



# How to build the ultimate data center cooling solution

# Introduction

Unfathomable amounts of data are created every single day, and as global population grows and more devices are connected, these vast quantities will only increase. Each year sees more growth than the last, and this trend is set to continue long into the future as we stream more media than ever, and cloud-based artificial intelligence begins to take center stage. Looking at 2018 alone, the world created 33 zettabytes of data. This might not sound like much, but it is the equivalent of 660 billion Blu-rays of information. In just one single year.

All of this data needs to be stored somewhere, and purpose-built data centers are the best solution when so many applications are now being moved to the cloud. As the data we create increases, the number of data centers around the world will continue to grow at a rapid rate. However, designing and building the best possible data center can be complex, as the operating conditions need to be ideal to meet extremely high demands on reliability and uptime. At the same time, the energy consumption needs to be as low as possible to limit environmental impacts and running costs.

The various pieces of equipment in data centers consume a significant amount of power and generate a lot of heat. This means the data centers need to be cooled, as if the temperature rises it can have a negative impact on the technology, and in worst case scenarios could lead to fire.

When building a data center cooling or humidification system there is a lot to consider, from the different types of cooling available to the most effective media. We are here to offer advice on how to design the best solution for your specific needs.



# Considering the climate

One of the priorities for any modern data center is the amount of power consumed, and how it impacts not only the local environment, but the world around us. Data centers currently consume 2% of the world's power, which is huge. However, it is predicted that by 2030 that figure could rise to 8%, which is a huge number for just one part of one industry. With this in mind, any data center builder or owner needs to carefully consider how to limit energy use, and in turn environmental impact.

8% of the  
world's power

## What to consider

When designing a data center, you need to consider carefully what you actually need, as what works for you may not be optimal for someone else. It depends on a wide range of factors, from where in the world your data center is, to how clean the local water is, to the size of your specific location.

A common issue is over-specifying. Businesses want to invest in the best solutions, of course, but building an underground water-purifying plant in a country where the water is already extremely clean not only results in needless financial outlay, but consumes a significant amount of energy which takes its toll environment.

The same applies to cooling or humidification – a data center in California will need a more powerful system than one based in the north of Sweden, which could rely more on natural cooling to keep the right temperature levels, thus reducing power consumption. However, during the winter humidification will be essential where the climate is cold and dry.

The key is to take all local factors into consideration, and avoid taking a homogenous approach to all data centers when each one needs individual attention.

## How to take action

Given the increasing amounts of data we rely on, building more data centers is a necessity. This does not mean that they need to consume as much power as you may think, though, as technology exists specifically to reduce environmental impact.

There are larger, more infrastructural decisions to make, like whether you can be powered by green energy from solar panels or wind farms, but there are also system-level decisions that can have a significant impact on energy consumption.

Specifically thinking about cooling and humidification, which in terms of power usage is one of the most significant factors, the technology you choose will make a big difference. Even choosing the right cooling media can result in energy savings, so it is important to research and discover how you can help contribute to creating a more efficient data center, and a more environmentally friendly industry.



# Which cooling or humidification solution is right for you?

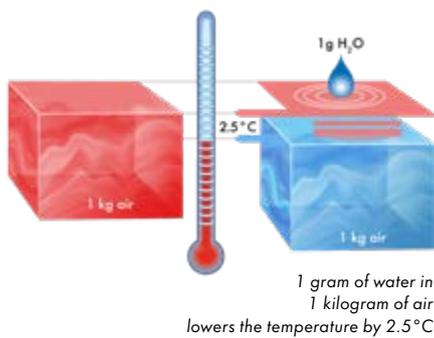
There are a number of different technologies available for cooling and humidifying, and each has its positives and negatives. When it comes to cooling large data centers, evaporative cooling/humidification tends to be the most efficient method, but there are a number of options within this category. Here, we explore the pros and cons of each.

