Abstract:
The invention relates to a method for cooling an ICT room, which ICT room contains at least one row of continuous racks having ICT equipment that needs to be cooled, wherein: - at a long side of the row there is an aisle, - opposite the long side of the row of continuous racks there is a wall, and - above the aisle a partition element has been provided, wherein the partition element and the wall keep relatively cold cooling air below the partition element, separated from comparatively warm air above the partition element, wherein cooling air from the aisle, via a side of the row of continuous racks facing the aisle, is directed through openings in the continuous racks, in order to cool the ICT equipment to be cooled and the air heated due to the cooling exits the racks at the side of the row of continuous racks directed away from the aisle, wherein the partition element comprises a supply duct for cooling air, and cooling air is introduced into the aisle from above. The invention is characterized in that it also comprises the forming of an air curtain near at least one end of the aisle by means of an air exit opening that is connected to the supply duct for providing a seal between the aisle and the ICT-room situated outside the aisle. The invention also relates to a partition element for an ICT-room which partition element comprises an air duct.
A method for cooling an ICT room, as well as a separation element

The present invention relates to a method for cooling an ICT room, which ICT room contains at least one row of continuous, racks having ICT equipment that needs to be cooled, wherein:
- at a long side of the row there is an aisle,
- opposite the long side of the row of continuous racks there is a wall, and
- above the aisle a partition element has been provided, wherein the partition element and the wall keep relatively cold cooling air below the partition element, separated from comparatively warm air above the partition element,
wherein cooling air from the aisle, via a side of the row of continuous racks facing the aisle, is directed through openings in the continuous racks, in order to cool the ICT equipment to be cooled and the air heated due to the cooling exits the racks at the side of the row of continuous racks directed away from the aisle, wherein the partition element comprises a supply duct for cooling air, and cooling air is introduced into the aisle from above,
Such a method is known in the art. The energy expenditure of ICT rooms is very high, which is not only caused by the heat development in the ICT equipment in the ICT room, but also by the energy necessary for cooling the ICT equipment as well as by the discharge of heat from other heat sources, such as lighting. The use of a partition element reduces the energy expenditure for the cooling.

The present invention aims to provide a method that further reduces the energy expenditure for cooling.

To this end the method according to the invention is characterized in that the method also comprises the forming of an air curtain near at least one end of the aisle, by means of an air exit opening that is connected to the supply duct in order to provide a seal between the aisle and the ICT-room situated outside the aisle.

By supplying the cooling air from above, a saving of the energy costs that have to be made for supplying the cooling air is accomplished, since gravity helps moving the relatively cold cooling air that as a matter of fact has a higher specific gravity (in concreto to pass downwards). Herewith, it can be ascertained in a simple way that this cooling air is supplied along the entire height of the
aisle, and ICT equipment in the racks can be supplied with a sufficient amount of cooling air independent of the height thereof. In the present invention with the term ICT room - also called datacenter - every room is meant in which there are one or more rows with ICT equipment, the ICT equipment being selected from servers, Uninterruptable Power Supply (UPS), devices for data storage (hard disks) and circuits for telecommunication. The racks are usually 19" racks. In the present invention the term `continuous means that the racks of a row are situated against each other or are connected with each other by means of substantially airtight walls. It goes without saying that absolutely airtight is not necessary, but that any passage for cooling air not leading via the housings of the ICT equipment will in principle deteriorate the energy efficiency and should thus be avoided. Herewith, higher situated openings along which cold air can escape are worse than lower situated openings. At the side of the racks directed away from the aisle where cold air is supplied to the racks, heated cooling air exits the racks, which heated air rises and is kept separated from the cooling air by means of the partition element. The warm air may dissipate its heat via the wall of the ICT room, by active cooling or by the discharge of warm air from the ICT room. The method according to the invention can be implemented at relatively low cost, which further contributes to the economical aspect of the invention. The effective way of supplying cooling air according to the invention makes it further possible to control the cooling air supply in a simple way, namely by a measurement of the temperature difference between a point in the aisle that is situated relatively high and a point in the aisle that is situated relatively low. If this difference in temperature is greater than a desired value, the amount of cooling air supplied via the supply duct will be increased and/or the temperature of the cooling air supplied via the supply duct will be reduced until the difference in temperature has been lowered below this threshold value. Likewise, there will preferably be a lower threshold value in order to prevent too much cooling, which would be unfavourable from an economical point of view. The supply duct for cooling air, in the present invention also indicated by air duct or air supply duct, is preferably a duct in the longitudinal direction of the partition element, which permits the supply of cooling air to the aisle with little flow resistance. The wall of
the supply duct can advantageously be part of the not airtight wall from the partition element, which may accomplish a saving on material and weight.

