CLAIMS

1. A membrane distillation system comprising:

a flat-sheet composite mixed matrix hydrophilic/hydrophobic membrane having at least a hydrophilic layer and a hydrophobic layer;

the hydrophilic layer further comprising a hydrophilic polymer and inorganic nano-particles of high thermal conductivity selected from the group consisting of copper (II) oxide, boron nitride, aluminium nitride, aluminium, iron and silicon carbide; and

the hydrophobic layer further comprising a fluorinated surface-modifying macro-molecule (SMM).

2. The system as claimed in claim 1, wherein said hydrophilic polymer is a thermoplastic polymer.

3. The system as claimed in claim 2, wherein the thermoplastic polymer is selected from the group consisting of polysulfone, polyethersulfone, polyether-imide and cellulose acetate.

4. The system as claimed in claim 1, wherein said fluorinated surface-modifying macro-molecules (SMM) are oligomeric fluoropolymers synthesized using polyurethane chemistry, the surface-modifying macromolecules comprise fluorinated end groups.

5. The system as claimed in claim 1, wherein said fluorinated SMM is blended with the hydrophilic polymer-inorganic nano-particles dispersion.

6. The system as claimed in claim 5, wherein said SMM is selected from the group consisting of poly(urethane propylene glycol) and poly(urea dimethylsiloxane urethane).

7. The system as claimed in claim 1, where the composited mixed matrix membrane is adapted to possess a lower wetting tendency than commercial membranes of single hydro-phobic layer.

8. A phase inversion method for manufacturing a membrane distillation composite mixed matrix hydrophilic/hydrophobic membrane, said method comprising:

(a) dispersing a host hydrophilic polymer with a predetermined amount of insoluble

inorganic nano-particles and a non-solvent additive in a solvent to form a polymer-inorganic solution;

(b) adding a fluorinated surface modifying macromolecule (SMM) to the polymer inorganic solution to form a polymer-inorganic nano-particles SMM blend;

(c) casting said polymer-inorganic nano-particles SMM blend and allowing said solvent to evaporate at room temperature for a systematically variable predetermined time to form a cast film, to study and modify the evaporation time on the settling of the inorganic nano-particles in a bottom (or host hydrophilic) layer as well as the hydrophobic SMM migration to form a hydrophobic top layer, and whereby the the cast film is covered by a cover in such a manner as to control further evaporation of the solvent allowing more time for settling of the inorganic nano-particle in the bottom layer and migration of a hydrophobic SMM to an air/polymer interface; and

(d) immersing said cast film produced in step (c) in water to allow gelation,

wherein said host hydrophilic layer comprises at least one of polysulfone, polyethersulfone, polyetherimide, cellulose acetate and other polymers known as thermoplastics as a hydrophilic polymer and at least one of copper oxide, boron nitride, aluminium nitride, aluminium, iron, silicon carbide and other inorganic nano-particles of high thermal conductivity.

9. The method as claimed in claim 8, further comprising maximizing the temperature polarization coefficient in the hydrophilic sublayer, according to the following equations:

$$U = \left(\frac{1}{h_f} + \frac{1}{h_s} + \frac{1}{h_p} \right)^{-1} (1 - \theta)$$

and

$$\theta = \theta_f + \theta_p + \theta_s - 2$$

where θ_f, θ_S and θ_P are the temperature polarization coefficients corresponding to the feed, hydrophilic sub-layer and permeate phases, respectively; and are defined as follows:

$$\theta_f = 1 - \frac{U}{h_f} = \frac{T_{m,f} - T_{b,p}}{T_{b,f} - T_{b,p}}$$

$$\theta_s = 1 - \frac{U}{h_s} = \frac{(T_{b,f} - T_{b,p}) - (T_{m,p} - T_{s,p})}{T_{b,f} - T_{b,p}}$$

$$\theta_p = 1 - \frac{U}{h_p} = \frac{T_{b,f} - T_{s,p}}{T_{b,f} - T_{b,p}}$$

10. The method as claimed in claim 8, wherein said hydrophobic top-layer is of a polymeric nature such as an SMM.

11. The method as claimed in claim 8, wherein said non-solvent additive is selected from the group consisting of *y*-butyrolactone, ethanol and lithium chloride.

12. The method as claimed in claim 8, wherein said solvent is N,N-dimethylacetamide or 1-methyl-2-pyrrolidone.

13. The method as claimed in claim 8, exhibited higher permeate flux because of the higher thermal conductivity of the sub-layer and the decrease in the resistance of the water vapour migration in the hydrophobic layer.