Technology	Pros	Cons
Electrode boiler	<ul style="list-style-type: none"> <li>• Versatile</li> <li>• Low initial cost</li> <li>• Good control</li> <li>• Wide range of capacity</li> <li>• Compact</li> <li>• Simple installation</li> </ul>	<ul style="list-style-type: none"> <li>• High running costs</li> <li>• High maintenance costs</li> <li>• Poor lifetime value</li> <li>• Difficult cylinder disposal</li> <li>• Cannot cool the air</li> </ul>
Resistive boiler	<ul style="list-style-type: none"> <li>• Versatile and durable</li> <li>• Accurate control</li> <li>• Very little maintenance</li> <li>• High operational reliability</li> <li>• Wide range of capacity</li> <li>• Simple installation</li> </ul>	<ul style="list-style-type: none"> <li>• High running costs</li> <li>• More expensive than electrode boiler</li> <li>• High energy consumption</li> <li>• Some resistive humidifiers</li> <li>• Cannot cool the air</li> </ul>
Gas-fired boiler	<ul style="list-style-type: none"> <li>• Low running costs</li> <li>• Energy efficient</li> <li>• Good lifetime cost</li> <li>• Easy maintenance</li> <li>• High capacity</li> </ul>	<ul style="list-style-type: none"> <li>• High capital cost</li> <li>• Large physical footprint</li> <li>• Complex installation</li> <li>• Gas maintenance must be done by specialists</li> <li>• Cannot cool the air</li> </ul>
Spray atomisers	<ul style="list-style-type: none"> <li>• High capacity</li> <li>• Close control</li> </ul>	<ul style="list-style-type: none"> <li>• Some systems need compressed air</li> <li>• All applications need a water treatment system to get rid of minerals in the water</li> <li>• Sound levels can be high</li> <li>• Must be incorporated into L8 risk assessment</li> <li>• High maintenance requirements due to cleaning and changing of nozzles</li> <li>• Droplet separator required</li> </ul>
Ultrasonic atomisers	<ul style="list-style-type: none"> <li>• Very low running costs</li> <li>• Clean applications</li> <li>• Close control</li> <li>• Special and spot applications</li> </ul>	<ul style="list-style-type: none"> <li>• High cost per kg humidity</li> <li>• Low capacity per humidifier</li> <li>• Must have water treatment system to get rid of minerals in the water</li> <li>• Limited capacity</li> <li>• Creates aerosols</li> <li>• Large vapor plumes in direct air</li> <li>• Maintenance can be costly</li> <li>• L8 risk assessment required</li> </ul>
Evaporative	<ul style="list-style-type: none"> <li>• Very short evaporative distance needed in AHUs</li> <li>• Very low running costs</li> <li>• Runs with mains or treated water</li> <li>• Infrequent maintenance</li> <li>• Will give you very close control</li> </ul>	<ul style="list-style-type: none"> <li>• Water reservoir can be contaminated if the water management system is wrongly designed</li> <li>• L8 risk assessment required</li> </ul>

Each technology can work for a data center but when it comes to energy use and running costs, which are crucial considerations, evaporative cooling/humidification is likely the best option. When it comes to the cons of these solutions, equipment selection can mitigate most of them, and it is the most environmentally friendly way to effectively cool or humidify a data center.



# System essentials



Only allows  
for 28.8 hours of  
downtime  
per year

For the data centers of the future, evaporative cooling/humidification is widely regarded as the optimal solution. As with any technology, there are risks if it is implemented incorrectly, and major rewards if you choose the right system for your specific needs.

## What can go wrong?

Evaporative systems rely on the mains supply or other water sources to control temperatures in data centers. Fans draw air through the modules of media which have water running through them. This cools and humidifies the air before it enters the server rooms. When the right equipment is installed, this is a risk-free process. The issue is, thanks to a wide range of equipment being on the market, some are more prone to faults and failures.

Faults in the system can lead to water being sprayed by powerful fans directly into server rooms, and water and servers do not mix well. In best case, investing in sub-optimal technology means more time spent on maintenance, which can lead to downtime. This downtime is a critical issue with data centers, as even a couple of minutes can lead to significant costs.

