CLAIMS

1. A membrane obtainable from curing a composition comprising:
(i) a curable compound comprising at least two acrylic groups and a quaternary ammonium group;
(ii) solvent;
and optionally (iii) a curable compound having one ethylenically unsaturated group.

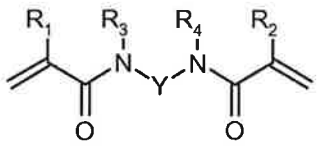
2. A membrane according to claim 1 wherein the composition further comprises a radical initiator.

3. A membrane according to any one of the preceding claims wherein the at least two acrylic groups are acrylamide groups.

4. A membrane according to any one of the preceding claims wherein component (ii) comprises water or a mixture comprising water and a water-miscible organic solvent.

5. A membrane according to any one of the preceding claims wherein the curable compound having one ethylenically unsaturated group further comprises a cationic group.

6. A membrane according to any one of the preceding claims wherein component (i) comprises a compound of the Formula (1):



Formula (1)

wherein:

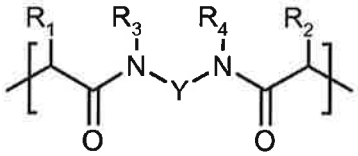
R_1 and R_2 are H;

R_3 and R_4 are each independently H or alkyl, or R_3 and R_4 together with the N atoms to which they are attached and Y form an optionally substituted 6- or 7-membered ring; and

Y is a linking group comprising an optionally substituted and optionally interrupted alkylene or arylene group;

provided that the compound of Formula (1) has 1, 2, 3 or 4 quaternary ammonium groups.

7. A membrane comprising a structural unit of Formula (1'):



Formula (1')

wherein:

R_1 and R_2 are H;

R_3 and R_4 are each independently H or alkyl, or R_3 and R_4 together with the N atoms to which they are attached and Y form an optionally substituted 6- or 7-membered ring; and

Y is a linking group comprising an optionally substituted and optionally interrupted alkylene or arylene group;

provided that the structural unit of Formula (1') has 1, 2, 3 or 4 quaternary ammonium groups.

8. A membrane according to any one of the preceding claims having an IEC of at least 3.0 meq/g of total dry weight of the composition.

9. A composition comprising:

(i) 2 to 80 wt% of a curable compound comprising at least two acrylic groups and a quaternary ammonium group;

(ii) 15 to 70 wt% of solvent;

(iii) 1 to 70 wt% of curable compound having one ethylenically unsaturated group;

(iv) 0 to 40 wt% of curable compound comprising at least two acrylic groups and being free from quaternary ammonium groups; and

(v) 0 to 10 wt% of radical initiator.

10. A composition according to claim 9 comprising:

(i) 4 to 70 wt% of curable compound comprising at least two acrylic groups and a quaternary ammonium group;

(ii) 25 to 45 wt% of solvent comprising water or a mixture comprising water and a water-miscible organic solvent;

(iii) 10 to 60 wt% of curable compound having one ethylenically unsaturated group;

(iv) 0 to 30 wt% of curable compound comprising at least two acrylic groups and being free from quaternary ammonium groups; and
(v) 0.1 to 10 wt% of radical initiator.

11. A composition comprising:
(i) 5 to 80 wt% of a curable compound comprising at least two acrylic groups and a quaternary ammonium group;
(ii) 20 to 45 wt% of solvent
(iii) 0 to 60 wt% of curable compound having one ethylenically unsaturated group;
(iv) 0 to 30 wt% of curable compound comprising at least two acrylic groups and being free from quaternary ammonium groups; and
(v) 0.1 to 10 wt% of radical initiator.

12. A composition according to claims 9 to 11 wherein the acrylic groups of compound (i) are acrylamide groups.

13. A composition according to claims 9 to 11 wherein curable compound (iii) comprises a cationic group.

14. A composition according to claims 9 to 11 wherein the ethylenically unsaturated group of curable compound (iii) is an acrylic group.

15. A process for preparing a membrane comprising the following steps:
a) applying a composition to a support; and
b) curing the composition to form a membrane;
wherein the composition comprises (i) a curable compound comprising at least two acrylic groups and a quaternary ammonium group; (ii) solvent; and optionally (iii) a curable compound having one ethylenically unsaturated group; and
wherein the curing is performed by radical polymerisation using electromagnetic radiation.

16. A process according to claim 15 wherein the composition is as defined in any one of claims 9 to 14.

17. A process according to claim 15 or 16 wherein the curing is performed using electron beam or UV radiation.

18. A process according to any claim 17 wherein the composition is cured by irradiation with an electron beam or UV light for a period of less than 30 seconds.

19. A process according to any one of claims 15 to 18 wherein the composition is applied continuously to a moving support by means of a manufacturing unit comprising a composition application station, an irradiation source for curing the composition, a membrane collecting station and a means for moving the support from the composition application station to the irradiation source and to the membrane collecting station.

20. A process according to any one of claims 15 to 19 wherein the curable composition is applied to the support moving at a speed of over 5 m/min.

21. Use of a membrane according to any one of claims 1 to 8 for the separation or purification of liquids, vapours or gases.

22. An electrodialysis or reverse electrodialysis unit, a flow through capacitor device, an electrodeionization module, a continuous electrodeionization module, a fuel cell, a diffusion dialysis apparatus, a membrane distillation module or a membrane electrode assembly comprising one or more polymeric membranes according to any one of claims 1 to 8.

