

Claims

1. Method for operating a data centre at a power utility efficiency PUE of at most 1.3 comprising:
 - (i) a building for housing a multiplicity of racks (202), each rack being an open rack housing IT equipment,
 - (ii) the racks (202) being an open rack housing IT equipment (200)
 - (iii) the racks (202) comprise heat exchanging means (206, 207) being adapted to transfer the heat generated by the IT equipment to a fluid coolant, said heat exchanging means being an element of the racks or an element attached to the racks, preferably being located at the back side or element of the racks,
 - (iv) at least one first cooling circuit (203/204), said cooling circuit being a closed cooling circuit, which is adapted to supply the heat exchanging means (206, 207) of the racks (202) with a fluid coolant and is further adapted to convey the heated coolant away from the heat exchanging means (206, 207) of the racks (202) through the reflux of the cooling circuit,
 - (v) said first cooling circuit (203/204) being connected to a source providing coldness, said source being located outside the space housing the multiplicity of racks,
 - (vi) the IT equipment (200) located in the respective racks (202) having active means, preferably fans, for cooling parts of the IT equipment (200), preferably the CPU and/or GPU and/or a storage hardware, said active means creating an air flow (205) in the rack (202) towards the heat exchanging means (206, 207) being an element of the racks or an element attached to the racks, preferably being located at the back side or element of the racks (202),
 - (vii) said racks (202) having no other active means, in particular fans, except for those contained within the aforementioned IT equipment (200), for creating an air flow (205) in the rack (202) towards the heat exchanging means (206, 207) being an element of the racks or an element attached to the racks, preferably being located at the back side or element of the racks (202),

- (viii) said building for housing the multiplicity of racks (202) comprising no other active means, except for those contained within the aforementioned IT equipment (200), for creating an guided air flow,
- (ix) at least one electrical power input,
- (x) at least one mean for distributing the electrical power from the power input to the individual racks, allowing redundant power supplies in every rack,

comprising the measures

- (a) providing a fluid coolant from the source providing coldness to the heat exchanging means (206, 207) of the racks (202) within the first cooling circuit, said fluid coolant input flow entering the heat exchanging means (206, 207) having a temperature of 1K to 5K, preferably 1K to 3K, most preferred 1K to 2K, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202),
- (b) controlling the fluid coolant flow within the first cooling circuit (203, 204) which is adapted to supply the heat exchanging means (206, 207) of the racks (202) to maintain the temperature of fluid coolant entering the heat exchanging means (206, 207) of the racks (202) (input flow) having a temperature of 1K to 5K, preferably 1K to 3K, most preferred 1K to 2K, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202),
- (c) conveying the heated fluid coolant leaving the heat exchanging means (206, 207) of the racks (202) (return flow) to the source providing coldness, said source being located outside the space housing the multiplicity of racks, to remove the heat from the heated fluid coolant to a temperature of 1K to 5K, preferably 1K to 3K, most preferred 1K to 2K, below the temperature of the fluid coolant return flow and returning the fluid coolant to the at least one first cooling circuit and
- (d) the method for operating the data centre does not operate any additional air conditioners as the cooling function is completely taken over by the heat exchanging units of the racks.

2. The method as claimed in claim 1, wherein the power density of the IT equipment in the racks being at least 5kW (electrical) per rack, more preferred at least 8kW (electrical) per rack, most preferred at least 10kW (electrical) per rack.

3. The method as claimed in claim 1, wherein the racks (202) being arranged as two dimensional arranged data centres, where the racks are locat-

ed on one level, or as three dimensional arranged data centres, where the racks (202) are located on more than one level within the data centre.

4. The method as claimed in claim 1, wherein the power density of the IT equipment (200) installed and operating within the racks (202) creates a volumetric heat dissipation rate which corresponds to least about 5kW/m^2 , preferably to least about 10kW/m^2 , most preferred to least about 20kW/m^2 .

5. The method as claimed in claim 1, wherein the room temperature of the space housing the multiplicity of racks (202) is about $+2\text{K}$, preferably $+1\text{K}$, more preferably $+0.5\text{K}$, most preferred about the same, of the temperature of the return flow of the fluid coolant of the first cooling circuit.

6. The method as claimed in claim 1, wherein the source of coldness provides the back cooling through (i) external cold water sources, preferably ground or surface water, (ii) evaporation cooling which operate based on the evaporation principle, including evaporation cooling towers with or without open cooling towers, (iii) hybrid cooler or (iv) dry cooler.

7. The method as claimed in claim 1, wherein the fluid coolant entering the data centre for cooling via the at least one cooling circuit has temperature at most 0.2K below the temperature of the fluid coolant entering the heat exchanging means (206, 207).

8. The method as claimed in claim 1, wherein the temperature of the return flow of the fluid coolant of the first cooling circuit being at most 3K , preferably at most 2K , most preferred at most 1K , above the temperature supplied by the source of coldness entering the data centre for total power densities of up to 10kW (electrical) per rack or wherein the temperature of the return flow of the fluid coolant of the first cooling circuit being at most 4K , preferably at most 3K , above the temperature supplied by the source of coldness entering the data centre for total power densities of at least 10kW (electrical) per rack.

