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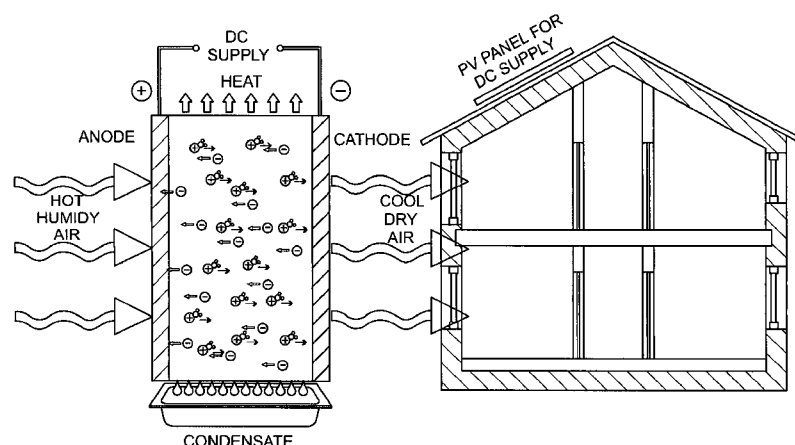


Figure 2

(57) Abstract: A dehumidification system is described for the dehumidification of a gas stream. The system has a gas inlet conduit defining at least one gas flow channel to receive gas to be dehumidified, a dehumidification unit including one or more desiccant elements each comprising a contained volume of solid desiccant material through which gas to be dehumidified is passed in use, and a gas outlet conduit defining at least one gas flow channel to convey dehumidified gas downstream. The desiccant element further comprises anode(s) and cathode(s) disposed in spaced arrangement about the contained volume of solid desiccant to apply a potential difference across the desiccant such as in use to drive electro- osmotic removal of water from the desiccant. An air-conditioning system embodying such a dehumidification system and methods of use of the same are also described.

**DEHUMIDIFICATION APPARATUS AND METHOD USING ELECTRO-
OSMOSIS FOR REMOVAL OF WATER FROM DESICCANT**

5 The present invention relates to the method of and apparatus for solid desiccant dehumidification, and relates particularly, but not exclusively, to regeneration of solid desiccant in a dehumidification system for residential building thermal comfort control, for example as part of an air-conditioning system.

10 For effective thermal comfort control it is desirable to control both temperature and humidity levels. Desiccant dehumidification is used in air-conditioning systems to ensure the air supplied to be in thermal comfort conditions. Liquid desiccant dehumidification systems which are large in volume are used in large scale air-conditioning systems. A solid desiccant
15 dehumidification system can be relatively small in volume and is suitable for residential air-conditioning.

A typical solid desiccant comprises a hygroscopic substance disposed in an airflow stream to remove water content from the airflow. The desiccant
20 material is arranged, for example in powder, gel, granular form etc., so that the flow stream to be dehumidified is able to pass through a body of desiccant material. Typical solid desiccants work through absorption or adsorption of water, or a combination of the two.

25 As saturation levels rise with use over time, the desiccant becomes less effective. Typical solid desiccants are re-useable, but must be regenerated for reuse by removal of the moisture content. In typical prior art air-conditioning systems, solid desiccant used for dehumidification is regenerated thermally. That is, the desiccant is heated by an external heat
30 source to drive off absorbed and/or adsorbed water. In particular, a

thermal wheel system is used. A body of desiccant material passes via an active stage where it is active in dehumidifying an airstream to a regeneration stage where it is regenerated by heating and then can be reused in the active stage.

5

A number of potential drawbacks can be identified in such a system. In particular, it can be seen that in a thermal wheel process only some of the desiccant material is active at any given time. Other desiccant material is in the regeneration stage. Redundant material is needed as a result of the regeneration process. Additionally, the use of thermal energy to regenerate desiccant can be inefficient. The latent heat input required to cause evaporation of water from the used desiccant is lost.

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It is desirable to provide a method of use of and regeneration of solid desiccant that offers an alternative to thermal regeneration, and in particular that is more efficient in its use of material and/ or energy.

15

In accordance with the invention in a first aspect there is provided a dehumidification system for the dehumidification of a gas stream, for example for use as a dehumidification module for thermal comfort control of ambient air, and for example as part of an air-conditioning system for a residential building or similar comfort-controlled volume. The dehumidification system comprises a gas inlet conduit defining at least one gas flow channel to receive gas to be dehumidified, a dehumidification unit including one or more desiccant elements each comprising a contained volume of solid desiccant material through which gas to be dehumidified is passed in use, and a gas outlet conduit defining at least one gas flow channel to convey dehumidified gas downstream. It is characterised in that a desiccant element further comprises an anode and a cathode disposed in spaced arrangement about the contained volume of

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solid desiccant electrically connectable to a suitable source of electrical power to apply in use a potential difference across the desiccant such as in use to drive electro-osmotic removal of water from the desiccant.

