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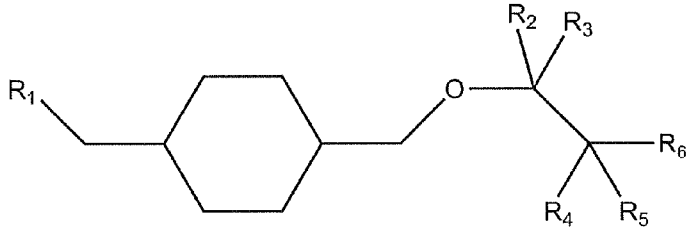
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(54) Title: ETHERAMINE COMPOUNDS



(1)

(57) Abstract: Embodiments described herein provide a compound that may be used in a variety of applications such as corrosion inhibition, additives for metalworking, mining reagents, epoxy curatives, emulsifiers, fuel or lubricant additives, surfactant manufacture, acid scavengers and asphalt additives. The compound has the following structure (1): where R_1 is a methoxy group, R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, and R_6 is an aminomethyl group.

ETHERAMINE COMPOUNDS

FIELD

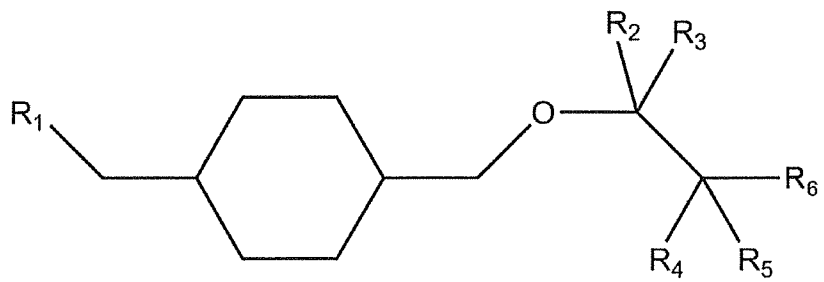
[0001] Embodiments described herein are generally related to aliphatic etheramines, and more specifically, to a cycloaliphatic etheramine.

BACKGROUND

[0002] Etheramines prepared from acrylonitrile are known as alkyloxypropylamines, which are used in a variety of applications such as corrosion inhibition, additives for metalworking, mining reagents, epoxy curatives, emulsifiers, fuel or lubricant additives, surfactant manufacture, acid scavengers and asphalt additives.

SUMMARY

[0003] Embodiments described herein provide an etheramine compound that may be used in a variety of applications such as corrosion inhibition, additives for metalworking, mining reagents, epoxy curatives, emulsifiers, fuel or lubricant additives, surfactant manufacture, acid scavengers and asphalt additives. The compound has the following structure:

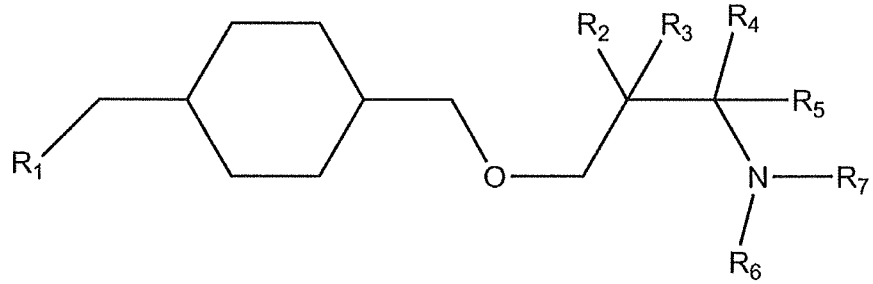


where R_1 is a hydrogen atom or a methoxy group,

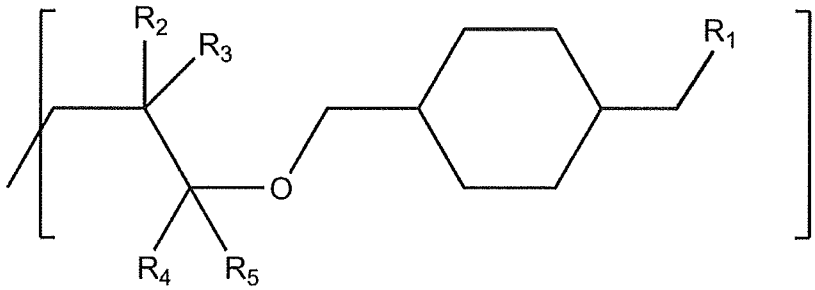
R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, and

R_6 is an aminomethyl group.

[0004] In another embodiment, an etheramine compound includes the following structure:



where R_6 has the structure

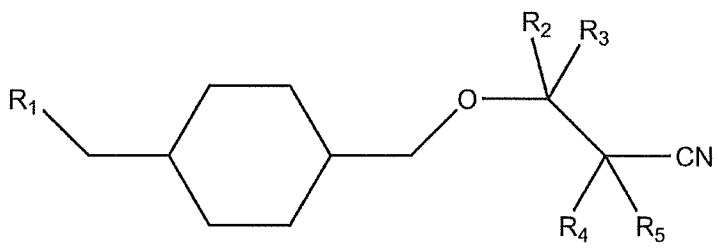


R_7 is a hydrogen atom or the same as R_6,

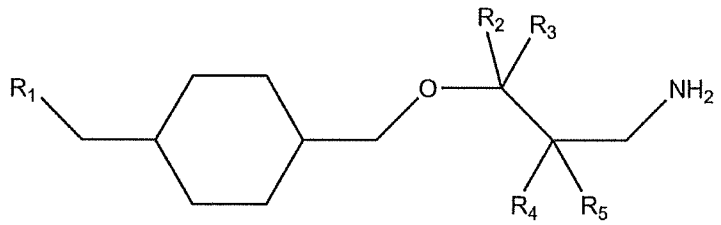
R_1 is a hydrogen atom or a methoxy group, and