9. The method as claimed in claim 1, wherein the method for operating the data centre does not have any other active means, in particular fans, for creating an air flow (205) in the rack towards the heat exchanging means except for such active means being present in the IT equipment located in the rack.

10. The method as claimed in claim 1, wherein the active means, in particu-

lar fans, being present in the IT equipment (200) create an air flow (205) in the rack towards the heat exchanging means which corresponds to an air volume current of 100 to 600 m³/(h*kW), which corresponds to at least 0.5 m/s, preferably of at least 0.8 m/s, in particular of at least 1.1m/s.

11. The method as claimed in claim 1, wherein the active means, in particular fans, being present in the IT equipment (200) create an air flow (205) in the rack towards the heat exchanging means which create an air back pressure by the heat exchanger corresponding to maximum 10Pa for air flow rate corresponding of up to 0.5 m/s, preferably maximum 16Pa for air flow rate corresponding of up to 0.8 m/s, more preferred maximum 20Pa for air flow rate corresponding of up to 1.1 m/s.

12. The method as claimed in claim 1, wherein the pressure drop across the heat exchanger is set below 22kPa for a volume current of 3m³/h for fluid coolant, preferably water, preferably below 54kPa for 5m³/h for fluid coolant, preferably water, most preferred below 200kPa for 10 m³/h for fluid coolant, preferably water.

13. The method as claimed in claim 1, wherein the flow rate for the fluid coolant, preferably water, is set from 0.9m³ per hour and per kW installed and operating for a difference of 1K and to 0.17m³ per hour and per kW installed and operating for a difference of 5K.

14. The method as claimed in claim 1, wherein the temperature of the fluid coolant entering the heat exchanging means (206, 207) is adjusted to 0.1 to 0.5K per kW installed and operating per Rack not exceeding 10kW per Rack, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202) or wherein the temperature of the fluid coolant entering the heat exchanging means (206, 207) is adjusted to 0.1 to 0.2K per kW installed and operating per Rack amounting between 10kW and 25 kW per Rack, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202), or wherein the temperature of the fluid coolant entering the heat exchanging means (206, 207) is adjusted to 0.1 to 0.125K per kW installed and operating per Rack amounting to above 25 kW per Rack, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202).

Claims

1. Method for operating a data centre at a power utility efficiency PUE of at most 1.3 comprising:
 - (i) a building for housing a multiplicity of racks (202), each rack being an open rack housing IT equipment,
 - (ii) the racks (202) being an open rack housing IT equipment (200)
 - (iii) the racks (202) comprise heat exchanging means (206, 207) being adapted to transfer the heat generated by the IT equipment to a fluid coolant, said heat exchanging means being an element of the racks or an element attached to the racks, preferably being located at the back side or element of the racks,
 - (iv) at least one first cooling circuit (203/204), said cooling circuit being a closed cooling circuit, which is adapted to supply the heat exchanging means (206, 207) of the racks (202) with a fluid coolant and is further adapted to convey the heated coolant away from the heat exchanging means (206, 207) of the racks (202) through the reflux of the cooling circuit,
 - (v) said first cooling circuit (203/204) being connected to a source providing coldness, said source being located outside the space housing the multiplicity of racks,
 - (vi) the IT equipment (200) located in the respective racks (202) having active means, preferably fans, for cooling parts of the IT equipment (200), preferably the CPU and/or GPU and/or a storage hardware, said active means creating an air flow (205) in the rack (202) towards the heat exchanging means (206, 207) being an element of the racks or an element attached to the racks, preferably being located at the back side or element of the racks (202),
 - (vii) said racks (202) having no other active means, in particular fans, except for those contained within the aforementioned IT equipment (200), for creating an air flow (205) in the rack (202) towards the heat exchanging means (206, 207) being an element of the racks or an element attached to the racks, preferably being located at the back side or element of the racks (202),

- (viii) said building for housing the multiplicity of racks (202) comprising no other active means, except for those contained within the aforementioned IT equipment (200), for creating an guided air flow,
- (ix) at least one electrical power input,
- (x) at least one mean for distributing the electrical power from the power input to the individual racks, allowing redundant power supplies in every rack,

comprising the measures

- (a) providing a fluid coolant from the source providing coldness to the heat exchanging means (206, 207) of the racks (202) within the first cooling circuit, said fluid coolant input flow entering the heat exchanging means (206, 207) having a temperature of 1K to 5K, preferably 1K to 3K, most preferred 1K to 2K, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202),
- (b) controlling the fluid coolant flow within the first cooling circuit (203, 204) which is adapted to supply the heat exchanging means (206, 207) of the racks (202) to maintain the temperature of fluid coolant entering the heat exchanging means (206, 207) of the racks (202) (input flow) having a temperature of 1K to 5K, preferably 1K to 3K, most preferred 1K to 2K, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202),
- (c) conveying the heated fluid coolant leaving the heat exchanging means (206, 207) of the racks (202) (return flow) to the source providing coldness, said source being located outside the space housing the multiplicity of racks, to remove the heat from the heated fluid coolant to a temperature of 1K to 5K, preferably 1K to 3K, most preferred 1K to 2K, below the temperature of the fluid coolant return flow and returning the fluid coolant to the at least one first cooling circuit and
- (d) the method for operating the data centre does not operate any additional air conditioners as the cooling function is completely taken over by the heat exchanging means of the racks.