A significant embodiment is characterized in that the wall is formed by a second row of continuous racks, and the row of continuous racks and the second row of continuous racks together constitute a double row of continuous racks, wherein the partition element extends between the double row above the aisle.

Such an arrangement is highly advantageous for the optimal use of the floor surface. In an ICT room there are usually more double rows of racks, and just like the supply sides for cooling air will be directed towards each other, the exit sides for heated cooling air will be directed towards each other. Between the rows there will thus be a (warm) aisle from which warm air will rise, which is kept separated from the cooling air by means of the partition element. The term "extends between the double row above the aisle" means both that the partition element is situated higher than the highest point of the racks and that it is situated at least partially lower than the highest point of the racks. In both cases namely the distance between both rows of racks is spanned.

As mentioned earlier, the partition element is near at least one end of the aisle arranged to provide an air curtain, such as for instance supplied by the firm Gelu-Frico (Helmond, NL) as Coolline KLS and Coolline KLS-DUO, especially to confine cold air and thereby to push away the warm air (in concrete to separate the warm air and cold air at both sides of the air curtain and to prevent at least partially mutual mixing).

An air curtain can be obtained with a (optionally horizontally and vertically adjustable) most often elongated air ventilation opening, in the technique known as air grate. This air ventilation opening may be disposed at the underside of the partition element principally above the supply opening from the ICT room towards the aisle, or at a side of that supply opening, in such a way that the air flow is supplied in the plane of that supply opening. For instance, an adjustable valve or the like can be provided in order to be able to control an air flow rate led through the opening without the necessity of an active component (a drive fan or the like). An air grate for this purpose is standard available on the market, for
instance of the brand Trox, type VAT-DG 75x525mm and is marketed by Schilt Luchttechniek BV, Energieweg 29, Postbus 3, 4230 BA in Meerkerk (Netherlands). Since the air grate produces a lower air resistance than the exit means (according to the invention preferably a perforated textile cloth of the partition element) a much higher air exit velocity will be obtained via the air grate, creating an air curtain and obtaining a good separation between warm and cold air near the head of the aisle. The effect obtained by applying the air curtain is a free entrance of service staff in the aisle while nevertheless an undisturbed, constant supply of cooled air will take place towards the equipment arranged in the racks (also indicated by cabinets) at least one of the sides near the head of the aisle under suction of the cooling air from the aisle.

Thus, personnel can exit and enter the aisle unhindered whilst nevertheless a good separation between relatively warm air outside the double row and the aisle is achieved.

According to one significant embodiment the partition element is arranged for the feeding of cooling air to the aisle along at least 70% of the length of the aisle, preferably at least 85%.

Thus, it can be accomplished that in the aisle a good supply of cooling air is provided so that ICT equipment can be cooled sufficiently, independent of their position in a rack of the row.

For a higher energy savings it is preferred that the partition element at the topside thereof is thermally insulating.

From the point of view of weight, ease of positioning, and cost it is preferred that the partition element comprises a supply duct that is at least partially formed of cloth, which supply duct is provided with through openings at the side directed towards the aisle, wherein the cooling air is supplied to the aisle via the through openings. This also provides the advantage of the proper mixing of the cooling air into a homogeneous mass.

According to a significant embodiment the air supplied to the partition element is conditioned first.