R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

[0005] In another embodiment, a method for forming an etheramine compound includes reacting 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol with an alkene having a nitrile group to form an intermediate compound having the structure:

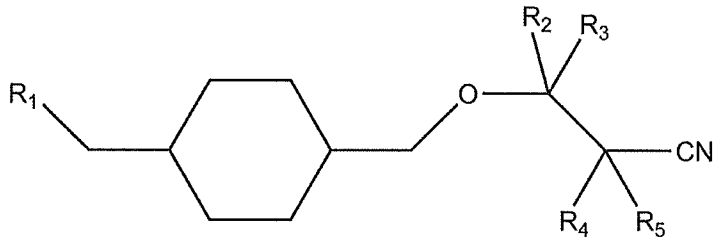


where R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, and hydrogenating the intermediate compound to form the etheramine compound having the structure:



where R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

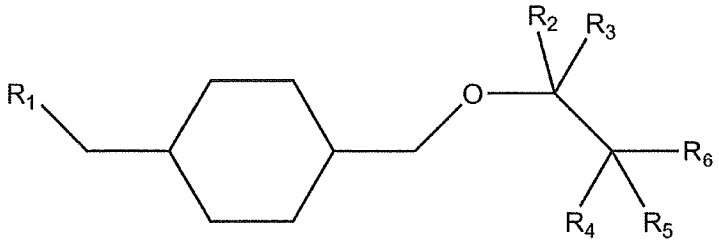
[0006] In another embodiment, an etheramine compound is formed by a method including reacting 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol with an alkene having a nitrile group to form an intermediate compound having the structure:



where R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, and hydrogenating the intermediate compound.

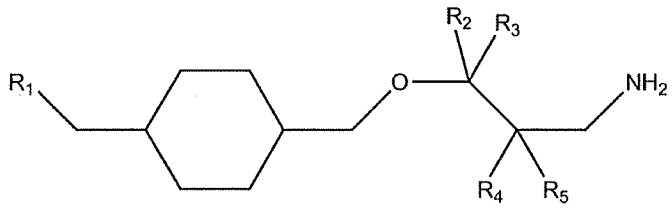
DETAILED DESCRIPTION

[0007] Embodiments described herein provide an etheramine compound that may be used in a variety of applications such as corrosion inhibition, additives for metalworking, mining reagents, epoxy curatives, emulsifiers, fuel or lubricant additives, surfactant manufacture, acid scavengers and asphalt additives. The etheramine compound has the following structure:



where R_1 is a hydrogen atom or a methoxy group,
R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, and
R_6 is an aminomethyl group.

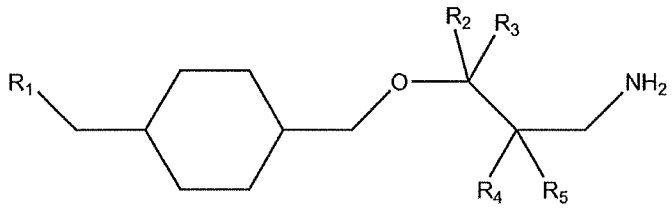
[0008] The etheramine compound may also have the structure:



(I)

where R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

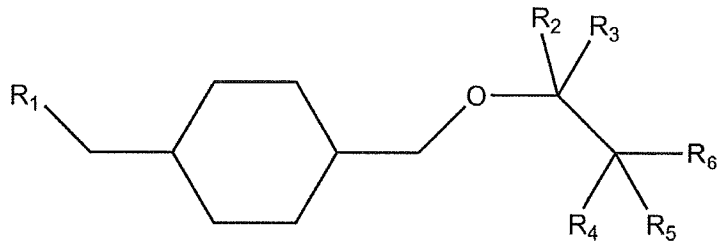
[0009] An etheramine compound having the structure:



(I)

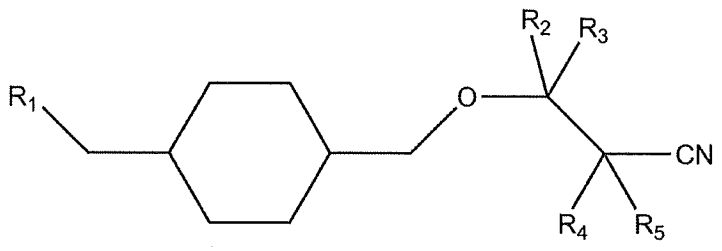
where R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, may be used in a variety of applications such as corrosion inhibition, additives for metalworking, mining reagents, epoxy curatives, emulsifiers, fuel or lubricant additives, surfactant manufacture, acid scavengers and asphalt additives.

[0010] The etheramine compound may be formed by reacting 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol with an alkene having a nitrile group to form an intermediate compound having the following structure:



where R_1 is a hydrogen atom or a methoxy group,
R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, and
R_6 is a nitrile group.