2. The method as claimed in claim 1, wherein the power density of the IT equipment in the racks being at least 5kW (electrical) per rack, more preferred at least 8kW (electrical) per rack, most preferred at least 10kW (electrical) per rack.

3. The method as claimed in claim 1, wherein the racks (202) being arranged as two dimensional arranged data centres, where the racks are locat-

ed on one level, or as three dimensional arranged data centres, where the racks (202) are located on more than one level within the data centre.

4. The method as claimed in claim 1, wherein the power density of the IT equipment (200) installed and operating within the racks (202) creates a volumetric heat dissipation rate which corresponds to least about 5kW/m^2 , preferably to least about 10kW/m^2 , most preferred to least about 20kW/m^2 .

5. The method as claimed in claim 1, wherein the room temperature of the space housing the multiplicity of racks (202) is about $+2\text{K}$, preferably $+1\text{K}$, more preferably $+0.5\text{K}$, most preferred about the same, of the temperature of the return flow of the fluid coolant of the first cooling circuit.

6. The method as claimed in claim 1, wherein the source of coldness provides the back cooling through (i) external cold water sources, preferably ground or surface water, (ii) evaporation cooling which operate based on the evaporation principle, including evaporation cooling towers with or without open cooling towers, (iii) hybrid cooler or (iv) dry cooler.

7. The method as claimed in claim 1, wherein the fluid coolant entering the data centre for cooling via the at least one cooling circuit has temperature at most 0.2K below the temperature of the fluid coolant entering the heat exchanging means (206, 207).

8. The method as claimed in claim 1, wherein the temperature of the return flow of the fluid coolant of the first cooling circuit being at most 3K , preferably at most 2K , most preferred at most 1K , above the temperature supplied by the source of coldness entering the data centre for total power densities of up to 10kW (electrical) per rack or wherein the temperature of the return flow of the fluid coolant of the first cooling circuit being at most 4K , preferably at most 3K , above the temperature supplied by the source of coldness entering the data centre for total power densities of at least 10kW (electrical) per rack.

9. The method as claimed in claim 1, wherein the method for operating the data centre does not have any other active means, in particular fans, for creating an air flow (205) in the rack towards the heat exchanging means except for such active means being present in the IT equipment located in the rack.

10. The method as claimed in claim 1, wherein the active means, in particu-

lar fans, being present in the IT equipment (200) create an air flow (205) in the rack towards the heat exchanging means which corresponds to an air volume current of 100 to 600 m³/(h*kW), which corresponds to at least 0.5 m/s, preferably of at least 0.8 m/s, in particular of at least 1.1m/s.

11. The method as claimed in claim 1, wherein the active means, in particular fans, being present in the IT equipment (200) create an air flow (205) in the rack towards the heat exchanging means which create an air back pressure by the heat exchanger corresponding to maximum 10Pa for air flow rate corresponding of up to 0.5 m/s, preferably maximum 16Pa for air flow rate corresponding of up to 0.8 m/s, more preferred maximum 20Pa for air flow rate corresponding of up to 1.1 m/s.

12. The method as claimed in claim 1, wherein the pressure drop across the heat exchanger is set below 22kPa for a volume current of 3m³/h for fluid coolant, preferably water, preferably below 54kPa for 5m³/h for fluid coolant, preferably water, most preferred below 200kPa for 10 m³/h for fluid coolant, preferably water.

13. The method as claimed in claim 1, wherein the fluid coolant is water, the flow rate for the water is set from 0.9m³ per hour and per kW installed and operating for a difference of 1K and to 0.17m³ per hour and per kW installed and operating for a difference of 5K.

14. The method as claimed in claim 1, wherein the temperature of the fluid coolant entering the heat exchanging means (206, 207) is adjusted to 0.1 to 0.5K per kW installed and operating per Rack not exceeding 10kW per Rack, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202) or wherein the temperature of the fluid coolant entering the heat exchanging means (206, 207) is adjusted to 0.1 to 0.2K per kW installed and operating per Rack amounting between 10kW and 25 kW per Rack, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202), or wherein the temperature of the fluid coolant entering the heat exchanging means (206, 207) is adjusted to 0.1 to 0.125K per kW installed and operating per Rack amounting to above 25 kW per Rack, below the temperature of the fluid coolant return flow exiting the heat exchanging means (206, 207) of the racks (202).