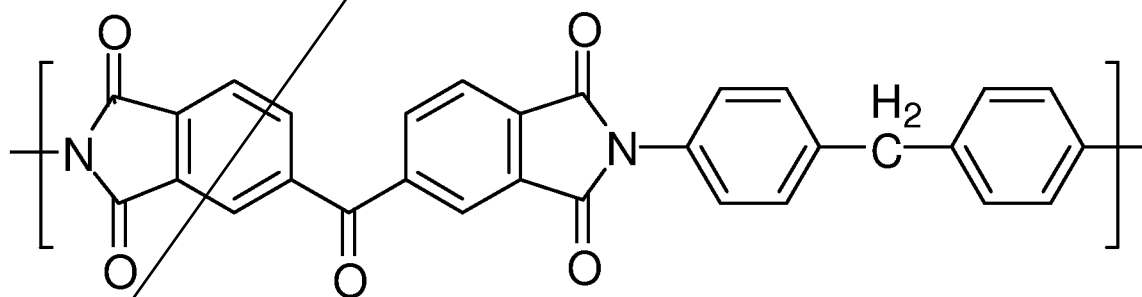
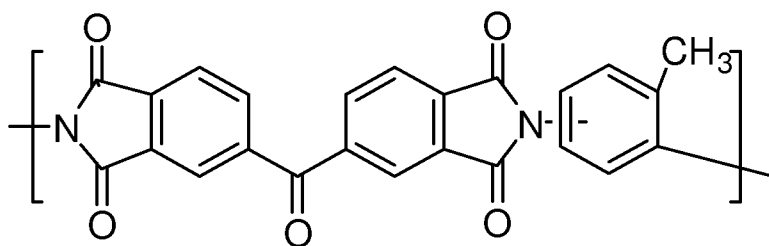


CLAIMS

1. A composite membrane for nanofiltration of a feed stream solution comprising a solvent and dissolved solutes and showing preferential rejection of the solutes, wherein the composite membrane comprises a thin polymeric film formed by interfacial polymerisation on a support membrane, wherein the support membrane is impregnated with a conditioning agent and is stable in polar aprotic solvents; and wherein the composite membrane is treated with an activating solvent prior to use in nanofiltration.
2. A membrane according to claim 1 in which the support membrane is formed from crosslinked polyimide, crosslinked polybenzimidazole, crosslinked polyacrylonitrile, Teflon, polypropylene, or polyether ether ketone (PEEK), or sulfonated polyether ether ketone (S-PEEK).
3. A membrane according to claim 1 or claim 2, where the polyimide used to form the crosslinked polyimide support membrane is at least one copolymer derived from (a) the condensation of benzophenone 3,3',4,4'-tetracarboxylic acid dianhydride and a mixture of (i) di(4-aminophenyl) methane and toluene diamine, or (ii) a mixture of 4,4'-methylenebis(phenyl isocyanate) and toluene diisocyanate; or (b) the condensation of 1H,3H-Benzo[1,2-c:4,5-c']difuran-1,3,5,7-tetrone with 5,5'-carbonylbis[1,3-isobenzofurandione], 1,3-diisocyanato-2-methylbenzene and 2,4-diisocyanato-1-methylbenzene.
4. The membrane according to any of claims 1 to 3, wherein the polyimide is a polyimide copolymer comprising from 10 to 90% of



and from 90% to 10% of



5. A membrane according to any one of the preceding claims, in which the support membrane comprises crosslinks formed from the reaction of aliphatic amines, aliphatic-aromatic amines and aromatic amines with a polyimide polymer.
6. A membrane according to any one of the preceding claims in which the conditioning agent is a non-volatile liquid.
7. A membrane according to any one of the preceding claims, wherein the conditioning agent is selected from one or more of synthetic oils (including polyolefinic oils, silicone oils, polyalphaolefinic oils, polyisobutylene oils, synthetic wax isomerate oils, ester oils and alkyl aromatic oils), mineral oils (including solvent refined oils and hydroprocessed mineral oils and petroleum wax isomerate oils), vegetable fats and oils, higher alcohols (such as decanol, dodecanol, heptadecanol), glycerols, and glycols (such as polypropylene glycols, polyethylene glycols, polyalkylene glycols).
8. A membrane according to any one of the preceding claims, where the thin film formed by interfacial polymerisation at the porous surface of the support membrane comprises a three dimensional polymer network resulting from the contacting of a first reactive monomer solution, and a second reactive monomer solution, wherein the first reactive monomer solution and the second reactive monomer solutions contain different reactive monomers, and the two reactive monomer solutions are immiscible.
9. A membrane according to claim 8, wherein the thin film comprises at least one of aliphatic or aromatic polyamide, aromatic polyhydrazide, poly-benzimidazolone, polyepiamine/amide, polyepiamine/urea, poly-ethyleneimine/urea, sulfonated polyfurane, polybenzimidazole, polypiperazine isophthalamide, a polyether, a polyether-urea, a polyester, or a polyimide or a copolymer thereof or a mixture thereof.