Data centers fall into a tier system, each with specific availability ratings. Investing in the wrong system can mean that your data center does not comply, and even the slightest unscheduled downtime can make a big impact. A Tier 1 data center, for example, has the lowest requirement out of the 4 tiers as they are usually server hotels or used to store pictures, and the minimum availability to meet Tier 1 standards is 99.671%. This only allows for 28.8 hours of downtime per year, which does not leave much room for error.

## Rewards for the right choices

As with any investment, there are risks, but getting your cooling system right can have real, tangible rewards. If you spend the time researching, and working with the right partner, you can benefit from an evaporative cooling system that not only keeps the right climate, but also makes the internal environment safer whilst using less energy to operate.

For instance, choosing the right combination of fans and evaporative cooling/humidifying media can give a lower pressure drop, which means you benefit from the same level of cooling efficiency from less power, as air passes through the media more easily. Choosing a location with purer water can mean less maintenance downtime, and lower initial investment, while opting for a cooler climate can save even more on energy.

Data centers and cooling systems are complicated, but with the right partner, choosing the best solution can be easy.



# Why media matters

It is important to see the cooling/humidification system as a whole, and something where each part is built to work in harmony with the others. From the air inlets and the fans to the media and pipework, every part is of equal importance. However, the evaporative cooling/humidification media is often seen as the heart, and that is with good reason.

The media is responsible for cooling/humidifying the air, holding the water, and ensuring that no contaminants are distributed into the data centers. It has two very important roles – to protect and to cool/humidify, and while it may not seem like the most advanced piece of equipment, good cooling/humidifying media can have astonishing amounts of innovation included.

There is a world of difference between the most basic, simple media and the more premium, forward thinking materials, and what you choose will depend on your exact needs. However, here is one area where looking at the best solution will not result in performance that you do not use – the best will always help with efficiency, safety and uptime.

## How to choose

The best way to make sure you are benefitting from the best solution is to work with an expert partner, but there are a few things to keep an eye out for which you will be able to see and feel when making a decision.

- Look for something firm and substantial. The media will be subject to constant air pressure, together with wetness, so the structural integrity needs to be strong. A robust, heavy solution with the right coating can last significantly longer than more basic media types
- At what air velocity will water droplets form and leave the media?
- At what air velocity do you have to install a droplet separator after the media to prevent that droplets forms and leave the media?
- What is the pressure drop over media at certain air velocities?
- Visualise how air will flow through it. Will it be easy? Is the design intricate, but with enough space for air to flow freely?
- See if it is easy to replace. Media will come in a metal frame, but some will be designed with easy installation and replacement in mind. Others will still need more parts attached, or welded on, in order to work properly.
- Does it have relevant safety certification? Some media is very simple in construction, but also extremely flammable. Others are designed with safety and security in mind.
- Is the media approved according to local and regional regulations i.e. EN norms for Europe, or UL/ETL norms for North America?

When making your decision, you need to choose a media that fits well with the rest of your cooling/humidifying system, but also contributes to energy and cooling efficiency. Getting this decision wrong can cause major problems. Getting it right means lower ongoing expenses, optimal uptime, and peace of mind.