- 5 The current invention lies in the use of electro-osmosis to drive desiccant regeneration.

The key to the invention is the use of a solid desiccant material, and the provision of at least one anode and at least one cathode spaced apart with
10 a mass of such solid desiccant material between them so as to apply an electro-osmotic potential across the solid desiccant material, to set up a condition where the solid desiccant material acts as a desiccant as wet gas is passed through it, and this desiccant is also being regenerated by the electro-osmotic process. The desiccant may thus be regenerated in
15 situ where it is used, and in particular preferably simultaneously as it is used, rather than via a separate and successive batch operation.

The process is potentially a more thermally efficient process than a thermal regeneration process. The problem of loss of energy attributable
20 to the latent heat input required to heat to evaporation in thermal regeneration systems such as thermal wheel systems does not arise. Use of the apparatus and method of the invention in air conditioning applications can lead to more efficient and easily controllable thermal comfort control of an indoor environment.

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In use, by application of a suitable electro-osmotic potential, an effectively continuous process of regeneration can be set up. The entire supply of desiccant may be kept constantly in use as an active dehumidification element, and may continually be regenerated so long as the electro-
30 osmotic potential is applied. This can be contrasted with a thermal

regeneration process, such as a thermal wheel process, which is essentially a batch process, and enables only some desiccant to be active, with other desiccant in a thermal regeneration condition.

- 5 Additionally therefore, the apparatus and method of the invention may provide for more efficient use of solid desiccant and/ or reduce the volume of desiccant required.

10 Such considerations may lead to a reduction in the size required for the desiccation unit for equivalent dehumidification capacity. Since a particular advantage of solid desiccant systems is their use on a small scale, this may be a particular advantage.

15 It is a particular advantage of the invention that it may be applicable to a wide range of known and readily available solid desiccant materials. Particularly preferably, solid desiccant materials may be used which inherently have both desiccant and electro-osmotic properties. Such materials then in themselves facilitate electro-osmosis when a suitable potential difference is applied across them. Additionally or alternatively
20 use may be made of filtration membranes in suitable arrangement with the solid desiccant materials, together to provide the necessary semi-permeable structures necessary to operation of electro-osmosis when a potential is applied between the anode and the cathode.

25 The invention is potentially applicable to a range of solid desiccant materials, where solid in this context includes, without limitation, desiccant materials comprising powders, particulates, gels, porous monoliths, desiccant materials contained within primary structures such as structured packing, all of the above between additional structural elements, whether

serving as membrane structures of otherwise, and any combinations of the same.

5 Nor is the invention considered limited to particular shapes or conformations of a given contained volume of solid desiccant material, provided the volume is conformed in such a way as to allow the passage of a wet gas through the desiccant material, and to allow placement of spaced anode(s) and cathode(s) to apply a suitable electro-osmotic potential across the volume.

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In a preferred case, a desiccant element comprises a contained volume of solid desiccant material with elongate conformation having an anode at a first end and a cathode at a second end.

15 In a particularly preferred conformation, a solid desiccant element is disposed to allow water condensing via the electro-osmotic regeneration process to be drawn out of the volume in use under the action of gravity, for example in that the solid desiccant element or the dehumidification unit of which solid desiccant element(s) form(s) a part is disposed in a
20 generally horizontal direction with a generally vertically disposed anode at one end and a generally vertically disposed cathode at the other end. This may make the condensate collection process particularly efficient.

25 A suitable condensate collection means, conveniently provided with a suitable conduit for drawing off the condensate, may be provided below the solid desiccation element and/ or below the dehumidification unit, to allow condensate to be drawn off under action of gravity during use.

30 In use, gas to be dehumidified, for example in the preferred case comprising ambient air, is drawn from a supply source such as

atmosphere through the gas inlet conduit, caused to flow through the solid desiccant element(s) comprising the dehumidification unit, and conveyed downstream via the gas outlet conduit in fluid communication with a volume to be supplied with dehumidified gas, for example comprising a residential volume to be supplied with conditioned air. A dehumidification system in accordance with the invention is accordingly preferably provided with suitable impeller means to drive this gas flow process, for example comprising a suitable gas impeller at the inlet and/or outlet and/ or otherwise in the fluid circuit.