The conditioning will in general comprise at least one of
- cooling;
- controlling the air humidity between 35 and 65%, preferably 40-55%,
- dust depletion of the air, and
- the well mixing of the cooling air into a homogeneous mass.

It is a highly significant aspect of the present invention that a high degree of homogeneous air supply can be provided, since in this way it can be accomplished that the air humidity is in a range where static charges can accumulate as little as possible. In practice damages to equipment due to accumulation of static charge is a significant problem.

Preferably, the conditioning comprises the cooling of air using an air conditioning cabinet that comprises an exit opening for conditioned air, the center line of which is at a height that deviates 1 m at the most from the height of the partition element where air exits the partition element at the underside, and preferably at most 0,5 m.

In this way, the energy costs for moving air in a vertical direction remain limited.

For a further limitation of the cost for cooling it is preferred that at least part of the air supplied to the partition element is conditioned outside air.

In that case at least the supplied outside air will be filtered in order to prevent dust and/or insects and the like from entering the ICT room.

According to a preferred embodiment the outside air is withdrawn from the environment at a height that deviates at most 1 m from the height of the partition element where air exits the partition element at the underside, and preferably at most 0,5 m.

In this way, the energy costs for moving air in a vertical direction remain limited.

The energy costs can be further reduced when the outside air is supplied from an environment rich of plants in which plants are present that protrude to a position above the supply opening for outside air.

The plants are preferably trees. Plants provide shadow and also because of the heat that is withdrawn as a result of vaporization of water from the leaves, relatively cold cooling air can be obtained without much effort. The plants are located within a distance of 8 m and preferably within a distance of less than 4 m from the air supply which leads to the air conditioning cabinet.

The energy costs can be further reduced when the outside air on the northern hemisphere is withdrawn from the environment at the
northern side of the ICT room, and on the southern hemisphere from the southern side.

A further preferred embodiment is constituted by a method wherein the air exit opening for forming the air curtain is arranged at an upper side of the end of the aisle and cooling air is supplied downwardly through the exit opening. The vertical airflow obtained therewith provides a suitable air curtain at the end of the aisle.

Yet another preferred embodiment is formed by a method wherein the air exit opening for forming the air curtain is arranged at a side of the end of the aisle and cooling air is supplied through the exit opening towards the opposite side of the aisle. This provides a horizontal airflow that only has to bridge the distance between two rows of racks containing equipment in order to provide an adequate seal of the aisle relative to the ICT room situated outside thereof.

This distance will generally be less than the distance from the upper side of the aisle down to the floor as a result of which an air curtain can be obtained with less effort.

The invention also relates to a partition element that is suitable for usage with the method according to the invention. In particular it relates to a partition element for an ICT room, which partition element comprises an air duct containing a supply opening for cooling air and at one side thereof is provided with through openings for the discharge of cooling air from the partition element.

Such a partition element will in general have a width of at least 60 cm, such as for instance 50-70 cm for a single row of racks limited by a wall, and for a double row for instance 100-130 cm.

According to an embodiment that can be realized in a simple way, the partition element comprises a frame in which as the air duct an air duct of cloth is suspended, which air duct is provided with the through openings for the discharge of cooling air from the partition element.

Herewith, the air duct formed from cloth preferably has wings in its longitudinal direction which wings are retained in a profile of the frame.

The cloth will be a textile that does not release fibres.

For increasing the energy efficiency, the partition element has a side that is not provided with through openings for the discharge of cooling air from the partition element and this side is thermally...
more insulating than the side that is provided with through openings for the discharge of cooling air from the partition element.

The present invention will now be illustrated by the drawing, wherein

fig. 1 represents a floor plan of an ICT room with a double row of continuous racks;
fig. 2 represents a front view of the double row racks of fig. 1;
fig. 3 shows a cross section of a partition element according to the invention, showing a detailed view;
fig. 4 shows an alternative cross section of a partition element according to the invention;
fig. 5 shows a top view of the partition element of fig. 3 in detail;
fig. 6 represents in a side view a cross section of an ICT building; and
fig. 7 shows an alternative embodiment of the implementation of an air curtain.

