Munters DesiCool™ removes excess heat in server room

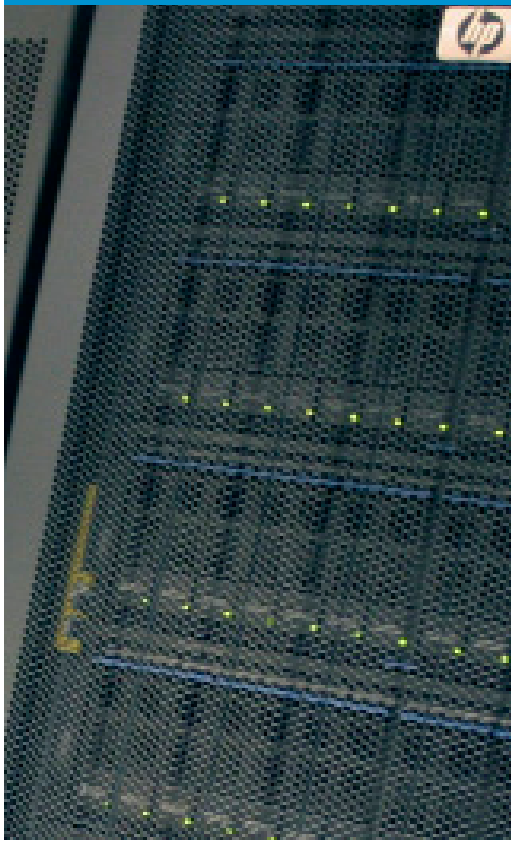
Corporate IT in Copenhagen University is bringing all their servers into two large server rooms located respectively in Copenhagen University Amager (KUA) and Panum together. Copenhagen University's 1200 servers are now being moved to physical and virtual servers in two new server rooms. Since the servers contain important research data, the ideal server room climate is of vital importance. Reliability and fire safety are the priority however the University of Copenhagen also considered energy use.

The University of Copenhagen has been a frontrunner in changing common practice in cooling server rooms to achieve substantial energy savings.

EKJ Consulting Engineers AS has an advisory service framework agreement with the University of Copenhagen Panum. As part of that agreement EKJ' s task was to establish the requirements for reliable temperature and humidity, however strong creative thinking also reduced energy consumption significantly with the added bonus of using surplus heat for heating a parking garage in winter.

The idea arose when EJK wanted to ventilate the server space, due to the stringent requirements to include ozone in the air - instead of cooling the server room a ventilation system was considered to meet the requirements for humidity.

DesiCool™



Benefits:

- **Low investment costs compared to traditional cooling**
- **Low running costs compared to traditional cooling systems**
- **No refrigerants needed**
- **No compressors needed**
- **Controls both temperature and humidity**

Munters

Cooling without cooling coils

The Munters DesiCool ventilation system in addition to regulating the humidity could also cool using tap water and does not use a traditional cooling coil. During summer the DesiCool system provides cooling without using electricity. During winter the heat energy recovery is so strong that there is no need for a post heater.

Today air treatment of servers is typically performed in a "closed" room to separate the air from the surrounding environment as much as possible. Utilising no outside air ventilation commonly server systems recycle the air and are equipped with cooling coils to remove the heat which servers generate. Or servers can be installed with server racks which are supplied directly with cooling water - as much cooling power is consumed for this as the server power consumption.

The optimum temperature for servers is 19-24 ° C and humidity in the range 45-55% RH.

Using outdoor air for ventilation

Changing common practice the EJK Munters solution brings the server room air from outside, which for a large part of the year provides sufficient fresh air with no need for cooling energy. In return, the supply air has an adequate quality, and no harmful levels of particles or gases. Before the Munters DesiCool ventilation solution was chosen, the air quality and outdoor air composition requirements were determined.

Panum analysed the outdoor air, the ozone concentration was higher than server manufacturer recommendations. Humidity can be regulated, however the Panum experts determined that higher ozone concentrations would not have a detrimental impact on the servers. It was therefore agreed to use outdoor air for ventilation for the server room, thus changing the current practice of recycling cooled air into the server room or injecting cooling into server racks. The way was paved to ventilate the server room with outdoor air.