10

In a more complete application of the invention, in the preferred case, a dehumidification system in accordance with the first aspect of the invention is disposed in stream as part of a thermal comfort heating and/or cooling system for the conditioning of ambient air, in particular to supply conditioned air to a comfort-controlled residential zone such as a residential building or similar volume. Thus, in this more complete aspect of the invention, a thermal comfort heating and/or cooling system for the conditioning of ambient air, in particular to supply conditioned air to a comfort-controlled residential zone such as a residential building or similar volume, comprises a dehumidification system in accordance with the first aspect of the invention.

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In accordance with this preferred arrangement, the gas inlet comprises an inlet for receiving ambient air, and the gas outlet comprises an outlet for supplying conditioned air to a comfort-controlled zone such as a residential building or similar volume.

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In each case, fluid communication may be indirect. That is, the inlet may be in fluid communication with an ambient air supply either directly or indirectly in the sense that it is otherwise fluidly downstream of a suitable

ambient air supply. The outlet may supply conditioned air to a comfort-controlled zone either directly or indirectly in the sense that it is in fluid communication with such a comfort-controlled zone fluidly further downstream. The whole may comprise part of a fluid circuit to draw ambient air, condition the same, feed dehumidified air to a comfort-controlled zone, and draw exhaust air from the comfort-controlled zone for discharge to ambient.

Additional means to condition the air may be provided fluidly in line between the initial source of ambient air and the ultimate comfort-controlled volume, whether in series or in parallel to the dehumidification system of the invention. In particular, means may be provided, for example fluidly in series with a dehumidification unit, to vary the temperature of the air, by heating and/or cooling the same. Suitable heating and/or cooling means for use in the conditioning for comfort control of ambient air for supply to a building will be well known, and conventional or bespoke systems may be suitable for use with the invention. For example, heat exchanger elements may be provided upstream and/or downstream of a dehumidification system in accordance with the invention. In a particularly preferred case, a suitable means to effect both heating and cooling on a selective basis is provided.

To reduce corrosion effects, a protective membrane may be provided at an electrode, at least at the cathode. Additionally or alternatively, an electrode, and for example at least the cathode, may be selected from a hydrophobic material.

In a preferred embodiment, suitable control means may be provided to apply a variable electro-osmotic potential across the electrodes and/or to control the rate of flow of gas through the desiccant volume so as to

control the extent to which water is removed from the gas flow. In particular, the control means may be adapted to establish a variably controllable constant rate of regeneration of desiccant, such that desiccant is regenerated in a steady-state or pseudo-steady-state process as
5 opposed to the batch process of the thermal wheel.

Notwithstanding the above, in a possible embodiment the control means is adapted to apply electro-osmotic potential in pulsed manner with a suitable pulse interval where lower or no potential is applied. Such a
10 pulsed application may help to minimise Joule heating effects. However, even where electro-osmotic potential is applied in pulsed manner it is still generally desirable to establish a constant pulse rate and intensity to maintain a steady and continuous regeneration of the desiccant during use.

15 In accordance with the invention in a further aspect there is provided a dehumidification method for the dehumidification of a gas stream, for example for thermal comfort control of ambient air, and for example as part of a method of air conditioning of a residential building or similar
20 comfort-controlled volume.

The method comprises the steps of:
receiving gas to be dehumidified from a suitable supply source;
passing gas to be dehumidified through a solid desiccant material to
25 extract water vapour therefrom;
conveying the dehumidified gas onwards;
applying an electro-osmotic potential across the solid desiccant such as to drive electro-osmotic removal of water from the desiccant.

The method of the invention is distinctly characterised by the application of an electro-osmotic potential across the solid desiccant to regenerate the same. In particular, the regeneration step is preferably performed simultaneously with the dehumidification process, such that desiccant is constantly regenerated in a continuous rather than a batch process, and therefore such that the entire desiccant stock, rather than a part batch thereof may be kept in use. In particular, a steady-state or pseudo steady-state condition is established as above described. As described above such a steady-state or pseudo steady-state condition does not exclude cases where the electro-osmotic potential is applied as a repeating pulse.

In a preferred application of the method, the method comprises a method of conditioning of ambient air by the removal of moisture therefrom, in particular to supply conditioned air to a comfort-controlled zone such as a residential building or similar volume. The method comprises drawing external ambient air as a gas supply, dehumidifying the air in the manner above described, and supplying the dehumidified air, for example to the comfort-controlled zone.

The method is most preferably part of a more complete air-conditioning method for provision of conditioned and comfort-controlled air to a residential building or similar volume, in which additionally a step of controlling the temperature of the air supply is effected, conveniently either upstream or downstream of the dehumidification step, to provide air, for example to the comfort-controlled volume, at a desired comfort-controlled temperature.

Other preferred features of the method will be understood by analogy with those described for the system hereinabove.

The invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a schematic of an apparatus for air conditioning of a room including a dehumidification system in accordance with an embodiment of the invention;

Figure 2 is an alternative representation in schematic form of how such a system might work in association with a building;

Figures 3 and 4 represent graphically an explanation of the potential for enhanced efficiency offered by the use of electro-osmotic regeneration in accordance with the invention.

A diagram of a possible system is illustrated in figures 1 and 2.

Figure 1 illustrates in schematic form the circuit of a domestic AHU flow system with an electro-osmotic dehumidification unit in accordance with an embodiment of the invention.

Outside air is drawn through an inlet into an inlet flow conduit and thus drawn through arrays of solid desiccant formed as a suitable elongate desiccant volume. Suitable solid desiccant materials are discussed below. The desiccant material removes moisture from the outside air as it passes through the arrays in familiar manner. To that extent, operation of the solid desiccant dehumidifier is relatively conventional.

The example is characterised as an embodiment of the distinct system and method of the invention by the rest of the electro-osmotic dehumidification unit. An electrode is disposed at either end of the elongate solid desiccant array, the electrodes respectively forming an anode and a cathode across which an electro-osmotic potential can be applied by a suitable power source.

In use, a suitable potential difference is applied between these electrodes to effect a continuous electro-osmotic regeneration of the solid desiccant, regeneration taking place with the desiccant in situ, and ideally effectively simultaneously with dehumidification (in the sense that a batch of desiccant need not be removed from use for regeneration as is the case in thermal wheel processes). Thus, the entire desiccant is potentially active at the same time as the entire desiccant is potentially being regenerated. This can be contrasted with systems where a batch of solid desiccant is active and another batch is being regenerated, such as thermal wheel systems.

In a possible modification, a pulsed electro-osmotic potential is applied, to reduce Joule heating effects.

The electrical power source for the electrodes is not specifically pertinent to the invention, but in the embodiment illustrated, a convenient source of power is provided by photovoltaic panel arrays, which may for example be mounted on a building roof. These arrays are used to charge a battery.

The battery is shown in communication with a distributor as a source to apply electro-osmotic potential to the electrodes. An additional electrical power source connection is provided via a DC/AC convertor to an AC power source such as a mains grid power source or generator.

In the illustrated embodiment, an impeller fan is provided downstream of the electro-osmotic dehumidification unit to draw the humidified air from an outlet of the dehumidification unit and through a distributing conduit to a supply outlet where it is supplied to the comfort-controlled room. Return outlets and a return duct allow air to be forced out of the air-conditioned room to complete the circuit.

In the illustrated embodiment, the dehumidification unit of the invention is shown operating in parallel with an air heating and cooling system which can be of any suitable standard or bespoke design.

5

Figure 2 is an alternative schematic illustration of the use of the principles of the invention to control and air-condition a building. A solid desiccant unit is shown (not to scale) through which hot humid air from outside is drawn. The air is dehumidified by action of the desiccant and cool dry air supplied to the building. The application of a potential difference between the anode and cathode drives the electro-osmotic regeneration of the desiccant, condensate being drawn out of the bottom of the desiccant volume under action of gravity and heat discharged out of the top.

15 By way of illustrative example only, the following solid desiccants may be considered for use in the system of figures 1 and 2.

Name	Linear Formula (or main component)	Properties				
		Description	Form	Particle size	Pore size	Surface area
Aluminium oxide	Al ₂ O ₃	weakly acidic	Powder	~150 mesh	58 Å	155 m ² /g
Magnesium sulphate	MgSO ₄	Neutral	Powder	10~200 micron	N/A	N/A
Molecular sieves, 3 Å powder (Fluka)	KnNa ₁₂ -n[(AlO ₂) ₁₂ (SiO ₂) ₁₂]-xH ₂ O	Alkaline	Powder	10~200 micron	3 Å	N/A
Diatomaceous earth (Calcined)	SiO ₂ (≥95%)	Neutral	Powder	10~200 micron	N/A	N/A
Zeolite	SiO ₂ , Al ₂ O ₃	Alkaline	Powder	~400 mesh	~24Å	600~900 m ² /g
Silica gel	SiO ₂	Neutral	Particles	0.5~2mm	N/A	N/A

In a possible mode of operation, the following parameters can be considered:

Working electric potential applied: 10 to 15 V/cm.

5 Power consumption: 1.5w – 3.5w per 100cm².

The current limit is set up to 0.450 A to avoid the severe joule effect.

The generated water flow rate is 1.35 μ L/min (Zeolite peak value).

10 The invention comprises a system and method as above described, and is not considered to be limited by any particular theory of operation.

