Equipment for supplying chilled fluid for an air conditioning installation and air conditioning installation with said equipment

Equipment (1) for supplying chilled fluid to an installation (100) for air conditioning an environment (2) comprises means (6) for supplying chilled liquid at a first temperature \( T_1 \) to radiant panels (7), in which the value of the first temperature \( T_1 \) is such that the temperature of the inner surfaces of the environment (2) is kept above the dew point \( T_{dw} \) of the air present in the environment (2). The equipment (1) also comprises second supply means (8) for supplying chilled fluid at a second temperature \( T_2 \) to a heat exchange element (9) positioned within the environment (2), in which the value of the second temperature \( T_2 \) is such that the temperature of the heat exchange surface of the heat exchange element (9) is kept below the dew point \( T_{de} \).
Description

[0001] The present invention relates to equipment for supplying chilled fluid for an air conditioning installation according to the preamble of Claim 1.

[0002] Air conditioning installations are known in the relevant art and are commonly used for air conditioning in the winter.

[0003] Radiant panel air conditioning installations are increasingly popular and commonly consist of equipment for supplying chilled liquid, or a chiller unit, having a water chiller, a pump and a set of pipes for distributing the water or other chilled liquid to one or more panels which form the terminal units for heat exchange with the environment.

[0004] Radiant panels are typically spiral-shaped and can be embedded in the floor, in the walls or in the ceiling of the environment to be air-conditioned, so as to be completely invisible and allow the space normally occupied by conventional environmental terminals to be used more satisfactorily for interior design. Furthermore, the larger heat exchange surface produces greater comfort.

[0005] In air conditioning in the winter, radiant panels can use water at a lower temperature (35°C) than that used in a conventional radiator (60-90°C), resulting in greater efficiency of the heat sources used that can be used, such as heat pumps and condensing boilers.

[0006] In summer air conditioning, the use of radiant panels gives rise to a problem: if the temperature of the floor, walls or ceiling falls below the dew point of the air present in the environment, said air reaches saturation point, leading to the formation of condensation. Clearly, the presence of condensation and moist surfaces in the air conditioned environment is extremely unpleasant for the user.

[0007] To overcome this drawback, it was proposed to use a temperature controller connected to one or more temperature and humidity sensors located in the environment to be air-conditioned, and to control valves located in the fluid circuit. In particular, the temperature controller is set to keep the temperature of the water circulating in the panels sufficiently high to prevent the formation of condensation in the environment to be air-conditioned.

[0008] However, in summer air conditioning, the aforesaid solution does not remove the excess humidity present in the environment to be air conditioned. Indeed, it should be noted that, in order for comfortable conditions to be present, the latent heat exchange, in other words the removal of water vapour from the air by condensation, should constitute 20-25% of the total exchanged power. To overcome this drawback, a radiant panel installation has been proposed which is combined with a dehumidifier intended to remove a certain quantity of humidity from the treated air so as to bring the air conditioned environment into the comfort conditions which are ideal not only in thermal terms but also in terms of moisture content.

Typically, a dehumidifier consists of a refrigerating circuit and a fan, both housed in a one-piece casing. The fan draws air from the environment at a certain temperature and sends it to an evaporating unit where the air is cooled and gives up some of its humidity by condensation of the water vapour on the cold surface of the heat exchanger. The cooled and dehumidified air then passes through a condensing unit which returns the air, slightly heated, to the environment. A dehumidifier therefore reduces the humidity but also heats the air which is reintroduced into the environment.

[0010] To oppose this effect of heating the air by the dehumidifier it is necessary to increase the capacity of the refrigerating unit supplying the radiant panels, and the radiant panels themselves, to a power equal to the electrical power absorbed by the compressor of the dehumidifier.

[0011] The aforesaid solution reduces the problems of the heating of the air by the dehumidifier, but causes an unacceptable increase in the costs of fitting the air conditioning installation, especially in the case of installations for domestic use. It should also be noted that the power per unit of surface area which can be given up by the radiant panel to the environment is limited by the typical heat transfer coefficients of the walls in which the panels are fitted, and also by the furnishings located adjacent to these walls.