[0011] The intermediate compound may also have the structure:



(II)

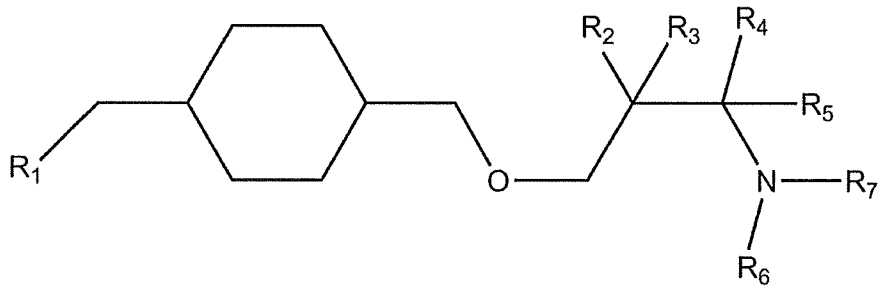
where R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

[0012] The alkene having a nitrile group may be acrylonitrile or any suitable straight or branched alkene having a nitrile group. The reaction temperature may range from about -20 degrees Celsius to about 60 degrees Celsius, such as from about 19 degrees Celsius to about 33 degrees Celsius.

[0013] The reaction between 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol and the alkene having a nitrile group may be a cyanoethylation reaction. In one embodiment, acrylonitrile is reacted with 4-

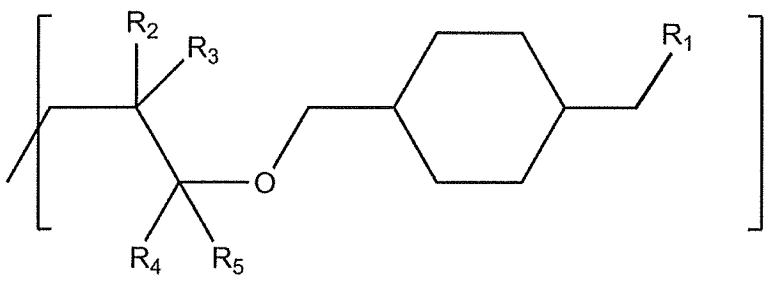
methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol in a cyanoethylation reaction. The cyanoethylation reaction may be reversible and equilibrium limited. Using an excess of acrylonitrile can provide a higher alcohol conversion. A base catalyst may be used to facilitate the reaction of the alcohols. Suitable base catalysts include alkali hydroxides, and alkali alkoxides such as sodium methylate, amines, guanidines, or solid bases such as KF on alumina. At the end of the cyanoethylation reaction the catalyst may be neutralized to limit byproduct formation. Any solvent that does not interfere with the reaction may also be employed.

[0014] Hydrogenation of the intermediate compound may be performed by reacting the intermediate compound with hydrogen gas to form the etheramine compound. The etheramine compound having the structure (I) may be a primary amine. Alternatively, the etheramine compound may be a secondary amine or tertiary amine having the following structure:



(III)

where R_6 has the following structure:



(IV)

R_7 is a hydrogen atom or the same as R_6,

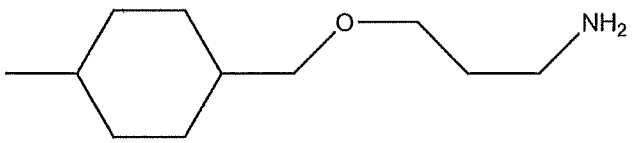
R_1 is a hydrogen atom or a methoxy group, and

R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

[0015] Different catalyst used in the hydrogenation reaction between the intermediate compound and hydrogen gas may determine whether the etheramine compound is a primary amine, secondary amine or tertiary amine. Primary means that the etheramine compound includes at least 40% by weight of the primary amine. For example, a cobalt catalyst may cause the etheramine compound to be a primary amine, such that the amount of primary amine in the etheramine compound may be over 80% by weight. Secondary means that the etheramine compound includes at least 40% by weight of the secondary amine. For example, a nickel catalyst may cause the etheramine compound to be a secondary amine, such that the amount of secondary amine in the etheramine compound is over 40% by weight. Tertiary means that the etheramine compound includes at least 40% by weight of the tertiary amine. For example, a platinum catalyst may cause the etheramine compound to be a tertiary amine, such that the amount of tertiary amine in the etheramine compound is over 40% by weight. Formation of a primary amine may be also increased by the presence of ammonia in the hydrogenation reaction mixture to limit coupling at the nitrogen of the amine and the nitrile carbon.

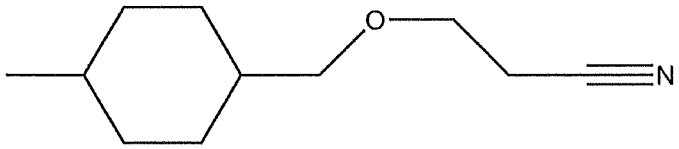
[0016] The hydrogenation reaction may be carried out catalytically in batch or continuous reactors. Reduction with a hydrogen donor can also be applied stoichiometrically. The hydrogenation reaction may be performed at a temperature between about 20 degrees Celsius and about 140 degrees Celsius, such as between about 80 degrees Celsius and about 120 degrees Celsius. The hydrogenation reaction may be performed between about 14.3 psig and about 2000 psig.