Nevertheless, the discussion below with reference to figures 3 and 4 is intended to assist in an appreciation of possible efficiencies and advantages associate with the electro-osmotic process of the invention.

15 The process being used to regenerate the desiccant is generally known and will be readily understood. Electro-osmosis is the motion of a liquid through an immobilized set of particles, a porous plug, a capillary, or a membrane, in response to an applied electric field. It is the result of the force exerted by the field on the counter-charge in the liquid inside the

20 charged capillaries, pores, etc. The moving ions drag the liquid in which they are embedded along. The electro-osmotic velocity, u_{eo} (ms⁻¹), is the uniform velocity of the liquid far from the charged interface. Usually, the measured quantity is the volume flow rate of liquid (m³s⁻¹) through the capillary, plug, or membrane, divided by the electric field strength, $Q_{eo,E}$

25 (m⁴V⁻¹s⁻¹), or divided by the electric current, $Q_{eo,I}$ (m³C⁻¹). It is the application of in the system and method of the invention that produces the distinct advantages discussed over prior art systems of regeneration.

30 The total heat from the inward air is made up of sensible heat (Q_{air}) and latent heat (Q_{vapour}) respectively, as shown in Figure 3. The method

depends on coupling the electro-osmotic force to pump water through a desiccant membrane with the desiccant effect on one surface of the membrane. Operation differs from the thermal regeneration process in that it enables separation of the latent heat load from the sensible heat load. It is not necessary to heat the desiccant being regenerated.

The operation of an example system in accordance with the invention with an electro-osmotic dehumidifier is compared with conventional system; the system COP with EO regeneration is 45.6% higher than the COP of convention system with thermal wheel regeneration. In terms of regeneration, the energy consumption from the electro-osmosis is more than 40% lower than the energy used by the thermal wheel. This is as shown in Figure 4 and Table 1.

Table -1:

	Electro-osmotic dehumidification	Thermal wheel	Saving Rate (EO)
Cooling strategies route	(A-D)-B	A-C-E-B	
Energy consumed by the compressor(based on the same weather condition)	14	22	36%
Reheat energy	0	8	
Dehumidification Energy	4	0	
Total Energy consumed	18	30	40%
Cooling capacity= $0.24 \eta_{total} \gamma Q_v (h_1 - h_2)$	42	48	+12.6%
COP Value=cooling capacity/total energy*	$42/(14+4)=2.33$	$48/(22+8)=1.6$	+45.6%

*In the above table this comparison of COP value is based on the same air condition. With different pre-cooling strategies, the EO method can achieve higher evaporated temperature for the compressor as seen in the Psychometric chart and the table. Cooling capacity is calculated by the
5 total cooling load which is equal to energy cost by the compressor multiplied by a factor of efficiency because of heat loss during process.

Thus, the apparatus and method of the invention offer an inherently more thermally efficient regeneration process than a thermal wheel process and
10 offer the potential for more efficient and more easily controllable thermal comfort control of an indoor environment.

CLAIMS

1. A dehumidification system for the dehumidification of a gas stream comprising a gas inlet conduit defining at least one gas flow
5 channel to receive gas to be dehumidified, a dehumidification unit including one or more desiccant elements each comprising a contained volume of solid desiccant material through which gas to be dehumidified is passed in use, and a gas outlet conduit defining at least one gas flow channel to convey dehumidified gas
10 downstream;
wherein the desiccant element further comprises an anode and a cathode disposed in spaced arrangement about the contained volume of solid desiccant to apply a potential difference across the desiccant such as in use to drive electro-osmotic removal of water
15 from the desiccant.
2. A dehumidification system in accordance with claim 1 wherein the volume of solid desiccant material comprises a solid desiccant material is selected to have both desiccant and electro-osmotic
20 properties.
3. A dehumidification system in accordance with claim 1 or claim 2 wherein the volume of solid desiccant material comprises filtration membranes in suitable arrangement with the solid desiccant
25 material, together to provide both desiccant and electro-osmotic properties.
4. A dehumidification system in accordance with any preceding claim wherein the desiccant element comprises a contained volume of

solid desiccant material with elongate conformation having an anode at a first end and a cathode at a second end.

5. A dehumidification system in accordance with claim 4 wherein the solid desiccant unit is disposed to allow water condensing via the electro-osmotic regeneration process to be drawn out of the volume under the action of gravity in use.
6. A dehumidification system in accordance with claim 5 wherein the solid desiccant unit is disposed in a generally horizontal direction with a generally vertically disposed anode at one end and a generally vertically disposed cathode at the other end.
7. A dehumidification system in accordance with claim 5 or 6 further comprising a suitable condensation collection means provided below the desiccation element.
8. A dehumidification system in accordance with any preceding claim further comprising an impeller to draw gas to be dehumidified through the dehumidification unit in use.
9. A dehumidification system in accordance with any preceding claim wherein a protective membrane is provided at an electrode.
10. A dehumidification system in accordance with any preceding claim wherein at an electrode comprises a hydrophobic material.
11. A dehumidification system in accordance with any preceding claim comprising control means to apply in use a variable electro-osmotic potential across the electrodes and/or to control the rate of flow of

gas through the desiccant volume so as to control the extent to which water is removed from the gas flow.