[0012] The object of the present invention is therefore to propose an equipment for supplying chilled fluid to an installation for air conditioning of an environment, this equipment having structural and functional characteristics such that they meet the aforesaid requirements while simultaneously overcoming the drawbacks encountered in the prior art.

[0013] This object is achieved by the equipment for supplying chilled fluid to an air conditioning installation according to Claim 1.

[0014] In a further aspect, this object is achieved by an installation for air conditioning of environments according to Claim 13.

[0015] Further characteristics and advantages of the equipment and the installation according to the present invention will be made clear by the following description of a preferred example of embodiment, provided solely for guidance and without restrictive intent, with reference to the attached figures, in which:

- Figure 1 shows a first embodiment of an equipment according to the present invention,
- Figure 2 shows a second embodiment of an equipment according to the present invention,
- Figure 3 shows a third embodiment of an equipment according to the present invention, and
- Figure 4 shows a diagram of an installation which uses the equipment according to the present inven-
With reference to the attached figures, the number 1 indicates the whole of equipment for supplying chilled fluid to an installation 100 for air conditioning one or more environments, for example the environment 2 shown in Figure 4.

Each environment 2 is delimited by a plurality of structural elements (not shown in the figures) having corresponding inner surfaces inwardly facing said environment 2.

Typically, the structural elements of the environment 2 comprise a floor, a ceiling and a plurality of lateral walls.

The equipment 1 comprises first supply means for supplying a chilled liquid, for example water, at a first temperature $T_1$ to a fluid circuit for radiant panels 7 housed within at least one of the structural elements of the environment 2 to exchange heat with said environment 2 through the corresponding inner surface.

To simplify the description of the present invention, reference will be made below to the case in which the radiant panels 7, which are known and are therefore not described more fully, are housed within the lateral walls of the environment 2. Alternatively, the radiant panels 7 can be fitted in the ceiling or in the floor, or in both of these.

To prevent the formation of condensation on the inner surfaces of the structural elements in which the radiant panels are housed, the first temperature $T_1$ is set at a value such that the temperature of these inner surfaces is held above the dew point $T_{dr}$ of the air present in the environment 2.

In order to remove excess humidity present in the environment 2, the equipment 1 comprises second supply means for supplying a chilled fluid, which may be liquid or gas, at a second temperature $T_2$ to a heat exchange element 9 positioned within the environment 2 and having a heat exchange surface 9a designed to exchange heat with the environment 2. In particular, the second temperature $T_2$ is set to a value such that the heat exchange surface is held at a temperature below the dew point $T_{de}$ of the air treated by said heat exchange element 9. Consequently, the second means for supplying a fluid at the temperature $T_2$ can be used to supply a heat exchange element 9 in such a way as to condense the water vapor present in the air treated by it, thus appropriately dehumidifying the environment 2.

The first temperature $T_1$ is selected taking into consideration the thermal resistance of the walls in which the radiant panels 7 are fitted.

For example, the chilled liquid can be delivered to the radiant panels at a temperature $T_1$ of 18°C and to the heat exchange element 9 at a temperature $T_2$ of 7°C.

It should be noted that the first temperature $T_1$ can be lower than the dew point $T_{de}$ of the air present in the environment 2, while the temperature of the inner surfaces of the walls is nevertheless kept above the dew point $T_{dr}$ of the air present in the environment 2. This is because it is necessary to take into consideration the thermal resistance $C_w$ of the walls in which the radiant panels 7 are housed.

For example, if the environment 2 is at a temperature of 28°C with a relative humidity of 65%, the dew point $T_{dr}$ of the air present in the environment 2 is 20.8°C. In this case, supplying fluid at a temperature $T_1$ of 18°C to the radiant panels 7 enables the temperature of the inner surfaces of the peripheral structural elements to be kept above 20.8°C.

If the heat exchange element 9 is intended to treat air outside the environment 2, the second temperature $T_2$ has to be lower than the dew point $T_{de}$ of the air outside, regardless of the dew point $T_{dr}$ of the air present in the environment 2.