1. A membrane obtained from curing a composition comprising:

(i) a curable compound comprising (a) at least two acrylamide groups; and (b) at least one quaternary ammonium group;

(ii) solvent;

and optionally (iii) a curable compound having one ethylenically unsaturated group.

2. A membrane according to claim 1 which comprises 20 to 45 wt% of component (ii).

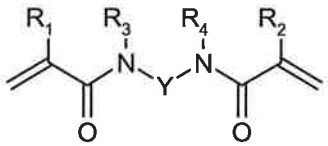
3. The membrane according to any one of the preceding claims wherein the composition further comprises a radical initiator.

4. The membrane according to any one of the preceding claims wherein optional component (iii) is present.

5. The membrane according to any one of the preceding claims wherein component (ii) comprises water or a mixture comprising water and a water-miscible organic solvent.

6. The membrane according to any one of the preceding claims wherein the curable compound having one ethylenically unsaturated group further comprises a cationic group.

7. The membrane according to any one of the preceding claims wherein component (i) comprises a compound of the Formula (1):



Formula (1)

wherein:

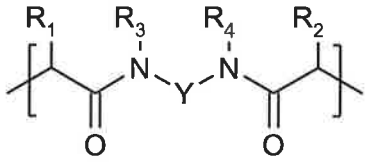
R_1 and R_2 are H;

R_3 and R_4 are H; and

Y is a linking group comprising an optionally substituted and optionally interrupted alkylene or arylene group;

provided that the compound of Formula (1) has at least one of 1, 2, 3 or 4 quaternary ammonium groups, wherein the at least one of 1, 2, 3 or 4 quaternary ammonium groups may be present as substituents and/or interruptions within the Y group.

8. The membrane according to any one of the preceding claims comprising a structural unit of Formula (1'):



Formula (1')

wherein:

R_1 and R_2 are H;

R_3 and R_4 are H; and

Y is a linking group comprising an optionally substituted and optionally interrupted alkylene or arylene group;

provided that the structural unit of Formula (1') has at least one of 1, 2, 3 or 4 quaternary ammonium groups, wherein the at least one of 1, 2, 3 or 4 quaternary ammonium groups may be present as substituents and/or interruptions within the Y group.

9. The membrane according to any one of the preceding claims wherein the composition further comprises a radical initiator, component (ii) comprises water or a mixture comprising water and a water-miscible organic solvent and optional component (iii) is present and further comprises a cationic group.

10. The membrane according to any one of the preceding claims wherein the molar fraction of curable compounds comprising at least two acrylamide groups and a quaternary ammonium group, relative to the total number of moles of curable compounds present in the composition, is at least 0.30.

11. The membrane according to any one of the preceding claims wherein the composition comprises:

(i) a curable compound comprising (a) at least two acrylamide groups; and (b) at least one quaternary ammonium group;

(ii) a solvent;

(iii) a curable compound having one ethylenically unsaturated group;

(iv) a curable compound comprising at least two acrylamide groups and being free from quaternary ammonium groups; and

(v) a radical initiator; and

wherein the composition comprises:

(a) 2 to 80 wt% of component (i), 15 to 70 wt% of component (ii), 1 to 70 wt% of component (iii), 0 to 40 wt% of component (iv); and 0 to 10 wt% of component (v); or
(b) 5 to 80 wt% of component (i), 20 to 45 wt% of component (ii), 0 to 60 wt% of component (iii), 0 to 30 wt% of component (iv); and 0.1 to 10 wt% of component (v).

12. An electrodialysis or reverse electrodialysis unit, a flow through capacitor device, an electrodeionization module, a continuous electrodeionization module, a fuel cell, a diffusion dialysis apparatus, a membrane distillation module or a membrane electrode assembly comprising one or more polymeric membranes according to any one of claims 1 to 11.

13. A process for preparing a membrane comprising the following steps:
a) applying a composition to a support; and
b) curing the composition to form a membrane;
wherein the composition comprises (i) a curable compound comprising (a) at least two acrylamide groups; and (b) at least one quaternary ammonium group; (ii) solvent; and optionally (iii) a curable compound having one ethylenically unsaturated group; and
wherein the curing is performed by radical polymerisation using electromagnetic radiation.

14. The process according to claim 13 wherein the composition comprises:
(i) a curable compound comprising (a) at least two acrylamide groups; and (b) at least one quaternary ammonium group;
(ii) a solvent;
(iii) a curable compound having one ethylenically unsaturated group;
(iv) a curable compound comprising at least two acrylamide groups and being free from quaternary ammonium groups; and
(v) a radical initiator; and
wherein the composition comprises:
(a) 2 to 80 wt% of component (i), 15 to 70 wt% of component (ii), 1 to 70 wt% of component (iii), 0 to 40 wt% of component (iv); and 0 to 10 wt% of component (v); or
(b) 5 to 80 wt% of component (i), 20 to 45 wt% of component (ii), 0 to 60 wt% of component (iii), 0 to 30 wt% of component (iv); and 0.1 to 10 wt% of component (v).

15. The process according to claim 13 or 14 wherein the curing is performed using electron beam or UV radiation.

16. The process according to any one of claims 13 to 15 wherein the composition is applied continuously to a moving support by means of a manufacturing unit comprising a composition application station, an irradiation source for curing the composition, a membrane collecting

station and a means for moving the support from the composition application station to the irradiation source and to the membrane collecting station.

17. The process according to claim 16 wherein the curable composition is applied to the support moving at a speed of over 5 m/min.

18. Use of a membrane according to any one of claims 1 to 11 for the separation or purification of liquids, vapours or gases.