- 5 12. A dehumidification system in accordance with claim 11 wherein the control means is adapted to apply electro-osmotic potential in pulsed manner.
- 10 13. A thermal comfort heating and/or cooling system for the conditioning of ambient air comprising a dehumidification system in accordance with any preceding claim.
- 15 14. A thermal comfort system in accordance with claim 13 wherein the gas inlet of the dehumidification system is fluidly in communication with and downstream of a suitable ambient air supply and the gas outlet of the dehumidification system is fluidly in communication with and upstream of a comfort-controlled zone such as a residential building or similar volume.
- 20 15. A thermal comfort system in accordance with claim 13 or 14 additionally comprising means to vary the temperature of the air, by heating and/or cooling the same.
- 25 16. A dehumidification method for the dehumidification of a gas stream comprising the steps of:
receiving gas to be dehumidified from a suitable supply source;
passing gas to be dehumidified through a solid desiccant material to extract water vapour therefrom;
conveying the dehumidified gas onwards;

applying an electro-osmotic potential across the solid desiccant such as to drive electro-osmotic removal of water from the desiccant.

- 5 17. The method of claim 16 wherein the regeneration step is performed simultaneously with the dehumidification process.
18. The method of claim 16 or 17 wherein the electro-osmotic potential is applied as a repeating pulse.
- 10 19. A method of conditioning of ambient air by the removal of moisture therefrom, comprising the steps of:
drawing external ambient air as a supply,
dehumidifying the air in accordance with the method of one of
15 claims 16 to 18 and
supplying the dehumidified air.
20. The method of claim 19 comprising the additional step of controlling the temperature of the air.
- 20