# Finding the perfect fit

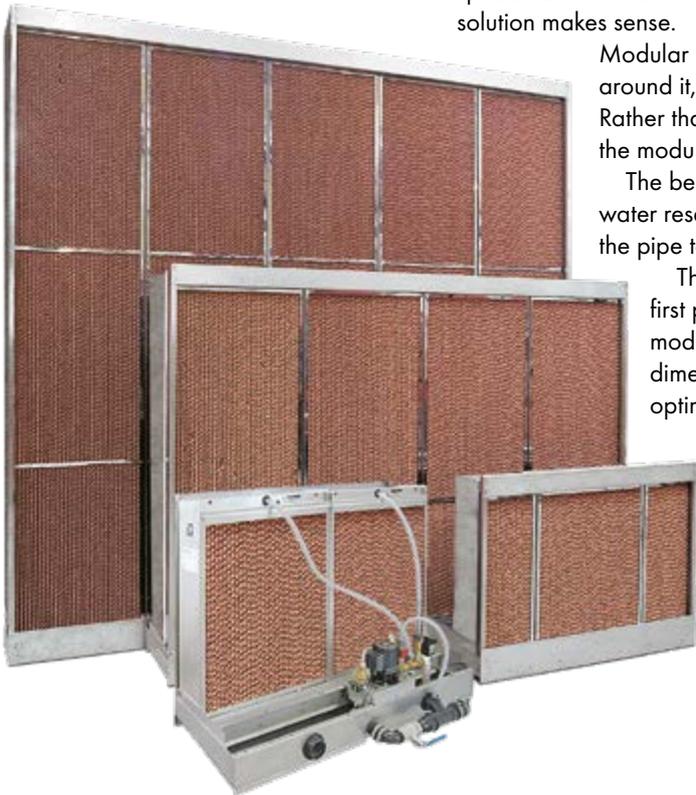
The media is the heart, but that heart needs a good home to be effective. When designing a direct evaporative cooling system such as a wet wall or a CRAH unit, some opt for a certain media, then build custom frames to fit them on to. This can work well, but it can be costly and can lead to problems further in the future. For example, if one unit needs to be replaced, a whole new frame might need to be built to the exact same specifications. That is why, in terms of efficiency and ease-of-use, investing in a modular solution makes sense.

Modular systems ensure that the media is matched perfectly to the frame around it, and makes the building process much more straightforward. Rather than having to deal with separate components, you can just click the modules into place.

The best modular systems also come with the connecting pipes and water reservoirs, so once they are in place it is as simple as connecting the pipe to the supply, and then it is ready to go.

This reduces the amount of time required to build the system in the first place, but can also vastly reduce potential downtime when a module needs to be replaced. The units are also designed to specific dimensions relating to the fans that push the air through, further optimizing efficiency.

Choosing a modular solution can make a real difference in the long-term, and if you choose the right partner, the return on your initial investment can be surprisingly quick.

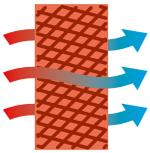


# The Munters solution



GLASdek™ GX40 is a unique double-coated material giving superior performance.

GLASdek™ GX60 has an additional carbon coating giving the material extreme performance.