On the other hand, if the heat exchange element 9 is intended to treat the air in the environment 2, for example in the case of recirculated air, the second temperature $T_2$ has to be lower than the dew point $T_{de}$ of the air in said environment 2.

In all cases, the temperature $T_1$ of the liquid supplied to the fluid circuit for the radiant panels 7 is higher than the temperature $T_2$ of the fluid supplied to the heat exchange element 9 which acts as a dehumidifier.

The heat exchange element 9 is advantageous for its particular heat exchange surface, or in other words the direct expansion terminal, of a fan coil unit which is fitted in the wall or false ceiling of the environment 2 to supplement the system of radiant panels 7, and which is supplied by the equipment 1 with a liquid at the temperature $T_2$, for example 7°C.

Alternatively, the heat exchange element 9 can be the heat exchange element of a condenser unit in which the direct expansion terminal is fitted in the environment 2 and is supplied by the equipment 1 with a gas at the temperature $T_2$. In this case, the temperature $T_2$ of the gas of the condenser unit can be kept slightly lower than the temperature $T_{de}$ selected for the fluid supply of a fan coil unit. For example, the gas can be supplied at a temperature $T_2$ of 5°C. An advantage of this different embodiment is found in the fact that the connecting lines between the equipment 1 and the heat exchange element 9 supplied with gas have a smaller diameter than in the case in which the exchange element is supplied with liquid, and therefore their installation in the building works of the environment 2 is less obtrusive.

In a first embodiment (Figure 1), the first supply means comprise a first chiller module 6 for supplying the chilled liquid at the first temperature $T_1$ to the radiant panels 7, and the second supply means comprise a second chiller module 8 for supplying the chilled fluid at the second temperature $T_2$ to the heat exchange element 9.

The two chiller modules 6, 8 of the equipment 1 can be two independent chiller units for supplying the radiant panels and the heat exchange element, of a fan coil unit for example, each chiller unit being thermodynamically optimized to supply liquid at the temperatures $T_1$ and $T_2$ respectively.
In an alternative embodiment as shown in Figure 2, the equipment 1 comprises a casing 10 housing the two chiller modules 6, 8, a first delivery connection 11 for supplying the chilled liquid at the first temperature $T_1$ to the radiant panels and a first return connection 12 for receiving the liquid from the radiant panels, a second delivery connection 13 for supplying the chilled fluid at the second temperature $T_2$ to the heat exchange element 9 and a second return connection 14 for receiving the fluid from the heat exchange element 9.

Essentially, the equipment 1 takes the form of a single unit having a casing 10 housing the two chiller modules 6, 8, each of which can in turn be housed in a corresponding casing (not shown in the figures).

It should be noted that the ratio between the thermal output required to supply the radiant panels and that required for the heat exchange element is not constant, but varies according to the type of installation. Consequently, the embodiment described above is particularly advantageous in that it enables two independent chiller modules with different outputs to be housed in the same casing, with the provision of a single electrical power supply and, as indicated by the rest of the description, a single control logic.

The two chiller modules 6, 8 may have the same dimensions in plan view and may be provided with suitable fixing means so that chiller modules with different outputs can be combined according to the requirements of the user.

For example, for any given output of the chiller module 6 supplying the radiant panels 7, the output of the chiller module 8 supplying the heat exchange element 9 can vary if, as mentioned above, the heat exchange element 9 is intended to treat the recirculated air from the environment 2 or, at least partially, fresh air from the outside. The output is greater in the second case because the fresh air from outside, which is used to provide an air change in the air conditioned environment 2, has worse levels of temperature and humidity than in the case where the exchange element 9 only has to treat internal recirculated air.

Each module can include a compressor 15, an evaporator 16, a condenser 17, a pump 18, a thermostatic valve 19, an expansion tank 20, a water filter 21, valves 22 for the replacement of the water filter 21, and all the other typical plumbing components of chilled fluid supply modules required to reduce the installation time by comparison with the case in which these components have to be fitted separately.

The chiller module 6 for the radiant panels 7 can also include a water storage tank 23.