[0017] In one embodiment, the etheramine compound is 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine and has the following structure:



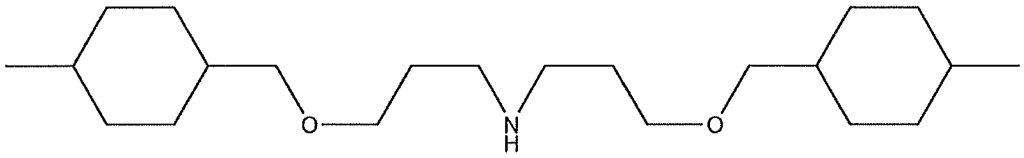
(V)

[0018] The 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine may be formed by reacting 4-methylcyclohexane methanol with acrylonitrile to form 3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile, which has the following structure:



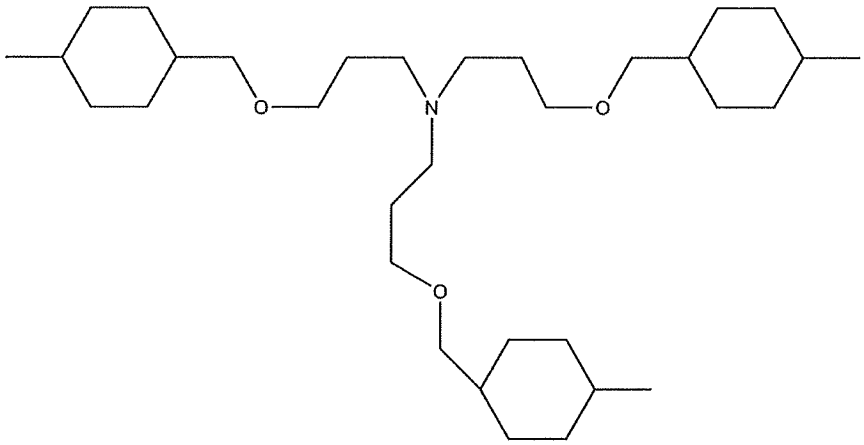
(VI)

3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile is then hydrogenated in the presence of a cobalt catalyst and ammonia to form 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine, although secondary and tertiary amines may be present. If the catalyst used in the hydrogenation reaction is a nickel catalyst and no ammonia is present in the reaction mixture, the product of the hydrogenation reaction may be iminobis{3-[(4-methylcyclohexyl)methyloxy]propane, which is a secondary amine having the following structure:



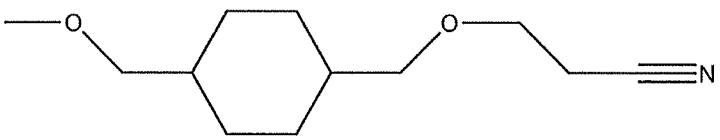
(VII)

[0019] If the catalyst used in the hydrogenation reaction is a platinum catalyst and no ammonia is present in the reaction mixture, the product of the hydrogenation reaction may be a tertiary amine having the following structure:



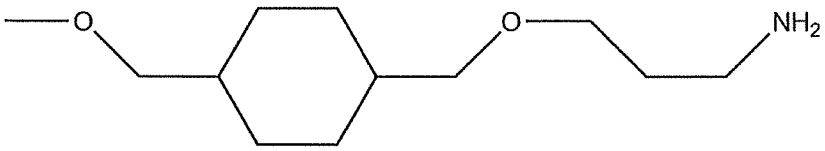
(VIII)

[0020] In one embodiment, a reactant, which is a mixture of 4-methylcyclohexane methanol and 4-methoxymethylcyclohexane methanol, is reacted with acrylonitrile to form an intermediate compound, which is a mixture of 3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile and 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanenitrile, which has the following structure:



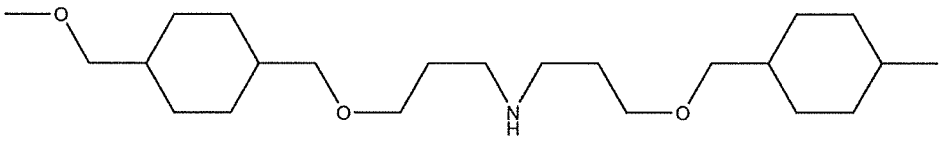
(IX)

The intermediate compound is then hydrogenated with a cobalt catalyst and ammonia to form an etheramine compound, which is a mixture of 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine and 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanamine, which has the following structure:



(X)

[0021] If the catalyst used in the hydrogenation reaction is a nickel catalyst and ammonia is not added to the reaction mixture, the etheramine compound formed by the hydrogenation reaction may be a mixture of iminobis{3-[(4-methylcyclohexyl)methyloxy]}propane and N-3-[(4-methyloxy methylcyclohexyl)methyloxy]propyl-3-[4-methylcyclohexyl]methyloxy]-1-propanamine, which has the following structure:



(XI)

[0022] The etheramine compound, such as 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine, 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanamine, iminobis{3-[(4-methylcyclohexyl)methyloxy]}propane or N-3-[(4-methyloxy methylcyclohexyl)methyloxy]propyl-3-[4-methylcyclohexyl]methyloxy]-1-propanamine, is a novel etheramine compound that may be used as corrosion inhibitors, additives for metal working, silica flotation aids for the beneficiation of iron or phosphate ores, epoxy curatives, emulsifiers, fuel or lubricant additives, acid scavengers and asphalt additives. The etheramine compound may be also used as a starting material to form ethoxylated amine, amine oxide, quaternary ammonium or amphoteric surfactants. The intermediate compounds, such as 3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile and 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanenitrile, are also novel compounds.

[0023] The following examples are provided as illustrative examples and shall not be construed as delimitive of the scope of the disclosure whatsoever.

[0024] In one example, crude 4-methylcyclohexane methanol is used as the starting material. 4-methylcyclohexane methanol is a byproduct from the manufacture of cyclohexanedimethanol. The starting material, crude 4-methylcyclohexane methanol, in the following experiments, contained 4-5% water, 81% 4-methoxymethylcyclohexane methanol, 5% 4-methoxymethylcyclohexane methanol, and other impurities. Crude 4-methylcyclohexane methanol was reacted with excess acrylonitrile using sodium methylate catalyst to give an intermediate compound, which is a liquid containing suspended and crystallized solids. The intermediate compound was analyzed using gas chromatography-mass spectrometry, which identified peaks associated with 3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile and 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanenitrile.