10. A membrane according to claim 8 or claim 9 in which the thin film comprises residues of diaminobenzene, triaminobenzene, piperazine, poly-piperazine, polyetherimine, trimesoyl halide and diaminobenzene, trimesoyl chloride and m-phenylenediamine.
11. A membrane according to claim 8, wherein the first reactive monomer solution comprises but is not limited to an aqueous solution of an aliphatic/aromatic polyamine which may contain halo-, silyl- or siloxane-substituents.
12. A membrane according to any one of claims 8 to 11 in which the first reactive monomer solution comprises an aqueous solution of a polyamine or a mixture thereof with any of ethylene glycol, propylene glycol, glycerine, polyethylene glycol, polypropylene glycol, and copolymers of ethylene glycol and propylene glycol, and polar aprotic solvents.
13. A membrane according to any one of claims 8 to 11 in which the second reactive monomer solution comprises an organic solvent solution of aliphatic/aromatic mono- or poly-acyl halides which may contain halo-, silyl- or siloxane-substituents, including but not limited to aliphatic/aromatic acyl chlorides, including trimesoyl chloride, iso-phthaloyl dichloride, sebacoyl chloride, pentafluorooctanoylchloride or a mixture thereof.
14. A composite membrane according to any one of the preceding claims, wherein the composite membrane is treated with an activating solvent prior to use in nanofiltration.
15. A composite membrane according to any one of the preceding claims wherein the activating solvent is a polar aprotic solvent.
16. Use of a membrane of any one of claims 1-15 for nanofiltration of a feed stream solution comprising a solvent and dissolved solutes.
17. Use of a membrane as in claim 16, wherein the feed stream comprises at least one polar aprotic solvent.
18. An interfacial polymerisation process for forming a composite membrane for solvent nanofiltration as defined herein, comprising the steps of:
 - (a) impregnating a porous support membrane comprising a first conditioning agent, with a

first reactive monomer solution comprising :

- (i) a first solvent for the said first reactive monomer; (ii) a first reactive monomer and; (iii) optionally, an activating solvent, (iv) optionally, additives including alcohols, ketones, ethers, esters, halogenated hydrocarbons, nitrogen-containing compounds and sulphur-containing compounds, monohydric aromatic compounds;

wherein said support membrane is stable in polar aprotic solvents;

(b) contacting the impregnated support membrane with a second reactive monomer solution comprising:

- (i) a second solvent for the second reactive monomer; (ii) a second reactive monomer; (iii) optionally, additives including alcohols, ketones, ethers, esters, halogenated hydrocarbons, nitrogen-containing compounds and sulphur-containing compounds, monohydric aromatic compounds;

wherein the first solvent and the second solvent form a two phase system

(c) after a reaction period, immersing resulting composite membrane into a quench medium;

(d) treating the resulting asymmetric membrane with an activating solvent, and:

(e) optionally, impregnating the resulting composite membrane with a second conditioning agent.

19. A process according to claim 18, wherein the support membrane is formed from crosslinked polyimide, crosslinked polybenzimidazole, crosslinked polyacrylonitrile, Teflon, polypropylene, or polyether ether ketone (PEEK), or sulfonated polyether ether ketone (S-PEEK).

20. A process according to claim 18 or claim 19, wherein the first and/or second conditioning agent is selected from one or more of synthetic oils (including polyolefinic oils, silicone oils, polyalphaolefinic oils, polyisobutylene oils, synthetic wax isomerate oils, ester oils and alkyl aromatic oils), mineral oils (including solvent refined oils and hydroprocessed mineral oils and petroleum wax isomerate oils), vegetable fats and oils, higher alcohols (such as decanol, dodecanol, heptadecanol), glycerols, and glycols (such as polypropylene glycols, polyethylene glycols, polyalkylene glycols)

21. A process according to any one of claims 18 - 20, wherein the first reactive monomer solution comprises an aqueous solution of a polyamine.

22. A process according to any of claims 18 - 22, wherein the first reactive monomer solution comprises an aqueous solution of a 1,6 hexenediamine or poly(ethyleneimine).
23. A process according to any one of claims 18 - 22, wherein the first reactive monomer solution contains ethylene glycol, propylene glycol, glycerine, polyethylene glycol, polypropylene glycol, and copolymers of ethylene glycol and propylene glycol, or polar aprotic solvents.
24. A process according to any one of claims 18 - 23, wherein the second reactive monomer solution may contain mono-acyl chlorides, polyacyl chlorides or a mixture thereof, or other monomers.
25. A process according to any one of claims 18 - 24, wherein the second reactive monomer solution may contain trimesoyl chloride, iso-phthaloyl dichloride, or sebacoyl chloride or a mixture thereof.
26. A process according to any one of claims 18 - 25, wherein composite membrane is treated in step (d) with an activating solvent by immersion or washing in the activating solvent.
27. A process according to any one of claims 18 - 26, wherein composite membrane is treated in step (d) with an activating solvent by filtration through the membrane using the activating solvent.
28. A process according to any one of claims 18 - 27, wherein composite membrane is treated in step (d) with an activating solvent comprising DMF, NMP, DMSO, DMAc or a mixture thereof.
29. A process according to any of claims 18 to 28 in which the contacting time in step (b) is chosen from between 5 seconds and 5 hours.
30. A process according to any of claims 18 to 29 in which the temperature of the contacting step (b) solution is held between 10 and 100°C.