The starting point for the installation was server heat output of 180 kW, and the internal heat load for lighting, UPS systems etc. This heat is emitted mainly into the hot zone, which is after the air has passed through the server rack. Dimensioning therefore has to remove a total of 200 kilowatts of heat from the server room. This can be done conventionally with recirculation and 200 kW cooling year round.

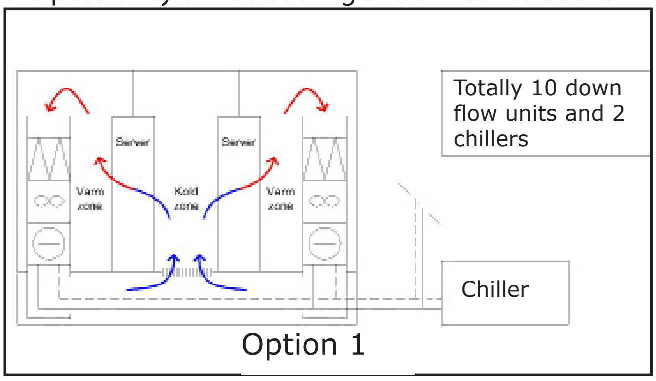
The other option is to remove the heat with a DesiCool air treatment solution calculated to handle outdoor and supply air temperatures, ΔT at injection and extraction and airflow, etc. must be able to cool the hot summer air down to a supply air temperature of 22 ° C, whilst the DesiCool ventilation system should cool around 200 kW.

Since reliability is the highest priority, commonly two refrigeration machines of 200 kW are installed, only to be used when outdoor temperature reaches 22 ° C.

Different options

There are four options to cool a server room. Air volumes will be the same whether recirculating or using a DesiCool ventilation solution, since the requirement in air temperature to the servers is the same regardless of the cooling solution chosen. With the current requirements, the following options were considered:

1) Traditional cooling with two refrigeration systems with the possibility of free cooling and air recirculation.

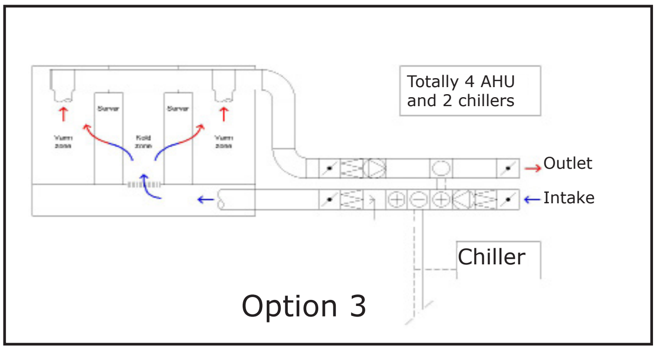


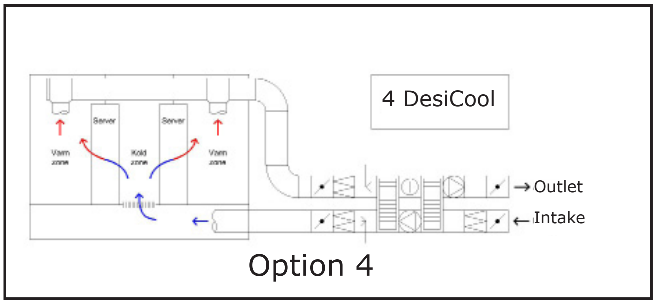
2) Conventional cooling with two refrigeration systems with the possibility of free cooling for server racks accessing the cooling water directly if server racks with high heat output are used. This type of server racks are typically used where space is constrained. But when there is enough space in the server room at Panum, this solution with the expensive racks was not considered and will therefore not be discussed further.

3) Four ventilation systems (for reliability) with cooling coils. It requires two identical systems cooling as one, but instead of down flow units the established ventilation installation, it has a larger pressure loss due to filters, dampers, channel transmission, etc. In turn, the cooling plant only operates when the outside temperature exceeds 22 ° C.

Requires relatively large ducts between the inlet / return equipment rooms and server rooms.

4) Four desiccant cooling systems with double rotating heat exchangers and evaporative coolers. This DesiCool solution requires no refrigeration plant. Rather it uses evaporative coolers. In the evaporative coolers the air uses energy to evaporate water, resulting in a drop in air temperature – so achieving the cooling effect. It also requires relatively large ducts between the inlet / return equipment rooms and server rooms.





