Claims

1. An air cooling system comprising:

a system inlet;

a dehumidifier;

an evaporative cooler; and

a system outlet;

wherein:

the air cooling system comprises a fluid flow path from the system inlet to the system outlet that passes through the dehumidifier and then the evaporative cooler;

the dehumidifier comprises at least two plate fin heat exchangers, each comprising fins coated with a desiccant composition that comprises a superabsorbent polymer and a hygroscopic material; and

the evaporative cooler is a counter-flow dew-point indirect evaporative cooler comprising:

a heat exchanging chamber separated by one or more channel plates, where each channel plate is arranged to provide at least one product channel and at least one working channel adjacent to one another,

where the at least one product channel has an air inlet at a first end and a product air outlet at a second end,

where the at least one working channel has a product air inlet formed through at least one channel plate bordering the working channel at an end region proximal to the product air outlet of the at least one product channel, and a working air outlet at an end region distal to the product air inlet;

at least one water supply means or apparatus;

a blower configured to propel air to the air inlet of the at least one product channel and thereby through the product air outlet of the at least one product channel, and the product air inlet and working air outlet of the at least one working channel; wherein:

each channel plate has a first surface facing into the at least one product channel that is, or is coated in, a water-impervious material and a second surface facing into the at least one working channel that may be, or may be coated with, a wicking material, provided that at least one channel plate surface in each working channel is, or is coated with, a wicking material;

the water supply means or apparatus is configured such that it can supply water to the wicking material on the second surface of each of the one or more channel plates;

the counter-flow dew-point evaporative cooler is configured such that in operation a minor fraction of air flowing through each product channel flows through a product air inlet into a working channel, and a major fraction of air flowing through each product channel flows through the product air outlet, where the minor fraction of air is from 5 to 25 wt% of air passing into the dry product channel.

2. The air cooling system according to Claim 1, wherein the means for supplying water to the wicking material is a first water tank, and the first water tank is configured to supply water to the wicking material by capillary action through the wicking material.

3. The air cooling system according to Claim 2, wherein the counter-flow dew-point indirect evaporative cooler comprises two or more water tanks configured to supply water to the wicking material by capillary action.

4. The air cooling system according to Claim 2 or 3, wherein each water tank is located outside of the heat exchanging chamber, and the wicking material extends from the heat exchanging chamber to each water tank, or is connected to a piece of wicking material which extends to each water tank.

5. The air cooling system according to any one of the preceding claims, wherein the wicking material comprises a fibre, cotton, gauze or tissue, optionally wherein the wicking material comprises a porous fibre material, such as a natural porous fibre material.

6. The air cooling system according to any one of the preceding claims, wherein the water-impervious material is selected from one or more of the group consisting of a water-impervious polymer (e.g. polyethylene, polypropylene or polyvinyl chloride) and a water-impervious metal (e.g. aluminium, copper or stainless steel).

7. The air cooling system according to any one of the preceding claims, wherein the minor fraction of air is from 10 to 15 wt% of air passing into the dry product channel.

8. The air cooling system according to any one of the preceding claims, wherein the superabsorbent polymer is selected from one or more of the group consisting of polyvinyl alcohol and a polyacrylate.

9. The air cooling system according to Claim 8, wherein the polyacrylate is selected from one or more of the group consisting of sodium polyacrylate and potassium polyacrylate.

10. The air cooling system according to any one of the preceding claims, wherein the hygroscopic material is selected from one or more of the group consisting of a salt and a glycol.

11. The air cooling system according to Claim 10, wherein the salt is an inorganic salt, optionally wherein the salt is selected from one or more of the group consisting of lithium chloride, calcium chloride, and sodium bromide.

12. The air cooling system according to Claim 10, wherein the salt is an organic salt, optionally wherein the salt is potassium formate.

13. The air cooling system according to Claim 10, wherein the glycol is selected from one or more of the group consisting of triethylene glycol, polyethylene glycol, diethylene glycol, ethylene glycol and tetraethylene glycol.

14. The air cooling system according to any one of the preceding claims, wherein:

(a) the weight ratio of superabsorbent polymer to hygroscopic material is from about 10:1 to about 1:2, optionally about 5:1 to about 1:1.5, for example about 2.5:1 to about 1:1.1; and/or

(b) the hygroscopic material is dispersed within the superabsorbent polymer.

15. The air cooling system according to any one of the preceding claims, wherein the desiccant composition further comprises an antibacterial agent, optionally wherein:

(a) the antibacterial agent is selected from one or more of the group consisting of ammonia, trimethylamine, acetic acid, an anilide, a biguanide, a heavy metal, a phenol and a cresol’ and/or

(b) the antibacterial agent is present in an amount of from 1 to 5 wt% compared to the total weight of the composition.

16. The air cooling system according to any one of the preceding claims, wherein:

(a) the superabsorbent polymer is polyvinyl alcohol and the hygroscopic material is lithium chloride, optionally wherein the weight ratio of polyvinyl alcohol to lithium

chloride is from about 5:1 to about 1:2, such as from about 2.5:1 to about 1:1.1, particularly from about 3:2 to about 1:1; or

(b) the superabsorbent polymer is sodium polyacrylate and the hygroscopic material is lithium chloride, optionally wherein the weight ratio of sodium polyacrylate to lithium chloride is from about 5:1 to about 1:2, such as from about 2.5:1 to about 1:1.1, particularly from about 3:2 to about 1:1.

17. The air cooling system according to any one of the preceding claims, wherein:

(a) the superabsorbent polymer is polyvinyl alcohol and the hygroscopic material is potassium formate, optionally wherein the weight ratio of polyvinyl alcohol to potassium formate is from about 10:1 to about 5:1, such as about 7:1 to about 5:1; or

(b) the superabsorbent polymer is sodium polyacrylate and the hygroscopic material is potassium formate, optionally wherein the weight ratio of sodium polyacrylate to potassium formate is from about 5:1 to about 1:2, such as from about 2.5:1 to about 1:1.1, particularly about 1:1.

18. The cooling system according to any one of the preceding claims, further comprising one or more blowers configured to propel air along the fluid flow path.

19. The air cooling system according to any one of the preceding claims, further comprising a power supply for supplying power to the dehumidifier and/or evaporative cooler.

20. The air cooling system according to Claim 19, wherein the power supply comprises or is connectable to one or more selected from the group consisting of a photovoltaic cell and photovoltaic thermal hybrid solar collector.