Fig. 1 shows the floor plan of an ICT room 100 in which two rows 101, 102 of continuous 19" racks 103 with an aisle 104 in between are indicated. Arrows indicate the airflow via the racks 103. Reference number 191 indicates a door of the ICT room 100.

Fig. 2 shows a front view of the two rows 101, 102 of racks 103 of fig. 1, wherein it can be seen that above the aisle 104 a partition element 200 is provided, wherein the partition element 200 connects to the topside of the rows 101, 102 and keeps relatively cold cooling air below the partition element 200 separated from the comparatively warm air above the partition element 200. Preferably, the separation is an airtight separation. The partition element 200 comprises a frame 201 that is provided with two hollow tubular like air ducts 221, 231, each possessing wings 222, 223, resp. 232, 233. In the embodiment disclosed here these fulfil a twofold function: They keep the hollow tubular like air ducts 221, 231 in position, and take care of keeping the relatively warm air above the partition element 200 and the comparatively cold air below the partition element 200 separated in a substantially airtight way.

The partition element 200 is shown in cross section in more detail in fig. 3. It can be seen that the distal longitudinal sides of
the wings 222, 223, 232, 233 are taken up in profiles 340 (cf. detail of fig. 3 where it is shown how a thickened longitudinal side 222' of the wing 222 is enclosed within the profile 340) and are thereby retained. This allows for compact transporting and assembling in situ (in or near the ICT room) of the partition elements. The profiles 340 are attached to longitudinally directed frame tubings 350 or form an integral part thereof.

The hollow tubular like air ducts are preferably formed of textile that does not release fibres or the like. A suitable material is PLI that is marketed by NorthAir (Rodenn, Nederland). In order to prevent fraying, this material is provided, preferably using a laser, with holes 360. Arrows indicate the flow of relatively cold cooling air at the underside (that is to say, the side directed towards the aisle) of the partition element 200. Reference number 391 refers to a lamp, such as an energy efficient high frequency TL tube light.

According to the invention, relatively cold cooling air, such as is supplied to the air ducts 221, 231, ends up above the aisle 104 in the aisle 104 where it spreads along the entire height through the entire aisle (optionally aided by gravity as a consequence of the relatively high density of relatively cold air). In the equipment placed in the 19" racks 103 there are generally fans that suck air at the side of the aisle 104 and deliver it at the backside of the racks (as indicated in fig. 1). There, this air will rise and thus ends up above the partition element 200, that keeps this relatively warm air separated from the comparatively cold air in the aisle 104.

In fig. 4 an alternative embodiment of a partition element 400 is shown. In the variant illustrated here, the hollow tubular like air ducts 421, 431 have been partly provided with rigid heat insulating plastic walls 401 in order to limit the transfer of heat from outside the partition element 400 towards the relatively cold cooling air that is still to be used and the air supply towards the aisle 104 is provided by a cloth 402 with holes, for instance the above mentioned PLI or a cloth of a woven material. The insulating plastic walls 421 have been slid in profiles 410. Reference number 491 refers to a lamp, such as a TL lamp.

Fig. 5 shows a top view in the longitudinal direction of a partition element 500 (of which the cross-section is shown in fig. 3) with two ducts 521, 531 for cooling air, two supply openings 551, 552
for cooling air in the form of connecting ducts. The cooling air flows via the supply openings 551, 552 into the air ducts 521, 531. The air ducts 521, 531 are ducts formed out of textile, which have been slid over pipe ends 551', 551" respectively 552', 552". In the embodiment illustrated here, the pipe ends 551" and 552" are sealed. The locations of exit grates 591 at the underside of the partition element 500 have been indicated, which exit grates 591 provide for an air curtain in the aisle situated below.

The use of two separate air ducts 521, 531, and more specifically, the use of two separate fans or the like for the feeding of air means that the reliability in operation can be maintained on a high level also during maintenance of the cooling equipment.