[0025] In another example, distillation of crude 4-methylcyclohexane methanol was conducted to remove water. The resulting 4-methylcyclohexane methanol has 0.7% water by weight and a hydroxyl number of 427 mg KOH/g. Cyanoethylation was carried out by addition of acrylonitrile by syringe pump to catalyzed 4-methylcyclohexane methanol (sodium methylate was used as the catalyst). 1997.98 g of 4-methylcyclohexane methanol (15.20 equivalents) was reacted with 835.7 g (15.75 mol) of acrylonitrile in the presence of 5.26 g sodium methylate at a temperature between about 19 degrees Celsius and about 33 degrees Celsius. The acrylonitrile was added over a period of about two hours. Infrared spectrophotometry analysis of the reaction mixture indicated about 69% conversion. Another 5.26 g of sodium methylate was added and the mixture was stirred for two hours and found to contain significant unreacted alcohol. After stirring for about six hours an additional 48.2 g of acrylonitrile was added. The mixture was allowed to further react at about 20 degrees Celsius for 24 hours. Then 3.63 g of acetic acid was added along with 23.5 g magnesium silicate and

the slurry was heated to about 80 degrees Celsius. The slurry was vacuum stripped at about 80 degrees Celsius and then filtered to obtain 2748 g of a clear and nearly colorless liquid having a hydroxyl number of 8.87 mg KOH/g, 0.5 ppm K and 0.8 ppm Na. The clear and nearly colorless liquid was identified to be 3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile.

[0026] The 3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile was hydrogenated in a tubular reactor over a solid form cobalt catalyst in the presence of ammonia at about 120 degrees Celsius and 2000 psig. 3-[(4-methylcyclohexyl)methyloxy]-1-propanenitrile was fed into the reactor at a rate of 100 g/h, ammonia was fed into the reactor at a rate of 70 g/h, and hydrogen gas was fed into the reactor at a rate of 50 l/h. The effluent was a dark amber-orange liquid. The dark amber-orange liquid was vacuum stripped to remove lights and analyzed. Gas chromatography/mass spectrometry gave m/z 185 for the major peaks, along with m/z 215, 353 and 383 for minor peaks. These correspond to 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine, 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanamine, iminobis{3-[(4-methylcyclohexyl)methyloxy]}propane and N-3-[(4-methyloxy methylcyclohexyl)methyloxy]propyl-3-[4-methylcyclohexyl]methyloxy]-1-propanamine. Nuclear magnetic resonance confirmed the presence of 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine and 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanamine.

[0027] The etheramine compound, such as 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine, 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanamine, iminobis{3-[(4-methylcyclohexyl)methyloxy]}propane or N-3-[(4-methyloxy methylcyclohexyl)methyloxy]propyl-3-[4-methylcyclohexyl]methyloxy]-1-propanamine, may be used for silica flotation in iron beneficiation. As high iron ores have been depleted, minerals with a lower iron concentration are processed to meet iron demand. Smelters require iron concentrations higher than concentration found in presently mined ores, thus forcing the use of separation

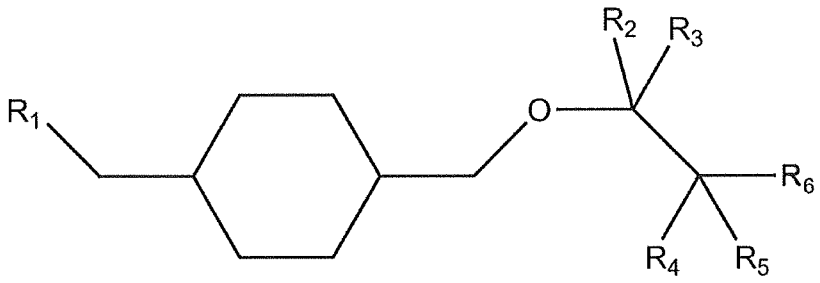
processes to beneficiate the iron. Silica is found along with iron in the mined ores. A commonly used separation process is the reverse flotation of silica. Silica gangue is removed by flotation in water, concentrating the iron by leaving the iron behind, hence the term reverse flotation. Before performing the reverse flotation, the slime formed by small particles may be beneficially removed by hydromechanical means. The etheramine compound may act as a collector to enhance the floatability of different mineral materials. The compound may act both as a collector and a frother, which is used to promote the creation of a semi-stable froth.

[0028] The etheramine compound, such as 3-[(4-methylcyclohexyl)methyloxy]-1-propanamine, 3-[(4-methoxy methylcyclohexyl)methyloxy]-1-propanamine, iminobis{3-[(4-methylcyclohexyl)methyloxy]}propane or N-3-[(4-methyloxy methylcyclohexyl)methyloxy]propyl-3-[4-methylcyclohexyl]methyloxy]-1-propanamine, may be used for curing of an epoxy resin. In one example, the etheramine compound having hydrogen equivalent mass of 98.0 (4.90 g) was mixed with ARALDITE® GY1610, which is a liquid epoxy resin with equivalent mass of 183 (9.15 g), in an aluminum weighing pan. Upon standing overnight, the mixture became a hard, brittle solid.

