CLAIMS

1. System for controlling temperature and water content of an air stream, the system (1) comprising
   - a contact device (10) for transferring thermal energy and water vapor between a medium and an air stream flowing through the contact device, the contact device (10) being configured to allow a contact between the medium and the air stream in which thermal energy and water vapor is transferred,
   - a first control device (20) for controlling water content of the medium,
   - a second control device (30) for controlling temperature of the medium,

   wherein the contact device (10), the first control device (20) and the second control device (30) are connected such that the medium is able to flow in a loop (50) comprising the contact device (10), the first control device (20), and the second control device (30),

   the system (1) further comprising processing circuitry (40) configured to control the first control device (20) and the second control device (30), and

   the system (1) comprising

   - a first sensor (S1) configured to measure a medium water content parameter, wc_{medium}, of the medium and to send signals indicative of the medium water content parameter to the processing circuitry, said medium water content parameter being a parameter indicative of an amount of water in the medium,
   - a second sensor (S2) configured to measure a medium temperature of the medium, T_{medium}, and to send signals indicative of the temperature to the processing circuitry,

   and the system (1) further comprising

- a third sensor (S3) configured to measure an air temperature of the air stream, T_{air}, and to send signals indicative of the temperature to the processing circuitry,
- a fourth sensor (S4) configured to measure an air water content parameter, wc_{air} of the air stream and to send signals indicative of the air water content parameter to the processing circuitry, said air water content parameter being a parameter indicative of an amount of water in the air stream,

wherein said third sensor and said fourth sensor are configured to measure air temperature and air water content in a downstream section, said downstream section being a section that the air stream passes after flowing through the contact device,

wherein the processing circuitry (40) is configured to control air temperature and air water content of the air stream passing through the contact device by

- receiving, from the first sensor, a first input signal comprising the medium water content parameter, wc_{medium},

- receiving, from the second sensor, a second input signal comprising the measured medium temperature, T_{medium},

- receiving, from the third sensor, a third input signal, comprising the measured air temperature, T_{air},

- receiving, from the fourth sensor, a fourth input signal comprising the measured air water content parameter, wc_{air},

determining, based on the received parameters, a desired temperature change, T_{change}, and desired water content change, wc_{change} of the medium as a first function f_1:

$$(T_{change}, wc_{change}) = f_1(T_{medium}, wc_{medium}, T_{air}, wc_{air}, f_2(T_{air}, wc_{air}))$$

wherein the second function $f_2(T_{air}, wc_{air})$ defines a relationship between the air temperature, T_{air}, and the air water content, wc_{air}, as co-dependent variables such that a change in the value of one of the air temperature, T_{air}, and the air water content, wc_{air}, affects the value of the other, and

wherein the desired temperature change, T_{change} and the desired water content change, wc_{change} are determined such that the air stream flowing through the contact device approaches a predetermined temperature setpoint, T_{set}, and a predetermined water content setpoint, wc_{set}, through contact with the medium in the contact device,

- generating a first control signal which is configured to cause the first control device to apply the water content change, wc_{change}, to the medium such that the medium water content changes from the value of the medium water content parameter, wc_{medium}, by the desired water content change, $f(wc_{medium},wc_{change})$

- generating a second control signal which is configured to cause the second control device to apply the temperature change, T_{change} to the medium such that the medium temperature changes from the measured medium temperature, T_{medium}, by the desired temperature change, $f(T_{medium},T_{change})$.

2. System according to claim 1, wherein the processing circuitry is further configured to
   - repeatedly receive the first input signal, the second input signal, the third input signal and the fourth input signal
   - update the first function f_1

- update the first control signal and second control signal based on said updated first function f_1.

3. System according to claim 1 or 2, wherein the system (1) is further configured to transmit the first control signal to the first control device (20) and to change the medium water content in the first control device (20) in response to said first control signal.

4. System according to any of claims 1-3, wherein the system (1) is further configured to transmit the second control signal to the second control device (30) and to change the medium temperature in the second control device (30) in response to the second control signal.

