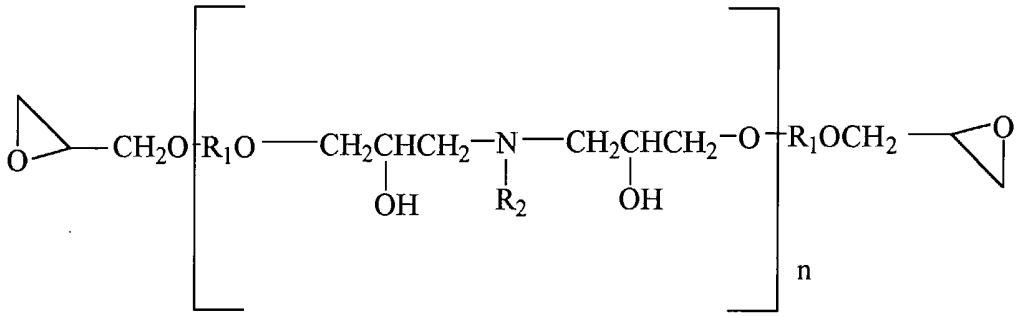
3) A composition according to claim 2 wherein said solvent component comprises water.

4) A composition according to claim 2 wherein said solvent comprises one or more organic solvents selected from the group consisting of: polyhydric alcohols; glycols; diols; glycol esters; glycol ethers; polyalkyl glycols; lower alkyl ethers of polyhydric alcohols; alcohols having fewer than about 8 carbon atoms per molecule; ketones; ethers; esters; and lactams.

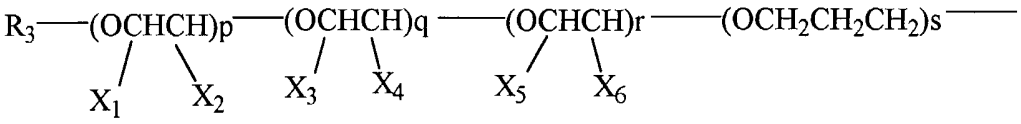
5) A composition according to claim 2 wherein said solvent comprises one or more organic solvents selected from the group consisting of: ethylene glycol, propylene glycol; butanediol; pentanediol; glycerol; propylene glycol laurate; polyethylene glycol; ethylene glycol monomethyl ether, ethylene glycol mono-ethyl ether; ethylene glycol mono-butyl ether; alcohols having fewer than about 8 carbon atoms per molecule such as methanol, ethanol, propanol, iso-propanol; acetone; dioxane; ethyl acetate, propyl acetate, tertiary-butyl acetate, and 2-pyrrolidone.

6) A composition according to any foregoing claim wherein the amount of said solvent component present is any amount between about 50 % and 99 % by weight based on the total weight of said composition.

7) A composition of matter which comprises a water-soluble dispersant having the structure:



in which R_1 may be any C_1-C_{100} aliphatic or aromatic hydrocarbyl group; R_2 may be any alkoxylated hydrocarbyl group defined by the structure:



in which R_3 is selected from the group consisting of: hydrogen, and any C_1 to about C_{24} hydrocarbyl group; X_1, X_2, X_3, X_4, X_5, and X_6 in each occurrence are independently selected from the group consisting of: hydrogen, methyl and ethyl, subject to the proviso that at least one of the two X groups that are attached to the same alkoxy unit are hydrogen, p, q, and r may each independently be any integer between zero and about 100, including zero, subject to the proviso that at least one of p, q, and r is not zero; n is any integer between 2 and about 20; and s may be either 0 or 1.

8) A composition according to claim 7 further comprising a solvent.

9) A composition according to claim 8 wherein said solvent component comprises water.

10) A composition according to claim 8 wherein said solvent comprises one or more organic solvents selected from the group consisting of: polyhydric alcohols; glycols; diols; glycol esters; glycol ethers; polyalkyl glycols; lower alkyl ethers of polyhydric alcohols; alcohols having fewer than about 8 carbon atoms per molecule; ketones; ethers; esters; and lactams.

11) A composition according to claim 8 wherein said solvent comprises one or more organic solvents selected from the group consisting of: ethylene glycol, propylene glycol; butanediol; pentanediol; glycerol; propylene glycol laurate; polyethylene glycol; ethylene glycol monomethyl ether, ethylene glycol mono-ethyl ether; ethylene glycol mono-butyl ether; alcohols having fewer than about 8 carbon atoms per molecule such as methanol, ethanol, propanol, iso-propanol; acetone; dioxane; ethyl acetate, propyl acetate, tertiary-butyl acetate and 2-pyrrolidone.

12) A composition according to any foregoing claim wherein the amount of said solvent component present is any amount between about 50 % and 99 % by weight based on the total weight of said composition.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/16369

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : C08L 63/00, 63/02, 39/00; C08F 8/12
US CL : 523/400, 403, 427; 524/555; 525/383
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 523/400, 403, 427; 524/555; 525/383

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,585,446 A (MARTEN et al.) 17 December 1996 (17/12/1996), col.2, line 62-col.3, line 3, col.3, lines 40-48, col.4, lines 19-22, col.5, lines 25-55, and col.6, lines 28-40.	1
X	US 6,077,884 A (HESS et al.) 20 June 2000 (20/06/2000), col.1, lines 7-10, col.3, lines 50-64, col.5, lines 4-6, and col.5, line 59-col.6, line 53.	7-9, 12
X	US 5,567,748 A (KLEIN et al.) 22 October 1996 (22/10/96), col.2, lines 15-29 and 61-62, col.3, lines 3-9 and 14-16, col.3, line 50-col.4, line 21, col.5, lines 4-22, col.10, lines 30-39 and 62-65, col.11, lines 1-5 and 21-30, col.14, lines 1-10, col.16, lines 56-65, col.17, lines 21-23, and col.18, line 63-col.19, line 5.	1-6
X	US 4,421,906 A (WADDILL et al.) 20 December 1983 (20/12/83), col.1, lines 8-10, col.2, lines 15 and 21-42, col.2, line 63-col.3, line 29, Example IIa(B) and Example IIb (X).	7-12
A	US 6,303,672 B1 (PAPALOS et al.) 16 October 2001 (16/10/2001)	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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04 August 2005 (04.08.2005)

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