[0029] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

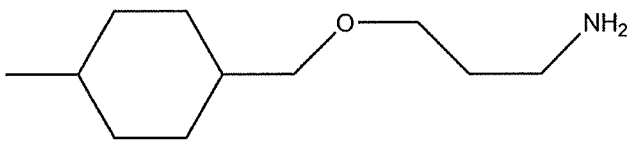
Claims:

1. A compound having the structure:

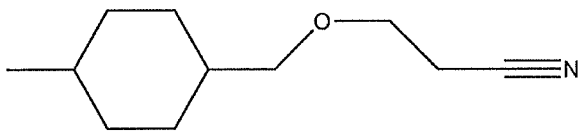


wherein R_1 is a hydrogen atom or a methoxy group,
R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group, and
R_6 is a nitrile group or an aminomethyl group.

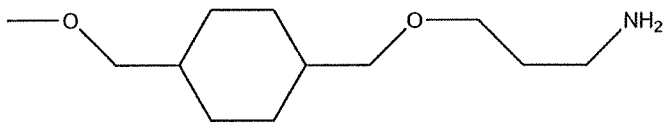
2. The compound of claim 1, wherein the compound has the structure:



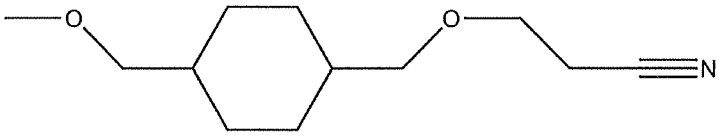
3. The compound of claim 1, wherein the compound has the structure:



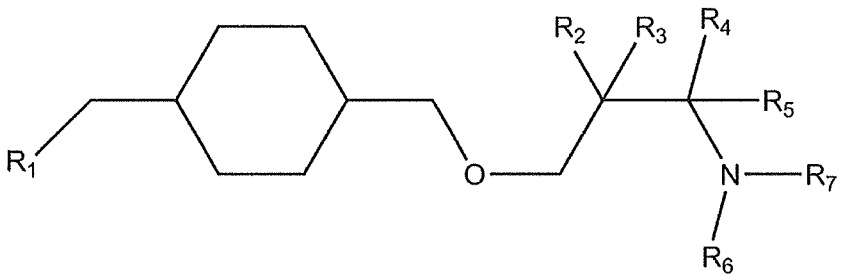
4. The compound of claim 1, wherein the compound has the structure:



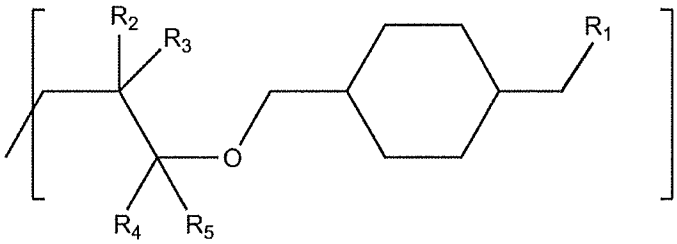
5. The compound of claim 1, wherein the compound has the structure:



6. An etheramine compound having the structure:



wherein R_6 has the structure

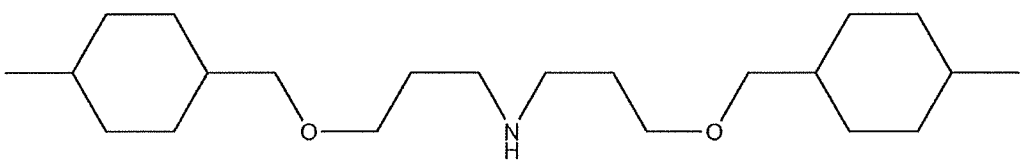


R_7 is a hydrogen atom or the same as R_6,

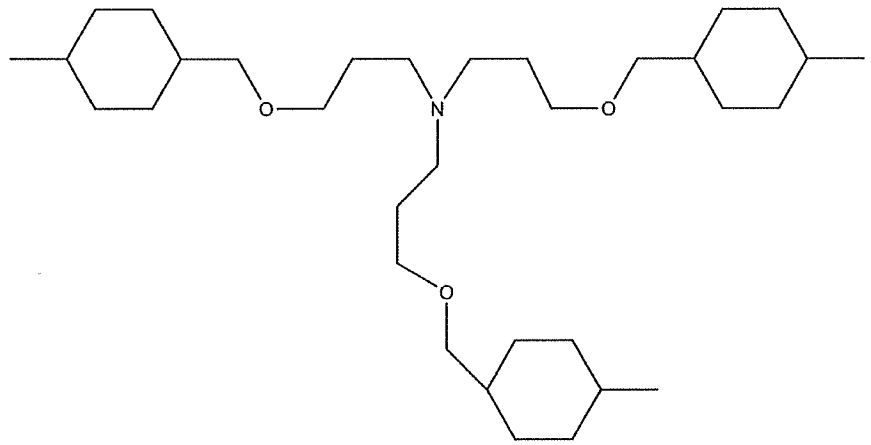
R_1 is a hydrogen atom or a methoxy group, and

R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

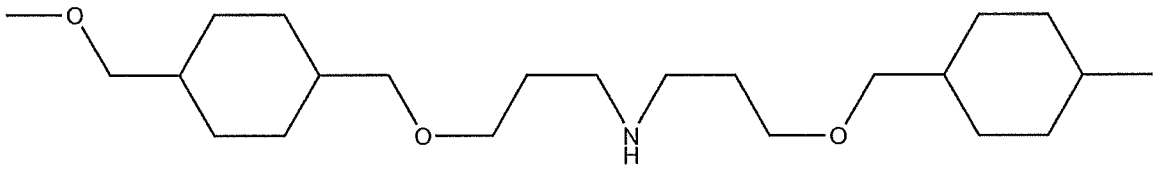
7. The etheramine compound of claim 6, wherein the etheramine compound has the structure:



8. The etheramine compound of claim 6, wherein the etheramine compound has the structure:

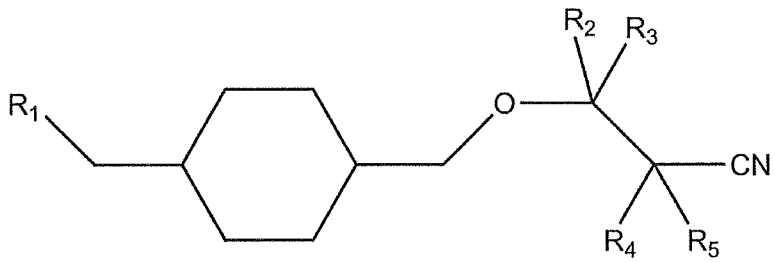


9. The etheramine compound of claim 6, wherein the etheramine compound has the structure:



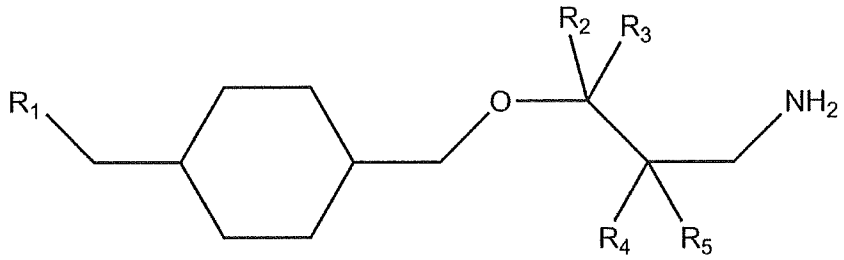
10. A method for forming an etheramine compound, comprising:

reacting 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol with an alkene having a nitrile group to form an intermediate compound having the structure:



wherein R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group; and

hydrogenating the intermediate compound to form the etheramine compound having the structure:

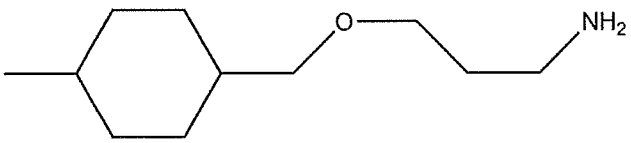


wherein R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

11. The method of claim 10, wherein the alkene having the nitrile group is acrylonitrile.

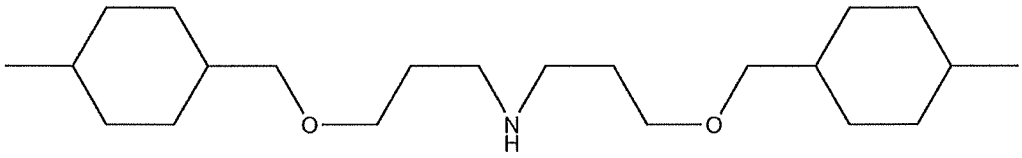
12. The method of claim 10, wherein a cobalt catalyst is used for the hydrogenating of the intermediate compound.

13. The method of claim 12, wherein the etheramine compound has the structure:



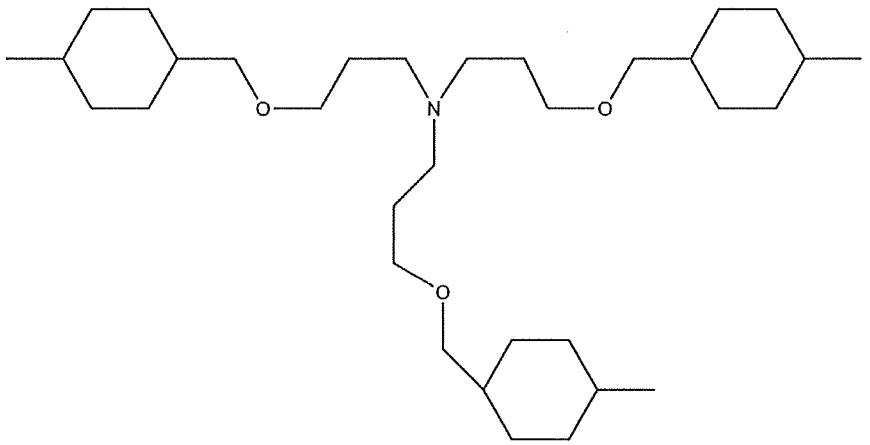
14. The method of claim 10, wherein a nickel catalyst is used for the hydrogenating of the intermediate compound.

15. The method of claim 14, wherein the etheramine compound has the structure:



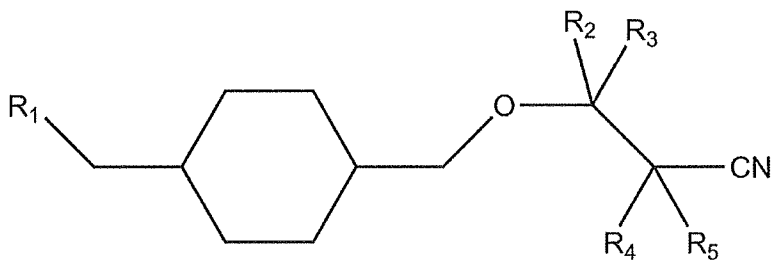
16. The method of claim 10, wherein a platinum catalyst is used for the hydrogenating of the intermediate compound.