The described options are listed in the table with a description of what it would cost in capital investment including investment and operating costs. It should be noted that these estimates of course relate to the circumstances at Panum

	Number and size of refrigeration	Cooling equipment operating time and performance	Total airflow from either the ventilation system or through downflowunits	Operating time ventilation system	Investment in Euro	Estimated running costs per year , in Euro
Option 1: Traditional cooling and downflow units	3 pcs at 100 kW	Always 180 kW cooling consumption	45.000 m³/h	Always	2.2 mio	120.000
Option 3: Ventilation with traditional cooling coils	3 pcs at 100 kW	In operation when temp over 22°C. 0-180 kW depending on ambient temp	45.000 m³/h	Always	2.4 mio	66.000
Option 4: DesiCool systems with evaporative coolers	None. Tap water is used.	Annual projected water use ca.400 m³.	45.000 m³/h	Always	1.6 mio	53.000

Option 1 is valued at 2.2 million Euro equipment supply costs - and approx. 120.000 Euro pr. year operating costs when the refrigeration system is in constant operation.
Option 3 is economic build valued at 2.4 million Euro equipment investment costs - as there should be both high security on refrigeration and ventilation systems. In contrast, the annual operating costs are 66.000 Euro pr. year.

Option 4 equipment supply costs are 1.6 million Euro and 53.000 Euro costs per years.

Option 4 - Munters DesiCool - is both the cheapest first time plant cost and operating costs. It was therefore chosen for the University supply.

Server space at Panum is laid out for a heat of 180 kW. The quantity of air needed to remove 180 kW heat when you allow temperature to rise 12 ° C, is 45 000 m^3 / h or 12.5 m^3 / s.

Since reliability is a top priority, equipment was designed to ambient conditions:

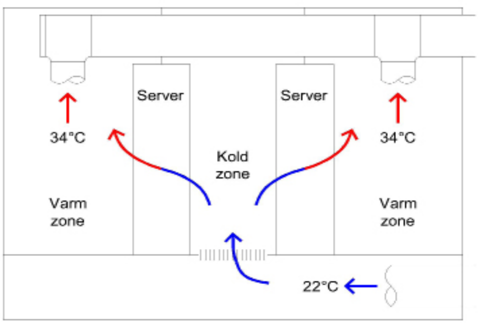
Outdoor, winter: -18 ° C / 10% RH
Outdoor, summer: +30 ° C / 60% RH
Outdoor, summer: +35 ° C / 35% RH

The physical server frame fans could treat up to 15,000 m^3 / h. the supply therefore required four plants of 15,000 m^3 / h (133% of dimensioning requirements) which means that there is a ventilation system in the reserve.

Cold and hot zones
Server space is divided into cold and hot zones via strip curtains. There is room for 59 server racks. Since not all racks are used from the start, the breakdown between cold and hot zones is made with transparent strip curtains. When there is a need of more servers strip curtains are replaced with server racks. In this way a flexible solution is achieved where there is no need to fill up the server room with server racks immediately. This principle can also be used at the normal temperature solution to recirculate the air in the server room.

Supply air is distributed under the computer floor, which acts as a pressure chamber, up through floor grilles to the cold zones. The cold zone temperature will increase a few degrees due to leaks between cold and hot zone. Then the air passes through the server rack where it is heated further and then exhausted out. It is sized for an air temperature increase of a total of 12 ° C.

Supply air must be between 19 and 24 ° C, which is why 22 ° C was chosen. Humidity is in the range of 45-50% RH.



Working principle of the DesiCool system:
The important components are a desiccant wheel with a reactivation coil, a heat recovery wheel and two evaporative coolers.