5. System according to any previous claim, further comprising

- a fifth sensor (S5) configured to measure an upstream air temperature of the air stream, $T_{upstream}$, and to send signals indicative of the temperature to the processing circuitry,
- a sixth sensor (S6) configured to measure an upstream air water content parameter, $wc_{upstream,}$ of the air stream and to send signals indicative of the upstream air water content to the processing circuitry, said upstream air water content parameter being a parameter indicative of an amount of water in the air stream,

wherein said fifth sensor and said sixth sensor are configured to measure upstream air temperature and upstream air water content in an upstream section, said upstream section being a section that the air stream passes before flowing through the contact device,

and wherein the processing circuitry is further configured to

- receive, from the fifth sensor, a fifth input signal, comprising the measured upstream air temperature, $T_{upstream}$,

- receive, from the sixth sensor, a sixth input signal comprising the measured upstream air water content, $wc_{upstream}$,

and the processing circuitry is further configured to determine the first function f_1 :

$$(T_{change}, wc_{change}) = f_1(T_{medium}, wc_{medium}, T_{air}, wc_{air}, f_2(T_{air}, wc_{air}), T_{upstream}, wc_{upstream}).$$

6. System according to any previous claim, wherein the processing circuitry (40) is further configured to determine the first function f_1 based on the received parameters and also on at least one contact device parameter, cd, of the contact device, as:

$$(T_{change}, wc_{change}) = f_1(T_{medium}, wc_{medium}, T_{air}, wc_{air}, f_2(T_{air}, wc_{air}), cd)$$

7. System according to claim 6, wherein one contact device parameter, cd, is a mass flow of the air stream or of the medium through the contact device, or wherein one contact device parameter, cd, is a back pressure.

~~8. System according to claim 6 or 7, wherein one contact device parameter, cd, is a back pressure.~~

~~9.~~8. System according to any previous claim, wherein the first control device (20) comprises a buffer (B) comprising a volume of the medium, and wherein changing the medium water content comprises adding water to the buffer and/or removing water from the buffer by regenerating a portion of the volume.

~~10. System according to any previous claim, wherein the second control device (30) comprises a heat exchanger.~~

~~11. System according to any previous claim, wherein the first sensor is arranged to measure the water content parameter of the medium, wc_{medium}, in the loop downstream of the second control device but upstream of the contact device.~~

~~12. System according to any previous claim, wherein the second sensor is arranged to measure the temperature of the medium, T_{medium}, in the loop downstream of the second control device but upstream of the contact device.~~

~~13.~~9. System according to any previous claim, further comprising at least one additional sensor (S7) configured to measure the temperature of the medium, T_{medium}, or the water content parameter of the medium, wc_{medium}, wherein the additional sensor is configured to measure the medium temperature, T_{medium}, or the water content parameter of the medium, wc_{medium}, in another part of the loop then the first sensor or the second sensor.

~~14. System according to any previous claim, wherein the processing circuitry is further configured to determine the first function f_1, using at least one proportional-integral-derivative controller, PID.~~

~~15. System according to any of claims 1-13, wherein the processing circuitry is configured to determine the first function f_1, using a linear-quadratic regulator, LQR.~~

~~16. System according to any of claims 1-13, wherein the processing circuitry is configured to determine the first function f_1, using model predictive control, MPC.~~

~~17. System according to any previous claim, wherein the contract device is an evaporator pad.~~

~~18. System according to any of claims 1-16, wherein the contact device is a liquid to air membrane energy exchanger, LAMEE.~~

~~19. System according to any previous claim, wherein the medium is a salt such as Calcium Chloride, $CaCl_2$, Magnesium Chloride, $MgCl_2$, or Potassium Sulfate, K_2SO_4.~~

~~20. System according to any previous claim, wherein the first sensor is configured to measure the medium water content parameter, wc_{medium}, by measuring a vapor pressure of the medium.~~

~~21.~~10. Computer implemented method for controlling temperature and humidity of an air stream in a system comprising a contact device for transferring thermal energy and water vapor between a medium and an air stream flowing through the contact device, the contact device being configured to allow a contact between the medium and the air stream in which thermal energy and water vapor is transferred; a first control device for controlling water content of the medium; a second control device for controlling temperature of the medium; and processing circuitry configured to control the first control device and the second control device, wherein the contact device, the first control device and the second control device are connected such that the medium is able to flow in a loop comprising the contact device, the first control device, and the second control device,

the method comprising:

- receiving, in the processing circuitry, a first input signal from a first sensor, said first input signal comprising a measured medium

water content parameter, wc_{medium}, indicative of the water content of a medium,

- receiving, in the processing circuitry, a second input signal from a second sensor, said second input signal comprising a measured medium temperature, T_{medium}, indicative of the temperature of the medium,