Fig. 6 shows a side view of an ICT building 600 with an ICT room 660 provided with a partition element 670 above an aisle 671 (the rows of racks are not represented). It can be seen that the partition element provides for air along the length of the aisle 671, wherein in the embodiment shown via exit grates in the partition element 660 additional air is supplied at the right side of the aisle 671, whereby a cold air curtain (big arrow directed downwardly) is formed. Thus, also the penetration of relatively warm air into the aisle is counteracted.

Fig. 7 shows an implementation wherein the air curtain is also formed as a substantially horizontal airflow. In this illustrated embodiment air is supplied both vertically and horizontally. However, the air curtain can also be formed by only a single horizontal airflow from one side or by two airflows from both opposite sides. Also a combination of a vertical and one or two horizontal airflows can be used. The air exit openings arranged at the sides are connected to an air duct provided in the partition element.

A cold air curtain, in casu an air curtain of cold air, is obtained with an (optionally horizontally and vertically adjustable) often elongated air exit opening, known in the technique as air grate. This air exit opening 591 can be provided at the underside of the partition element 670 (cf. fig. 7) or be provided at one of the or at both vertical sides 794, 795 of the aisle 104 and be connected to an air duct (in fig. 7 the air duct is not illustrated separately) that is provided in the partition element 670 (as illustrated in fig. 7) and may be formed of a single aperture 792; 793 or of more, sub-
stantially connecting apertures, which embodiments are considered as equivalent. In the plane of the supply opening the airflow from the air exit openings is led to the aisle 104. For instance, an adjustable valve or the like may be provided in order to control an airflow rate to be led through the aperture, without the need for an active component (a drive fan or the like). An air grate for this purpose is commercially available as such, for instance of the brand Trox, type VAT-DG 75x525mm and is marketed by Schilt Luchttechniek BV, Energieweg 29, Postbus 3, 4230 BA in Meerkerk (Netherlands).

Since the air grate produces a lower air resistance than the exit means (here the perforated textile cloth of partition element 670) a much larger air exit velocity is obtained by the air grate as a result of which an air curtain is formed and a good separation of warm and cold air at the head of the aisle 671 is obtained. The effect obtained by the use of the air curtain is a free access of service staff in the aisle 671 with which nevertheless also an uninterrupted constant supply of cooled air will take place towards the equipment arranged in the cabinets at both sides at the head of the row of cabinets with a suction of the cooling air from the aisle 671.

There is a feed pipe 672 for cold air, which air originates from an air conditioning cabinet 673. This comprises a supply opening 674 for air from the ICT room 660, which is adjustable using a valve 675. There also is a supply opening 676 for outside air, which preferably originates from a forest like environment and is situated (for the northern hemisphere) at the northern side of the ICT building 600. Incoming air is filtered by means of a filter 678, led through a cooling section 679 (for instance a heat pump), fed once again through a filter 680 and channelled by an air pump 681 via the feed pipe 672 towards the partition element 670. It can be seen that the height at which the outside air is withdrawn from the environment is principally the same as the height where air exits the partition element 670 at the underside thereof. Reference number 691 refers to a lattice shielded against rain. Likewise reference number 692 refers to a lattice.
1. A Method for cooling an ICT room, which ICT room contains at least one row of continuous racks having ICT equipment that needs to be cooled, wherein:
   - at a long side of the row there is an aisle,
   - opposite the long side of the row of continuous racks there is a wall, and
   - above the aisle a partition element has been provided, wherein the partition element and the wall keep relatively cold cooling air at the side of the partition element situated at the aisle, separated from comparatively warm air at the other side of the partition element,
   wherein cooling air from the aisle, via a side of the row of continuous racks facing the aisle, is directed through openings in the continuous racks, in order to cool the ICT equipment to be cooled and the air heated due to the cooling exits the racks at the side of the row of continuous racks directed away from the aisle, wherein the partition element comprises a supply duct for cooling air, and cooling air is introduced into the aisle from above,
   characterized in that the method also comprises the forming of an air curtain near at least one end of the aisle by means of an air exit opening that is connected to the supply duct in order to provide a seal between the aisle and the ICT-room situated outside the aisle.

