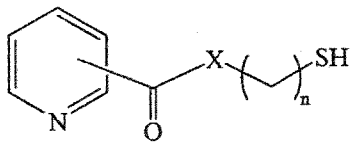
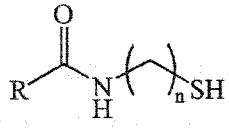
Claims

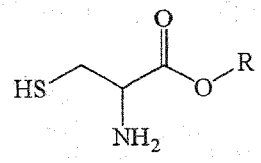
1. An ion exchange resin for producing bisphenol comprising aromatic polymer having a sulfonic acid group modified with at least one promoter selected from compounds shown in the structure (I), (II), (III), (IV) or its amine salt :



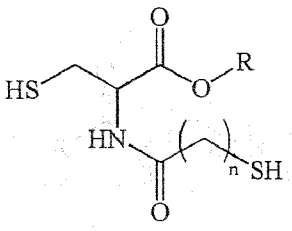
(I),



(II),



(III),



(IV),

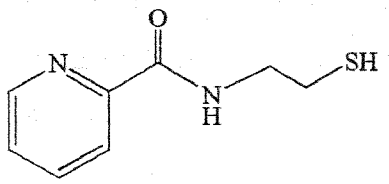
wherein

R represents hydrocarbon unit having 1 to 6 carbon atoms selected from alkyl group, alkenyl group, alkynyl group, phenyl group, or optionally hydrocarbon containing carbonyl group having 1 to 6 carbon atoms;

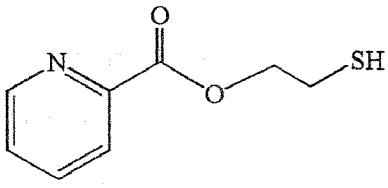
x represents heteroatom;

n is an integer number from 1 to 4.

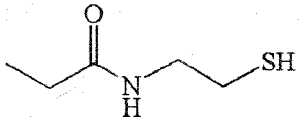
2. The ion exchange resin according to claim 1, wherein at least one promoter is selected from compounds shown in the structure (V), (VI), (VII), (VIII), (IX), (X), or its amine salt:



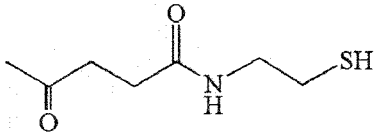
(V),



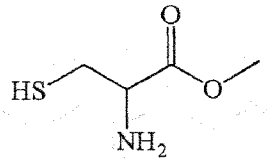
(VI),



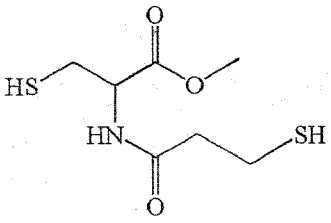
(VII),



(VIII),

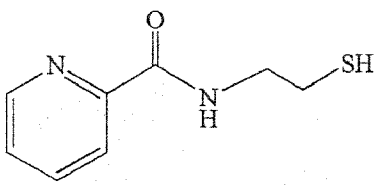


(IX),



(X).

3. The ion exchange resin according to claim 1 or 2, wherein the promoter is a compound as shown in the structure (V) or its amine salt



(V).

4. The ion exchange resin according to any one of the preceding claims, wherein the promoter further comprises aminoalkyl mercaptan or its amine salt.

5. The ion exchange resin according to claim 4, wherein aminoalkyl mercaptan is cysteamine.

6. The ion exchange resin according to claim 4 or 5, wherein aminoalkyl mercaptan or its amine salt is used in the amount of 10 to 90 % by mole of total promoter.

7. The ion exchange resin according to claim 6, wherein aminoalkyl mercaptan or its amine salt is used in the amount of 30 to 70 % by mole of total promoter.

8. The ion exchange resin according to claim 1, wherein the sulfonic acid group modified with promoter is 5 to 30 % of total sulfonic acid group.

9. The ion exchange resin according to claim 8, wherein the sulfonic acid group modified with promoter is 10 to 20 % of total sulfonic acid group.

10. The ion exchange resin according to any one of claims 1, 8, or 9, wherein the sulfonic acid group is modified with promoter through ionic bond.

11. The ion exchange resin according to claim 1, wherein the aromatic polymer containing sulfonic acid group is selected from polystyrene having sulfonic acid group or styrene-divinylbenzene copolymer having sulfonic acid group.

12. The ion exchange resin according to claim 11, wherein the aromatic polymer containing sulfonic acid group is styrene-divinylbenzene copolymer having sulfonic acid group.

13. The ion exchange resin according to claim 12, wherein the styrene-divinylbenzene copolymer having sulfonic acid group has divinylbenzene in the amount of 1 to 10 %.

14. The ion exchange resin according to claim 13, wherein the styrene-divinylbenzene copolymer having sulfonic acid group has divinylbenzene in the amount of 1 to 4 %.