- receiving, in the processing circuitry, a third input signal from a third sensor, said third input signal comprising a measured air temperature, T_{air}, indicative of a temperature of the air stream in a downstream section of the system, said downstream section being a section that the air stream passes after flowing through the contact device,

- receiving, in the processing circuitry, a fourth input signal from a fourth sensor, said fourth input signal comprising a measured air water content parameter wc_{air}, indicative of an amount of water in the air stream in the downstream section of the system,

- determining, using the processing circuitry, based on the received parameters, a desired temperature change, T_{change}, and desired water content change, wc_{change}, of the medium as a first function f_1:

$$(T_{change}, wc_{change}) = f_1(T_{medium}, wc_{medium}, T_{air}, wc_{air}, f_2(T_{air}, wc_{air}))$$

wherein the second function $f_2(T_{air}, wc_{air})$ defines a relationship between the air temperature, T_{air}, and the air water content, wc_{air}, as co-dependent variables, such that a change in the value of one of the air temperature, T_{air}, and the air water content, wc_{air}, affects the value of the other, and

wherein the desired temperature change, T_{change} and the desired water content change, wc_{change} are determined such that the air stream flowing through a contact device approaches a predetermined temperature setpoint, T_{set}, and a predetermined water content setpoint, wc_{set}, through contact with the medium in the contact device,

and the method further comprising

- generating, using the processing circuitry, a first control signal, C_1, which is configured to cause the first control device to apply the water content change, wc_{change}, to the medium such that the medium water content changes from the value of the medium water content parameter, wc_{medium}, by the desired water content change, $f(wc_{medium}, wc_{change})$, and

- generating, using the processing circuitry, a second control signal, C_2, which is configured to cause the second control device to apply the temperature change, T_{change} to the medium such that the medium temperature changes from the measured medium temperature, T_{medium}, by the desired temperature change, $f(T_{medium}, T_{change})$.

~~22.~~11. Method according to claim 10~~21~~, further comprising

- repeatedly receiving, in processing circuitry, the first input signal, the second input signal, the third input signal and the fourth input signal
- updating, using processing circuitry, the first function f_1, and
- updating, using processing circuitry, the first control signal and second control signal based on said updated first function f_1.

~~23.~~12. Method according to claim 10~~21~~ or 11~~22~~, further comprising

- transmitting the first control signal to a first control device, said first control device being configured to change the medium water content of the medium, and

- changing the medium water content in response to said first control signal.

~~24.~~13. Method according to any of claims ~~21-23~~10-12, further comprising

- transmitting the second control signal to a second control device, said second control device being configured to change the medium temperature of the medium, and

- changing the medium temperature in response to said second control signal.

~~25.~~14. Method according to any of claims 10-13~~21-24~~, further comprising

- receiving, in processing circuitry, a fifth input signal from a fifth sensor configured to measure an upstream air temperature of the air stream, $T_{upstream}$, said fifth input signal comprising the measured upstream air temperature, $T_{upstream}$,
  receiving, in processing circuitry, a sixth input signal from a sixth sensor configured to measure an upstream air water content parameter, $wc_{upstream,}$ of the air stream, said sixth input signal comprising the measured upstream air water content parameter, $wc_{upstream}$,

- determining the first function f_1 based on the received parameters as

$$(T_{change}, wc_{change}) = f_1(T_{medium}, wc_{medium}, T_{air}, wc_{air}, f_2(T_{air}, wc_{air}), T_{upstream}, wc_{upstream}).$$

~~26.~~15. Method according to any of claims ~~21-25~~10-14, further comprising

- determining the first function f1 based on the received parameters and on at least one predetermined contact device parameter, cd, of a contact device as

$$(T_{change}, \omega c_{change}) = f_1(T_{medium}, \omega c_{medium}, T_{air}, \omega c_{air}, f_2(T_{air}, \omega c_{air}), cd)$$

~~27. Method according to claim 26, wherein said contact device parameter, cd, is a mass flow of the air stream or a mass flow of the medium through the contact device, or said contact device parameter, cd, alternatively is a back pressure.~~

~~28. Method according to any of claims 21-27, further comprising~~

~~- determining the first function f_1, using at least one proportional-integral-derivative controller, PID.~~

~~29. Method according to any of claims 21-27, further comprising~~

~~- determining the first function f_1, using a linear-quadratic regulator, LQR.~~

~~30. Method according to any of claims 21-27, further comprising~~

~~- determining the first function f_1, using model predictive control, MPC.~~