DOMESTIC AHU FLOW DETAIL WITH EO DEHUMIDIFICATION UNIT CONFIGURATION

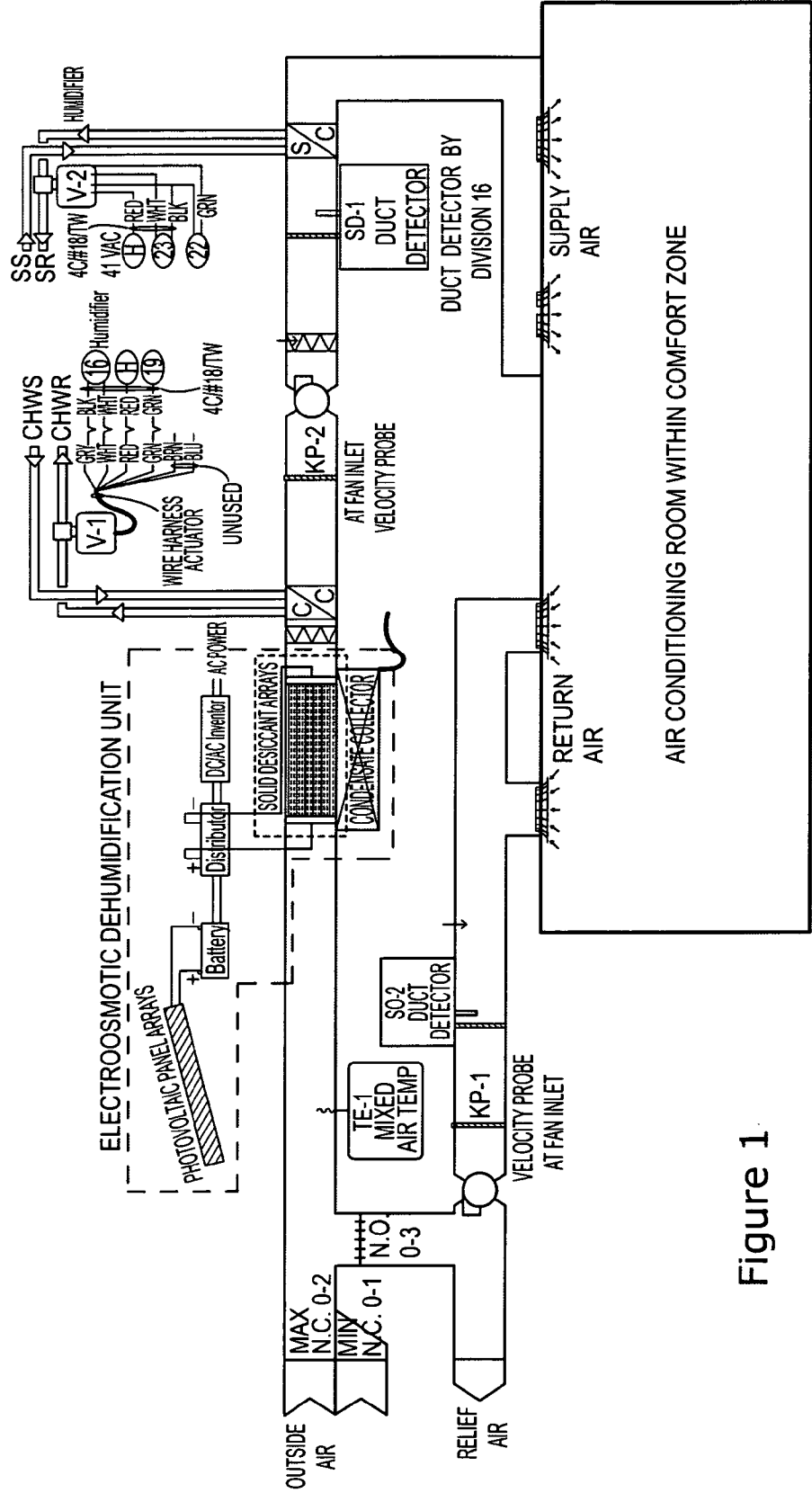


Figure 1

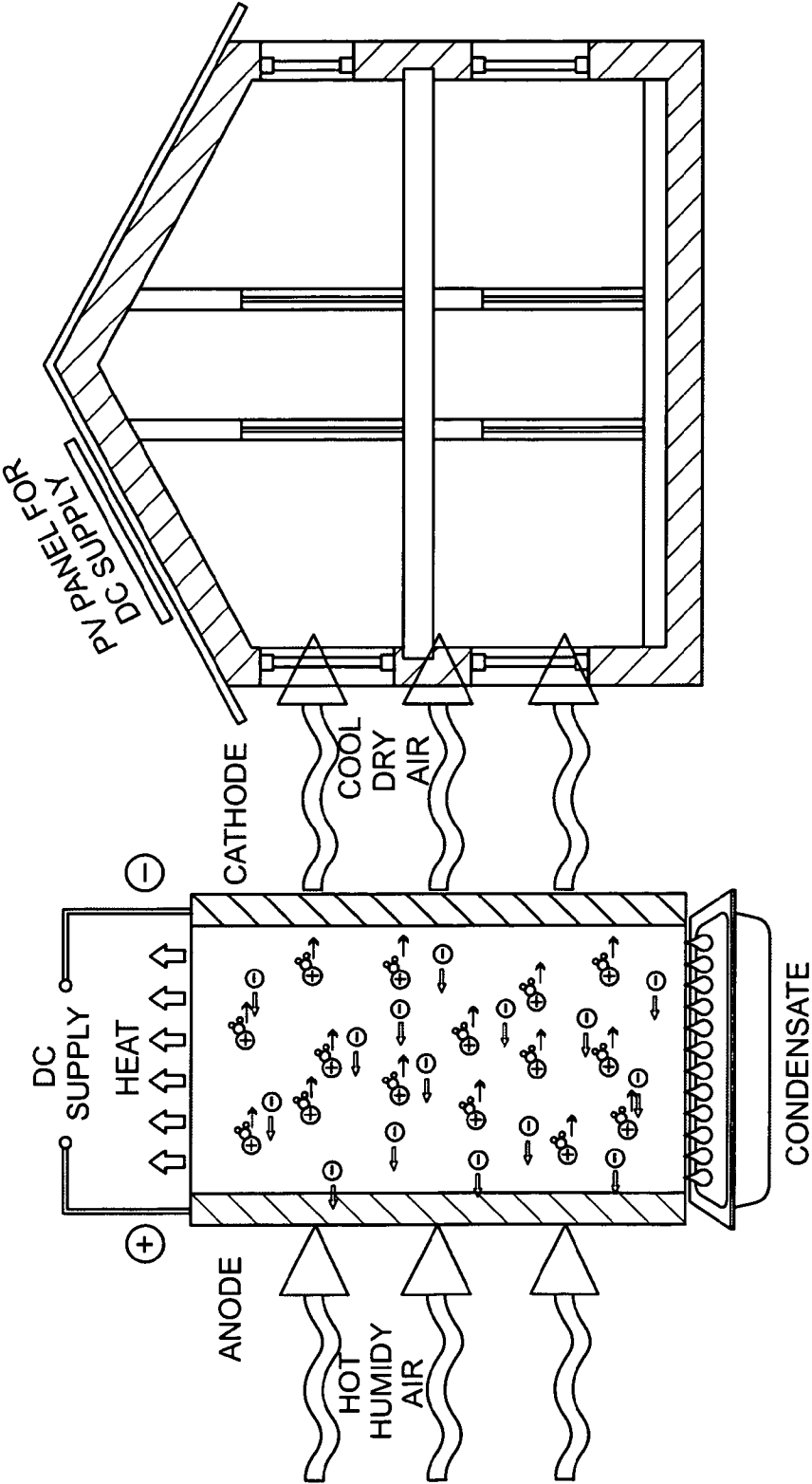


Figure 2

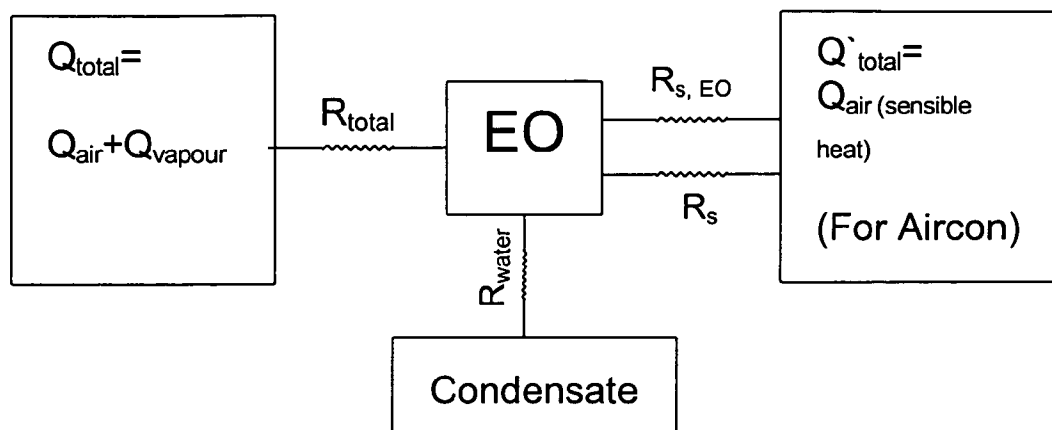


Figure 3

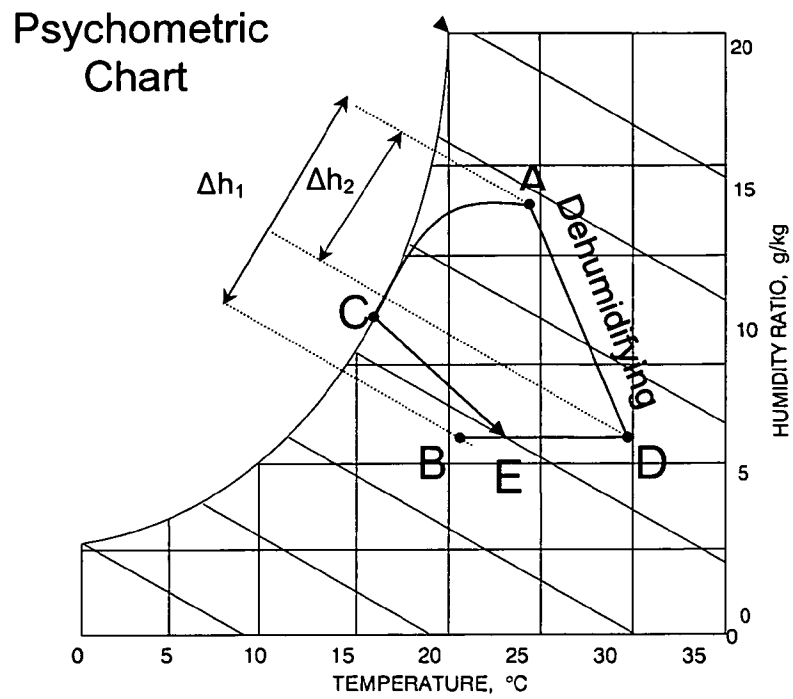


Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/004148

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24F3/14
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 2010 0104403 A (LG ELECTRONICS INC [KR]) 29 September 2010 (2010-09-29) paragraphs [0012], [0023] - [0027], [0033] - [0037], [0045] - [0051], [0053] - [0058], [0062] - [0070]; claims 1-5; figures 1-7 -----	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search

9 January 2013

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Authorized officer

Decking, Oliver

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/004148

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 20100104403 A	29-09-2010	NONE	