17. The method of claim 16, wherein the etheramine compound has the structure:



18. An etheramine compound formed by a method comprising:

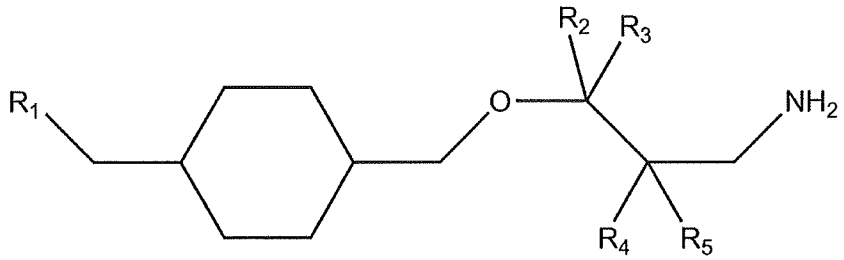
reacting 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol with an alkene having a nitrile group to form an intermediate compound having the structure:



wherein R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group; and

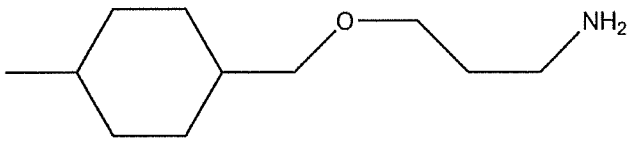
hydrogenating the intermediate compound.

19. The etheramine compound of claim 18, wherein the etheramine compound has the structure:



wherein R_1 is a hydrogen atom or a methoxy group and R_2, R_3, R_4 and R_5 are independently a hydrogen atom or an alkyl group.

20. The etheramine compound of claim 19, wherein the etheramine compound has the structure:



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 15/63062

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A01N 25/04, A01N 25/16 (2016.01)
CPC - C07C 2101/08, C07C 217/80, C07C 2101/18
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)
IPC(8) - A01N 25/04, A01N 25/16 (2016.01)
CPC - C07C 2101/08, C07C 217/80, C07C 2101/18

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)
Patbase, Google Patent, Google web
Search terms used: Etheramines prepared from acrylonitrile alkyloxypropylamines ethylnitrile cyclohexyl methanol
Pubchem substructure search

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,324,164 A (Merkel et al.) 06 June 1967 (06.06.1967); col 4, table, 1	1, 3
X	US 2009/0143623 A1 (Katsumata et al.) 04 June 2009 (04.06.2009); entire document, especially para [0048]: C-2	1, 3
A	US 6,576,794 B2 (Fukushima et al.) 10 June 2003 (10.06.2003); entire document	1, 3
A	US 5,932,526 A1 (Person Hei et al.) 03 August 1999 (03.08.1999); entire document	1, 3

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 March 2016 (21.03.2016)	30 MAR 2016
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 15/63062

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
-see supplemental pages-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1 and 3

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

--continued from Box III.--

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

Group I+: Claims 1-9 directed to a compound of formula listed in instant claim 1. Compound of formula will be searched to the extent when R1-R5 are hydrogen; R6 is a nitrile group. It is believed that claims 1 and 3 read on this first named invention, and thus these claims will be searched without fee. Applicant is invited to elect additional invention, wherein each invention will require additional fee. Applicants must specify the claims that encompass any additionally elected method. Applicants must further indicate, if applicable, the claims which encompass the first named invention, if different than what was indicated above for this group. Failure to clearly identify how any paid additional invention fees are to be applied to the '+' group(s) will result in only the first claimed invention to be searched. Additionally, an exemplary election wherein different actual variables are selected is suggested. An exemplary election would be a compound of formula listed in instant claim 1. Compound of formula will be searched to the extent when R1-R5 are hydrogen; R6 is a amino group (i.e., claims 1-2, 6-9).

Group II: Claims 10-20 directed to a method for forming an etheramine compound, comprising: reacting 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol with an alkene having a nitrile group to form an intermediate compound listed.

The groups of inventions listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features:

Group I+ includes the technical feature of a unique compound, not required by any other invention of Group I+

Group II includes the technical feature of a method for forming an etheramine compound, comprising: reacting 4-methylcyclohexane methanol or 4-methoxymethylcyclohexane methanol with an alkene having a nitrile group to form an intermediate compound listed, not required by Groups I+

Common technical features:

The inventions of Group I+ share the technical feature of compound of formula listed in instant claim 1.

Groups I+ and II share the technical feature of compound of formula listed in instant claim 1

This shared technical feature, however, does not provide a contribution over the prior art, as being being obvious over US 2009/0143623 A1 to Katsumata et al. (hereinafter Katsumata). Katsumata discloses a compound having a similar structure: wherein R2, R3, R4 and R5 are a hydrogen atom, and R5 is a nitrile group (para [0048]: C-2), but not where R1 is a hydrogen atom or a methoxy group and where there are additional (-CH2OCH2CH2CN) groups at the 3 and 6 position of the cyclohexyl ring. However, Katsumata further discloses where R1 is methoxy group (para [0048]: C-2), but where there is an additional -CH2CN bound to it. It would have been obvious to one with skill in the art to prepare the compound having the structure claimed where R2, R3, R4 and R5 are a hydrogen atom, and R5 is a nitrile group, as disclosed by Katsumata, but without additional groups at the 3 and 6 position and where R1 is a methoxy group through routine experimentation preparing similar compounds from cyclohexyl alkyl alcohols and acrylonitrile that have less nitrile groups in order to reduce the polarity of the compound.

As said methods were known in the art at the time of the invention these cannot be considered special technical features that would otherwise unify the inventions of Group I+ and II.

Groups I+ and II, thus lack unity under PCT Rule 13.