The heat exchange element 9 can be supplied with liquid, as shown in the attached figures, or with chilled gas, for example in a direct expansion system. In the latter case, clearly, the evaporator 16 of the chiller module 8 is omitted.

In a different embodiment, shown in Figure 3, the second supply means comprise a chiller module 8 for supplying chilled liquid at the second temperature $T_2$ to the heat exchange element 9 and the first supply means comprise a three-way valve 24 for mixing the chilled liquid supplied by the chiller module 8 at the second temperature $T_2$ with at least some of the return liquid from the radiant panels 7 in such a way that chilled liquid at the first temperature $T_1$ is supplied to the radiant panels 7. This embodiment provides a considerable cost saving, since it requires only one chiller module, in this example the chiller module 8, capable of producing liquid at the temperature $T_2$.

For example, the three-way valve 24 can mix some of the return water from the radiant panels 7 at 23°C with some of the chilled water at 7°C supplied by the chiller module 8 to supply the heat exchange element 9, thus providing a mixture of water having the temperature of 18°C required for the supply to the radiant panels 7.

The equipment 1 can advantageously comprise processing means 25 for receiving signals, which in the example are electrical signals but can alternatively be optical signals, at radio frequency or similar, representing the value $T_1$ of the temperature of the environment 2 and the value $T_{dp}$ of a temperature set by the user. In particular, the processing means 25 can process the two values of temperature $T_1$ and humidity $D_e$ of the environment 2, in order to determine the value of the dew point $T_{dp}$ of the environment 2 and process this value of the dew point $T_{dp}$ of the environment 2 and the temperature value set by the user $T_{sp}$ to determine a value of the first temperature $T_1$ of the supply to the radiant panels 7, above the dew point $T_{dp}$, and a value of the second temperature $T_2$ of the supply to the heat exchange element 9, below the dew point $T_{dp}$.

In the example shown in Figure 45, the values of temperature $T_1$, $T_{sp}$ and humidity $D_e$ are detected by one or more sensor means 26 fitted within each environment 2.

The processing means 25 can also process the value of the temperature $T_1$ and humidity $D_e$ outside the environment 2 to determine the value of the dew point $T_{dp}$ of the outside air and process this value of the dew point $T_{dp}$ of the outside air and the value of the temperature set by the user $T_{sp}$ to determine a value of the second temperature $T_2$ of the supply to the heat exchange element 9, below the dew point $T_{dp}$ of the outside air.

In the example shown in Figure 4, the values of temperature $T_e$ and humidity $D_e$ are detected by one or more sensor means 27 fitted outside the environments.

The processing means 25 can also process the values of the temperature of the fluid delivered by and returning to the supply means 6, 8 and the values of temperature in the delivery to the radiant panels 7, to determine the values of the temperatures $T_1$ and $T_2$ of the supplies of the supply means 6 and 8 respectively.

In the example shown in Figure 4, the temper-
ature values of the fluid delivered by and returning to the supply means 6 and 8 are detected by sensor means 28, 29 and 30, 31 respectively, and the temperature values of the delivery to the two radiant panels 7 are detected by sensor means 32, 33.

[0050] The processing means 25 are, for example, a logical processing unit of a known type, which is therefore not described more fully.

[0051] The equipment 1 can also comprise actuating means (not shown in the figures) for actuating the first supply means 6 to supply chilled liquid at the first temperature $T_1$ determined by the processing means 25, and for actuating the second supply means 8 to supply chilled fluid at the second temperature $T_2$ determined by the processing means 25.

[0052] If there is a plurality of environments, the processing means 25 can receive signals representing the values $T_r$, $D_r$ of the temperature and humidity of the environments 2 and the value $T_{sp}$ of the temperature set by the user, and can process these values $T_r$, $D_r$, $T_{sp}$ to determine a plurality of optimal temperature values for the supply to the radiant panels for each of the environments 2. The processing means 25 then process these optimal temperature values of the supply to the radiant panels, in order to determine the value of the temperature $T_l$ of the liquid to be supplied by the first supply means 6.