15. The ion exchange resin according to any one of claims 1, 11, or 12, wherein the aromatic polymer containing sulfonic acid group has particle size from 500 to 1500 micron.

16. The ion exchange resin according to claim 15, wherein the aromatic polymer having sulfonic acid group has particle size from 850 to 1400 micron.

17. The ion exchange resin according to claim 1, wherein the compound according to structure (I), (II), (III) or amine salt of said compound is prepared by the following step:

(a) mixing monocarboxylic acid and mercapto compound in a mole ratio of monocarboxylic acid to mercapto compound from 1:1 to 1:2; and

(b) adding carbodiimide and basic solution into the mixture obtained from step (a).

18. The ion exchange resin according to claim 17, wherein the monocarboxylic acid in step (a) is selected from 2-pyridinecarboxylic acid, 3-pyridinecarboxylic acid, 4-pyridinecarboxylic acid, 6-methyl-2-pyridinecarboxylic acid, 5-methyl-2-pyridinecarboxylic acid, 4-methyl- 2-pyridinecarboxylic acid, 3-methyl- 2-pyridinecarboxylic acid, 3-ethyl- 2-pyridinecarboxylic acid, propinoic acid, butanoic acid, pentanoic acid, levulinic acid, and hexanoic acid.

19. The ion exchange resin according to claim 18, wherein the monocarboxylic acid in step (a) is 2-pyridinecarboxylic acid, 4-pyridinecarboxylic acid, or levulinic acid.

20. The ion exchange resin according to claim 17, wherein the mercapto compound in step (a) is mercaptoamine or mercaptoalcohol.

21. The ion exchange resin according to claim 20, wherein the mercaptoamine is selected from cysteamine hydrochloride, 2-amino-1-propanethiol, 2-amino-1-propanethiol hydrochloride, 3-mercaptopropylamine hydrochloride, 3-amino-2-methyl-1-propanethiol, 3-amino-1-butanethiol, 3-amino-2-butanethiol, 4-amino-2-butanethiol hydrochloride, 3-amino-1-butanethiol hydrochloride, 3-amino-2,2-dimethyl-1-propanethiol, 3-amino-1-pentanethiol, 3-amino-1-pentanethiol hydrochloride, 3-amino-3-methyl-1-butanethiol, and 3-amino-3-methyl-1-butanethiol hydrochloride.

22. The ion exchange resin according to claim 21, wherein the mercaptoamine is cysteamine hydrochloride.

23. The ion exchange resin according to claim 20, wherein the mercaptoalcohol is selected from mercaptoethanol, 3-mercaptopropanol, 4-mercaptobutanol, 2,3-mercaptopropanol, 2-mercaptobutanol, 3-mercaptobutanol, or 3-mercapto-2-butanol.

24. The ion exchange resin according to claim 23, wherein the mercaptoalcohol is mercaptoethanol.

25. The ion exchange resin according to claim 17, wherein the carbodiimide in step (b) is selected from N,N'-dicyclohexylcarbodiimide, N,N'-diisopropylcarbodiimide, N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride, N-Methyl-N'-tert-butyl carbodiimide, N-ethyl-N'-tert-butylcarbodiimide, N-cyclohexyl-N'-tert-butylcarbodiimide, and 1,3-bis(2,2-dimethyl-1,3-dioxolan-4-ylmethyl)carbodiimide.

26. The ion exchange resin according to claim 25, wherein the carbodiimide is N,N'-dicyclohexylcarbodiimide.

27. The ion exchange resin according to claim 17, wherein the basic solution in step (b) is selected from pyridine, 4-dimethylaminopyridine, 2,4,6-trimethylpyridine, diisopropyl ethylamine, N-methylmorpholine, trimethylamine, and N,N-dimethylaniline.

28. The ion exchange resin according to claim 27, wherein the basic solution in step (b) is 4-dimethylaminopyridine.

29. The ion exchange resin according to claim 1, wherein the compound according to structure (III) or its amine salt is prepared by the following step:

(a) mixing chlorinating agent and alcohol having 1 to 4 carbon atom, wherein a volume ratio of chlorinating agent to alcohol is from 1:5 to 1:20; and

(b) adding cysteine or its salt into the mixture obtained from step (a), wherein a mole ratio of chlorinating agent to cysteine or its salt is from 5:1 to 10:1.

30. The ion exchange resin according to claim 29, wherein the chlorinating agent in step (a) is selected from thionyl chloride, acetyl chloride, hydrochloric acid, and trimethylsilyl chloride.

31. The ion exchange resin according to claim 30, wherein the chlorinating agent in step (a) is thionyl chloride.

32. The ion exchange resin according to claim 29, wherein the alcohol in step (a) is selected from methanol, ethanol, propanol, or butanol.

33. A method for producing bisphenol from phenol and ketone using the ion exchange resin according to any one of the preceding claims as a catalyst.

34. The method according to claim 33, wherein the phenol is unsubstituted phenol, the ketone is acetone, and the bisphenol is bisphenol A.