2. A method according to claim 1, wherein the wall is formed by a second row of continuous racks, and the row of continuous racks and the second row of continuous racks together constitute a double row of continuous racks, wherein the partition element extends between the double row above the aisle.

3. A method according to any of the preceding claims, wherein the partition element is arranged for the feeding of cooling air via the supply duct to the aisle along at least 70% of the length of the aisle, preferably at least 85%.
4. A method according to any of the preceding claims, wherein one side of the partition element situated away from the aisle is thermally insulating.

5. A method according to any of the preceding claims, wherein the partition element comprises a supply duct that is at least partially formed of cloth, which supply duct is provided with through openings at the side directed towards the aisle, wherein the cooling air is supplied to the aisle via the through openings.

6. A method according to any of the preceding claims, wherein the air supplied to the partition element is conditioned first.

7. A method according to claim 6, wherein the conditioning comprises the cooling of the air using an air conditioning cabinet that comprises an exit opening for conditioned air, the center line of which is at a height that deviates 1 m at the most from the height of the partition element where air exits the partition element at the underside, and preferably at most 0.5 m.

8. A method according to claim 6 or 7, wherein at least part of the air supplied to the partition element is conditioned outside air.

9. A method according to claim 8, wherein the outside air is withdrawn from the environment at a height that deviates 1 m at the most from the height of the partition element where air exits the partition element at the underside, and preferably 0.5 m at the most.

10. A method according to claim 8 or 9, wherein the outside air is supplied from an environment rich of plants in which plants are present that protrude to above the supply opening for outside air.

11. A method according to any one of claims 8 to 10, wherein on the northern hemisphere the outside air is withdrawn from the environment at the northern side of the ICT room, and on the southern hemisphere from the southern side.
12. A method according to any of the preceding claims, wherein the
air exit opening for forming the air curtain is arranged at an upper
side of the end of the aisle and cooling air is supplied downwardly
through the exit opening.

13. A method according to any of the preceding claims, wherein the
air exit opening for forming the air curtain is arranged at a side of
the end of the aisle and cooling air is supplied through the exit
opening towards the opposite side of the aisle.

14. A partition element for positioning above an aisle between heat
developing equipment placed in an ICT room, which partition element
comprises an air supply duct containing a supply opening for cooling
air and at a side situated at the aisle is provided with through
openings for the discharge of cooling air from the partition element.

15. A partition element according to claim 14, wherein the partition
element comprises a frame in which as the air duct an air duct of
cloth is suspended, said air duct being provided with the through
openings for the discharge of cooling air from the partition element.

16. A partition element according to claim 15, wherein the air duct
is formed from cloth, which cloth in its longitudinal direction has
wings that are retained in a profile of the frame.

17. A partition element according to any of the claims 14 to 16,
wherein the partition element has a side that is not provided with
through openings for the discharge of cooling air from the partition
element and this side is thermally more insulating than the side that
is provided with through openings for the discharge of cooling air
from the partition element.

18. A partition element according to any of the claims 14 to 17,
wherein the partition element along at least 70% of the length of the
aisle, preferably at least 85%, is provided with through openings for
the discharge of cooling air from the partition element.
INTERNATIONAL SEARCH REPORT

A CLASSIFICATION OF SUBJECT MATTER

INV. H05K7/20 F24F9/00

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)

H05K 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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>A</td>
<td>figures 1,4-7 page 2, lines 21-25 page 4, lines 3-11 page 5, line 6 - page 7, line 17</td>
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X Further documents are listed in the continuation of Box C

X 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

*E* earlier document but published on or after the international filing date

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'O' document referring to an oral disclosure, use, exhibition or other means

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**'I'** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

**'X'** document of particular relevance the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

**'Y'** document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

**'&'** document member of the same patent family

Date of the actual completion of the international search

27 May 2010

Date of mailing of the international search report

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Name and mailing address of the ISA/

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# INTERNATIONAL SEARCH REPORT

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