[0053] Finally, the actuating means actuate the first supply means 6 to make them supply chilled liquid at this first temperature $T_1$ determined by the processing means 25.

[0054] In summer operation, the first temperature $T_1$ is the lowest temperature of the plurality of optimal temperature values of the supply to the radiant panels, while in winter operation this temperature $T_1$ is the highest temperature of said plurality of optimal temperature values of the supply to the radiant panels.

[0055] The following text describes an example of application of the equipment 1 to an installation 100 for air conditioning a plurality of environments 2, each having the characteristics described above.

[0056] The installation 100 comprises fluid circuits for radiant panels 7 housed within at least one of the structural elements to exchange heat with the corresponding environment 2 through the corresponding inner surfaces, and equipment, in this example the equipment 1, for supplying chilled fluid, having first supply means 6 for supplying a chilled liquid at a first temperature $T_1$ to the fluid circuits for radiant panels 7, the value of said first temperature $T_1$ being such that the temperature of the corresponding inner surfaces is kept above the dew point $T_{de}$ of the air present in the corresponding environments 2.

[0057] The installation 100 also comprises heat exchange elements 9 positioned within each environment 2 and having corresponding heat exchange surfaces intended to exchange heat with the corresponding environments 2. The equipment 1 also comprises second supply means 8 for supplying a chilled fluid at a second temperature $T_2$ to the heat exchange elements 9, the value of the second temperature $T_2$ being such that the temperature of the heat exchange surfaces is kept below the dew point $T_{de}$ of the air treated by the corresponding heat exchange element 9.

[0058] Advantageously, the equipment 1 comprises processing means 25 of the type described above to receive signals representing the values $T_r$, $T_{sp}$ of the temperature of each environment 2, the value $T_{de}$ of a temperature set by the user and the value $D_r$, $D_{sp}$ of the humidity of each environment 2, to process the values of temperature $T_r$, $T_{sp}$ and humidity $D_r$, $D_{sp}$ to determine a plurality of optimal values of temperature of the supply to the radiant panels 7 and to the heat exchange elements 9 for each environment 2, and to process this plurality of optimal values of temperature to determine the value of the first temperature $T_1$ and the second temperature $T_2$.

[0059] The equipment also comprises the actuating means described above for actuating the first supply means 6 to supply chilled liquid at the first temperature $T_1$ determined by the processing means 25, and the second supply means 8 to supply chilled fluid at the second temperature $T_2$ determined by the processing means 25.

[0060] Advantageously, for each environment 2, the installation 100 comprises a three-way valve 34 for mixing the chilled liquid supplied by the first supply means 6 at the first temperature $T_1$ with at least some of the return liquid from the radiant panels 7 of the environment 2, to supply chilled liquid to the radiant panels 7 at the optimal temperature of the supply to the radiant panels determined by the processing means 25.

[0061] In the example in Figure 3, the three-way valve 34 corresponds to the valve 24, while in the examples shown in Figures 1 and 2 a three-way valve has to be provided for each radiant panel 7.

[0062] The installation 10 also comprises, for each radiant panel 7, a pump 35 which supplies chilled liquid to the radiant panels 7 at a sufficient pressure.

[0063] A further three-way valve 36 can be provided for mixing the chilled fluid supplied to the heat exchange element 9.

[0064] It is also possible to provide a manifold 37 connected to the supply means 6 and to the radiant panels 7, in order to supply a plurality of radiant panels 7.

[0065] The control of the installation 100 is preferably of the type having a plurality of independent environments. An example of temperature and humidity control of a plurality of independent environments conditioned by the installation 100 is described below.

[0066] In a first environment, for example the daytime living area of a house, there is fitted a wall-mounted control panel with an ambient temperature sensor, on which the user can use a keypad to specify the set point value of the desired ambient temperature. According to this set point value, the three-way valve, actuated by the processing means, for example a microprocessor logic unit, incorporated in the equipment 1, creates a suitable mixture of the water produced by equipment 1 with the
return water from the radiant panel circuit of the environment 2, to achieve the optimal supply temperature for the panels, according to a compensation algorithm which can also include the outside temperature and the ambient humidity.