Summer case 1. Most of the summer time the cooling performance is provided in such a way that the cooled air from the evaporative cooler in the exhaust cools the supply air indirectly through the heat recovery wheel. After that the supply air is further cooled in the supply evaporative cooler.
Summer case 2. At very warm and humid ambient conditions the desiccant wheel starts. The ambient air is consequently dehumidified and thereafter cooled according to case 1.
Winter case. At winter time the desiccant wheel works as an enthalpy wheel transferring both sensible heat and humidity. This results in two heat recovery wheels in series with a resulting heat temperature efficiency so high that there is no need for additional post heating.
Humidity is controlled by the evaporative cooler in the supply. The desiccant wheel in winter mode also recovers moisture with 75% efficiency. The water usage is minimised.
The DesiCool unit is provided with a couple of by-pass dampers. They open for by-pass over components that for the moment is not needed. Almost the whole year these dampers are open over the desiccant wheel supply side and over the desiccant wheel exhaust side including the reactivation coil. This saves a lot of fan energy!

(The by-pass dampers are not shown in fig. 4.)

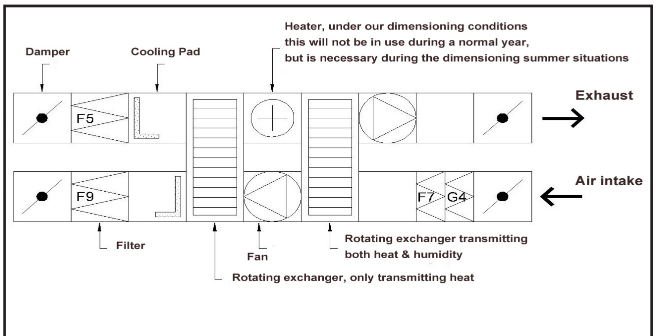


Fig. 4

The DesiCool ventilation plant's internal automation controls how the evaporative coolers and rotors are used to achieve the most energy-efficient process air. The coolers and rotors energy optimisation is dependent on both the set point of the supply air temperatures and humidity, and ambient air and exhaust air temperatures and humidity.

The reliable plant at Panum is designed with four parallel coupled DesiCool ventilation systems placed in pairs in two equipment rooms, each of which constitutes a fire cell.

There are two master systems with alternating operation – one in each equipment room- with full UPS supply (battery backup), and two slave systems also with alternating running and in their own equipment rooms with UPS supply of control panels.

In the event of power outages the master facilities continue unaffected, whilst the slave units come on-line when Panum's emergency power generator is started up, within 15 seconds.

If a DesiCool ventilation system is stopped due to servicing or error, the three other facilities maintain operations.

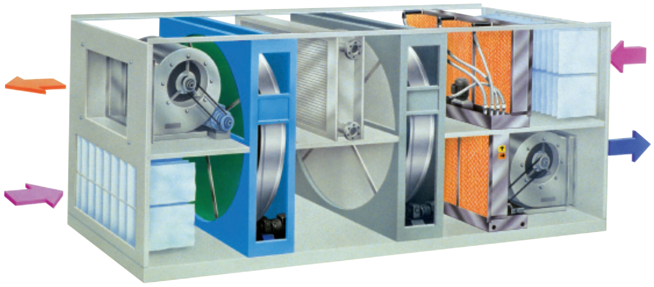
The Desicool systems controls have a fixed set-point for supply air temperature and a range of humidity. Air volume is controlled by a fixed differential pressure across the computer floor. This means that the more servers are placed in the server room, the more floor grilles must be loaded, and the DesiCool ventilation system will increase the air volume. The airflow is optimized thereby according to actual needs.

The exhaust air is approx. 34 ° C, heating the intake air in the winter. When it is advantageous the hot exhaust air is supplied to Panum's car park.

The plant was officially inaugurated in 2009 by KIT after commisioning and extensive operational testing. Detailed operational testing was necessary to ensure the plant was functioning properly before starting to move computer equipment into the server room. In early 2010 they began to install servers in parallel with the Desicool ventilation plant and climate conditions were closely monitored. In this commissioning period, it was possible to tune / optimize the DesiCool ventilation systems so that the plant operates as intended.

The temperature in the cold zones is now 23-24 ° C.

The humidity requirement band was changed from 45 - 50% RH to 30 - 60% RH, as it is was seen not to affect the servers. A wider range of humidity, means lower energy consumption and lower water consumption.



EKJ have greatly appreciated the close cooperation with Munters from start to finish. A constructive dialogue in an exciting and challenging project has resulted in significant savings for the University of Copenhagen, Group IT, who have received a prize for their effort as frontrunners in energy optimization.

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