31. A process according to any of claims 18 to 30 in which the second conditioning agent in step (b) is a non-volatile liquid.

32. A process according to any of claims 18 to 31 in which the second conditioning agent in step (b) is selected from one or more of synthetic oils (including polyolefinic oils, silicone oils, polyalphaolefinic oils, polyisobutylene oils, synthetic wax isomerate oils, ester oils and alkyl aromatic oils), mineral oils (including solvent refined oils and hydroprocessed mineral oils and petroleum wax isomerate oils), vegetable fats and oils, higher alcohols (such as decanol, dodecanol, heptadecanol), glycerols, and glycols (such as polypropylene glycols, polyethylene glycols, polyalkylene glycols).

33. A process according to any of claims 18 to 32 in which the resulting membrane is configured as spiral wound, plate and frame, shell and tube, or derivative designs thereof.

CLAIMS

1. An interfacial polymerisation process for forming a composite membrane for organic solvent nanofiltration, the process comprising the steps of:

(a) impregnating a porous support membrane comprising a first conditioning agent being a low volatility organic liquid, with a first reactive monomer solution comprising :

(i) a first solvent for the said first reactive monomer; (ii) a first reactive monomer and; (iii) optionally, an activating solvent, (iv) optionally, additives including alcohols, ketones, ethers, esters, halogenated hydrocarbons, nitrogen-containing compounds and sulphur-containing compounds, monohydric aromatic compounds;

wherein said support membrane is stable in polar aprotic solvents;

(b) contacting the impregnated support membrane with a second reactive monomer solution comprising:

(i) a second solvent for the second reactive monomer; (ii) a second reactive monomer; (iii) optionally, additives including alcohols, ketones, ethers, esters, halogenated hydrocarbons, nitrogen-containing compounds and sulphur-containing compounds, monohydric aromatic compounds;

wherein the first solvent and the second solvent form a two phase system

(c) after a reaction period, immersing resulting composite membrane into a quench medium;

(d) treating the resulting asymmetric membrane with an activating solvent being a polar aprotic solvent, and:

(e) optionally, impregnating the resulting composite membrane with a second conditioning agent being a non-volatile liquid.

2. The process according to claim 1, wherein the support membrane is formed from crosslinked polyimide, crosslinked polybenzimidazole, crosslinked polyacrylonitrile, Teflon, polypropylene, or polyether ether ketone (PEEK), or sulfonated polyether ether ketone (S-PEEK).

3. The process according to claim 1 or claim 2, wherein the first and/or second conditioning agent is selected from one or more of synthetic oils (including polyolefinic oils, silicone oils, polyalphaolefinic oils, polyisobutylene oils, synthetic wax isomerate oils, ester oils and alkyl aromatic oils), mineral oils (including solvent refined oils and hydroprocessed mineral oils and petroleum wax isomerate oils), vegetable fats and oils, higher alcohols (such

as decanol, dodecanol, heptadecanol), glycerols, and glycols (such as polypropylene glycols, polyethylene glycols, polyalkylene glycols)

4. The process according to any one of claims 1, 2 or 3, wherein the first reactive monomer solution comprises an aqueous solution of a polyamine.
5. The process according to any preceding claim, wherein the first reactive monomer solution comprises an aqueous solution of a 1,6 hexenediamine or poly(ethyleneimine).
6. The process according to any preceding claim, wherein the first reactive monomer solution contains ethylene glycol, propylene glycol, glycerine, polyethylene glycol, polypropylene glycol, and copolymers of ethylene glycol and propylene glycol, or polar aprotic solvents.
7. The process according to any preceding claim, wherein the second reactive monomer solution may contain mono-acyl chlorides, polyacyl chlorides or a mixture thereof, or other monomers.
8. The process according to any preceding claim, wherein the second reactive monomer solution may contain trimesoyl chloride, iso-phthaloyl dichloride, or sebacoyl chloride or a mixture thereof.
9. The process according to any preceding claim, wherein composite membrane is treated in step (d) with an activating solvent by immersion or washing in the activating solvent, or by filtration through the membrane using the activating solvent.
10. The process according to any preceding claim, wherein composite membrane is treated in step (d) with an activating solvent comprising dimethylformamide, N-methyl pyrrolidone, dimethylsulfoxide, dimethylacetamide or a mixture thereof.
11. The process according to any preceding claim, wherein the contacting time in step (b) is chosen from between 5 seconds and 5 hours.

12. The process according to any preceding claim, wherein the temperature of the contacting step (b) solution is held between 10 and 100°C.
13. The process according to any preceding claim, wherein the resulting membrane is configured as spiral wound, plate and frame, shell and tube, or derivative designs thereof.
14. A composite membrane for nanofiltration obtainable by the process of any preceding claim.
15. Use of membrane as claimed in claim 14 for nanofiltration of a feed stream solution comprising a solvent and dissolved solutes, wherein the feed stream comprises at least one polar aprotic solvent.