[0067] For example, in winter operation, the compensation algorithm is such that the panel supply temperature rises with a rise in the desired ambient temperature and with a fall in the outside temperature, while in summer operation the panel supply temperature rises with a rise in the dew point (which is a function of temperature and humidity) to prevent condensation formation.

[0068] The control of the heat exchange elements, for example the fan coil units, is active only in summer mode, for dehumidification, and can be provided in the following way: the wall-mounted control panel includes an ambient humidity sensor; the microprocessor incorporated in the equipment 1 compares the measured humidity with the desired humidity setpoint, specified by the user by means of the keypad on the wall-mounted panel, and sends an appropriate on or off signal to the fan coil unit to ensure that the desired humidity is maintained.

[0069] Preferably, the off signal is sent not only when the desired humidity has been reached, but also when, independently of the humidity, the temperature of the environment falls below a critical value for comfort, in order to prevent phenomena of sub-cooling of the environment. Essentially, temperature control has priority over humidity control.

[0070] After calculating the optimal temperatures of the water supplied to the panels of the individual environments, the microprocessor causes the first radiant panel supply means to produce water at the highest temperature in winter and at the lowest temperature in summer.

[0071] The microprocessor also causes the second supply means for the fan coil units, which are active only in summer mode, to produce water at an optimal temperature for dehumidification, for example 7°C (which can also be specified by the user), activating the fan coil units when at least one of the environments requires dehumidification. In a separate environment, for example the night-time area of a residence, the components and functions described above for the first environment are duplicated. A variant which simplifies the control process consists in having multi-zone control for the radiant panels but a single-zone control for the fan coil units.

[0072] As indicated by the above description, the equipment for supplying chilled fluid to an air conditioning installation according to the present invention makes it possible to meet the requirements and overcome the drawbacks referred to in the introductory part of the present description with reference to the prior art. Clearly, a person skilled in the art can make numerous modifications and variations to the equipment according to the invention described above, in order to meet contingent and specific requirements, all such modifications and variations being contained within the scope of protection of the invention as defined in the following claims.

Claims

1. Equipment (1) for supplying chilled fluid to an installation (100) for air conditioning of one or more environments (2), each delimited by a plurality of structural elements having corresponding inner surfaces inwardly facing the corresponding environment (2), said equipment (1) being characterized in that it comprises:

- first supply means (6) for supplying a chilled liquid at a first temperature (T1) to a hydraulic circuit for radiant panels (7) housed within at least one of said structural elements to exchange heat with said environment (2) through the corresponding inner surface, the value of said first temperature (T1) being such as to keep the temperature of said corresponding inner surface above the dew point (T_{dew}) of the air present in said environment (2), and

- second supply means (8) for supplying a chilled fluid at a second temperature (T2) to a heat exchange element (9) positioned within said environment (2) and having a heat exchange surface intended to exchange heat with said environment (2), the value of said second temperature (T2) being such as to keep the temperature of the heat exchange surface below the dew point (T_{dew}) of the air treated by the heat exchange element (9).

2. Equipment (1) according to Claim 1, in which said first temperature (T1) is lower than the dew point (T_{dew}) of the air present in said environment (2).

3. Equipment (1) according to Claim 1 or 2, in which said heat exchange element (9) is intended to treat the air of said environment (2), said second temperature (T2) being lower than the dew point (T_{dew}) of the air in said environment (2).

4. Equipment (1) according to Claim 1 or 2, in which said heat exchange element (9) is intended to treat air outside said environment (2), said second temperature (T2) being lower than the dew point (T_{dew}) of said air outside said environment (2).

5. Equipment (1) according to any one of Claims 1 to 4, in which said first temperature (T1) is higher than said second temperature (T2).

6. Equipment (1) according to any one of Claims 1 to 5, in which said first supply means comprise a first chiller module (6) for supplying the chilled liquid at the first temperature (T1) and said second supply
means comprise a second chiller module (8) for supplying said chilled fluid at the second temperature (T₂).

7. Equipment (1) according to Claim 6, comprising a casing (10) for housing said first (6) and second (8) chiller modules, a first delivery connection (11) for supplying the chilled liquid at the first temperature (T₁) to the radiant panels (7) and a first return connection (12) for receiving the liquid from the radiant panels (7), a second delivery connection (13) for supplying the chilled fluid at the second temperature (T₂) to the heat exchange element (9) and a second return connection (14) for receiving the fluid from the heat exchange element (9).

8. Equipment (1) according to any one of Claims 1 to 5, in which said second supply means comprise a chiller module (8) for supplying chilled liquid at the second temperature (T₂) to the heat exchange element (9) and said first supply means comprise a three-way valve (24) for mixing at least some of the chilled liquid supplied by said chiller module (8) at the second temperature (T₂) with at least some of the return liquid from said radiant panels (7) to supply chilled liquid at the first temperature (T₁) to said radiant panels (7).

9. Equipment (1) according to any one of Claims 1 to 8, comprising:

- processing means (25) for:

  - receiving signals representing the value (Tᵣ) of the temperature of the environment (2) and the value (Tₛᵦ) of a temperature set by user,
  - processing the two values of temperature (Tᵣ) and humidity (Dᵣ) of the environment (2) to determine the value of the dew point (Tᵣₑ) of the environment (2), and
  - processing said value of the dew point (Tᵣₑ) of the environment (2) and the value of the temperature set by user (Tₛᵦ) to determine the value of said first temperature (T₁) and the value of said second temperature (T₂),

- and actuating means for actuating the first supply means (6) to supply chilled liquid at the first temperature (T₁) determined by the processing means (25), and for actuating the second supply means (8) to supply chilled fluid at the second temperature (T₂) determined by the processing means (25).

10. Equipment (1) according to Claim 9, in which said processing means (25) are suitable for:

- receiving signals representing the values of the temperature (Tᵣ), humidity (Dᵣ), and temperature set by user (Tₛᵦ) of a plurality of environments (2) and the value (Tₛᵦ) of a temperature set by user,
- processing said values (Tᵣ, Dᵣ, Tₛᵦ) to determine a plurality of optimal values of temperature of supply to the radiant panels for each of said plurality of environments (2), and
- processing said plurality of optimal values of temperature of supply to the radiant panels to determine the value of said first temperature (T₁), said actuating means actuating said first supply means (6) to supply chilled liquid at said first temperature (T₁) determined by said processing means (25).

11. Equipment (1) according to Claim 10, in which, in summer operation, said first temperature (T₁) is the lowest of said plurality of optimal values of temperature of supply to the radiant panels.

12. Equipment (1) according to Claim 10 or 11, in which, in winter operation, said first temperature (T₁) is the highest of said plurality of optimal values of temperature of supply to the radiant panels.

13. Installation (100) for air conditioning one or more environments (2), each environment (2) being delimited by a plurality of structural elements having corresponding inner surfaces inwardly facing the corresponding environment (2), said installation (100) being characterized in that it comprises:

- hydraulic circuits for radiant panels (7) housed within at least one of said structural elements to exchange heat with the corresponding environment (2) through the corresponding inner surfaces,
- heat exchange elements (9) positioned within each environment (2) and having corresponding heat exchange surfaces intended to exchange heat with the corresponding environments (2),
- an equipment (1) for supplying chilled fluid, having first supply means (6) for supplying a chilled liquid at a first temperature (T₁) to said hydraulic circuits for radiant panels (7), the value of said first temperature (T₁) being such as to keep the temperature of said corresponding inner surfaces above the dew point (Tᵣₑ) of the air present in the corresponding environments (2), and second supply means (8) for supplying a chilled fluid at a second temperature (T₂) to the heat exchange elements (9), the value of the second temperature (T₂) being such as to keep the temperature of said heat exchange surfaces below the dew point (Tᵣₑ) of the air treated by the corresponding heat exchange element (9).
14. Installation (100) according to Claim 13, in which said equipment (1) additionally comprises:

- processing means (25) for:
  - receiving signals representing the values \(T_r\) of the temperature of each environment (2), the value \(T_{sp}\) of a temperature set by user, and the value \(D_r\) of the humidity of each environment (2),
  - processing said values of temperature \(T_r\), \(T_{sp}\) and humidity \(D_r\) to determine a plurality of optimal values of temperature of supply to the radiant panels (7) and to the heat exchange elements (9) for each environment (2),
  - processing said plurality of optimal values of temperature of supply to determine the value of said first temperature \(T_1\) and said second temperature \(T_2\), and
  - actuating means for actuating the first supply means (6) to supply chilled liquid at the first temperature \(T_1\) determined by the processing means (25), and for actuating the second supply means (8) to supply chilled fluid at the second temperature \(T_2\) determined by the processing means (25).

15. Installation (100) according to Claim 14, comprising, for each environment (2), a three-way valve (34) for mixing the chilled liquid supplied by the first supply means (6) at the first temperature \(T_1\) with at least some of the return liquid from the radiant panels (7) of said environment (2), to supply chilled liquid to the radiant panels (2) at the optimal value of temperature of supply to the radiant panels determined by the processing means (25).
# Documents Considered to Be Relevant

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of Document with Indication, Where Appropriate, of Relevant Passages</th>
<th>Relevant to Claim</th>
<th>Classification of the Application (IPC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 3 399 905 A (GETTMANN ET AL) 24 February 1976 (1976-02-24) * column 1, line 53 - column 4, line 50; figures 1-4</td>
<td>1,3,13</td>
<td>INV. F24F13/22 F24F5/00</td>
</tr>
<tr>
<td>X</td>
<td>US 3 102 399 A (MECKLER GERSHON) 3 September 1963 (1963-09-03) * column 5, line 14 - column 7, line 60; claims 1,13; figure 1</td>
<td>1,4,13</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US 3 782 132 A (LOHOF H, DT) 1 January 1974 (1974-01-01) * column 7, line 62 - column 8, line 11</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US 5 267 450 A (TAKEGAWA ET AL) 7 December 1993 (1993-12-07) * the whole document</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

The present search report has been drawn up for all claims.

**Category of Cited Documents**

- T: theory or principle underlying the invention
- E: earlier patent document, but published on, or after the filing date
- D: document cited in the application
- L: document cited for other reasons
- O: non-writtten disclosure
- P: intermediate document
- X: particularly relevant if taken alone
- Y: particularly relevant if combined with another document of the same category
- A: technological background
- S: member of the same patent family, corresponding document

---

Place of Search: Munich
Date of Completion of the Search: 7 June 2006
Examiner: Lienhard, D
This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-06-2006

<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AT 430973 A</td>
<td>15-03-1975</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BE 799664 A1</td>
<td>17-09-1973</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH 572599 A5</td>
<td>13-02-1976</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 2224242 A1</td>
<td>29-11-1973</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 414839 A1</td>
<td>01-02-1976</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2184956 A1</td>
<td>28-12-1973</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 1439178 A</td>
<td>09-06-1976</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IT 984763 B</td>
<td>29-11-1974</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NL 7306891 A</td>
<td>20-11-1973</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 7303333 A</td>
<td>24-04-1974</td>
</tr>
<tr>
<td>US 3102399 A</td>
<td>03-09-1963</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 3782132 A</td>
<td>01-01-1974</td>
<td>DE 2128331 A1</td>
<td>04-01-1973</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 7203116 A</td>
<td>28-02-1973</td>
</tr>
<tr>
<td>US 5267450 A</td>
<td>07-12-1993</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>WO 2004020913 A</td>
<td>11-03-2004</td>
<td>AU 2003264871 A1</td>
<td>19-03-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1535000 A1</td>
<td>01-06-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2075478 A1</td>
<td>25-08-1991</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 9113294 A1</td>
<td>05-09-1991</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0516674 A1</td>
<td>09-12-1992</td>
</tr>
</tbody>
</table>

For more details about this annex: see Official Journal of the European Patent Office, No. 12/82