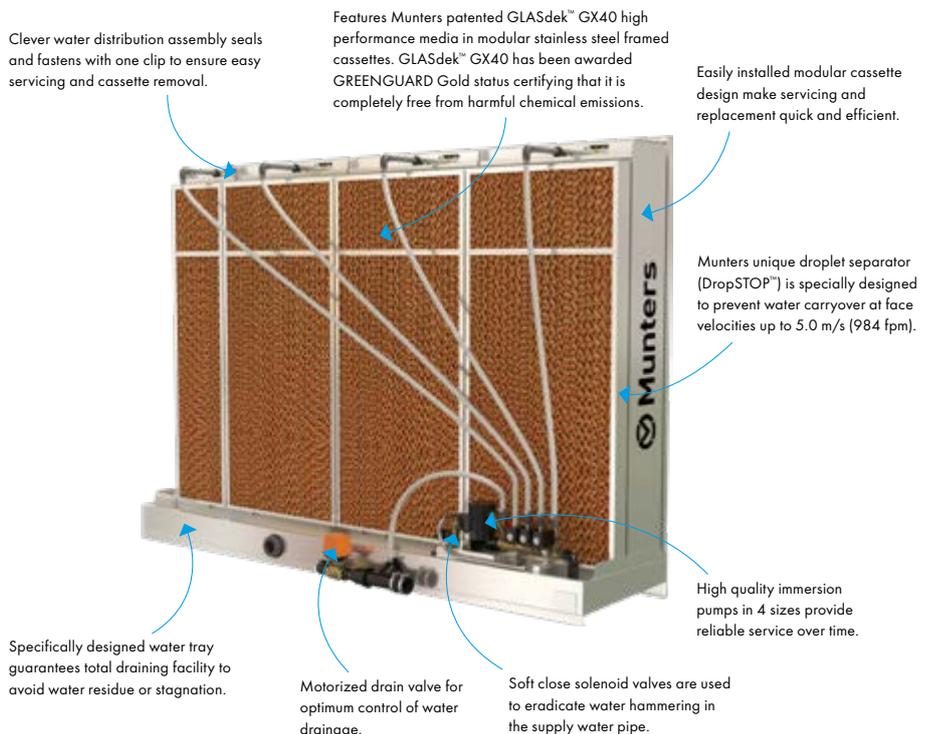
Munters GLASdek™ ceramic coating

With many cooling media types, if you walk through a data center you can feel water aerosols or drops coming off the walls. With Munters FA6™ cooling modules, there is nothing. Just cool air delivered in an energy efficient way. That is the Munters difference.

The FA6 modules come equipped with GLASdek™ GX40 media (evaporative media), which is non-combustible, robust and long lasting, and they also come ready to install with the necessary pipework and framing. These units can make a real difference to your cooling system, as they offer seven major competitive advantages:

- **Fire rating.** Our media is baked twice and ceramically coated, making it fire-rated according to ASTM E 84-97 a, as opposed to more common media types, which can be extremely flammable and do not necessarily comply to European norms and regulations
- **Velocity handling.** GLASdek GX40 pads can handle higher air velocities than the competition. This means you need less fan power for the required results, offering significant savings in the long run
- **Water quality.** Because of the unique pad design and manufacturing process, our modules can handle almost any water quality, no matter the hardness or the pH. This could mean you do not need to invest in a full water purifying system on site
- **Long lasting.** Because of how our media modules are made, they can last up to twice as long as the nearest competitor. This means less downtime, and better profit margins
- **Cleaning-in-place.** Because the pads are robust, and can handle almost any water quality, you can clean them using acids and disinfectants without ruining their integrity. This means, once again, less replacement pads, and better uptime
- **Certified against legionella.** Evaporative cooling relies on water troughs or direct water systems, and in the right conditions these can be home to legionella bacteria. GLASdek GX40 media is proven against legionella, eliminating the risk of infection amongst people in the surroundings of a data center as a result of cooling or humidification

These benefits, along with our years of climate expertise, make Munters the ideal partner for data center cooling. We know that uptime, safety and efficiency are your priorities, and we can offer solutions that are the very best in the industry.



# Selection guide

To help you evaluate the right solution, use this evaluation form to see which partner can meet your most important criteria.

Media	Importance	Munters	Comp 1	Comp 2
The material will not burn		✓		
The material has fire-rating according to ASTM E 84-97 a (i.e. equivalent to concrete gypsum and bricks)		✓		
The material has ceramic coating and is 100% inert		✓		
Tested against legionella*		✓		
Has hygiene certificates*		✓		
Approved GREENGUARD certification*		✓		
Can handle any water quality		✓		
Withstands pH levels between 3 and 11		✓		
Can handle air velocity of up to 5.0 m/s (984 fpm)		✓		
Have a low pressure drop that equals low energy consumption				
<b>Humidifier Modules</b>				
Easy to replace		✓		
CIP (Cleaning in Place) prepared		✓		
Designed around the media		✓		
Equipped with pipework		✓		
A well proven design		✓		

## \*Tested and certified

The inorganic material GLASdek™ GX40 and GX60 has been fire tested and classified as non-combustible material according to EN ISO 13501-1. RoHs compliant. Tested against the transfer of legionella (with contaminated water and air born bacteria) by external body. Certified for hygiene (no aerosols containing bacteria or legionella) at the University of Aachen, Germany by PD Dr. Med. Sebastian W. Lemmen. GREENGUARD Gold certified.



January 10, 2001

## Hygiene report on the Munters FA6 evaporative humidifier

The objective of the trial was to determine whether the Munters FA6 evaporative humidifier could convey human pathogen legionella into the air.

With the help of an experimental trial procedure, closely replicating practice, 21 different experiments were carried out with *Legionella pneumophila* in concentrations of 1,000 to 10,000,000 CFU/l at air speeds of up to 4.2 m/s. The following was proven:

By applying the principle of 'cold steam humidification' as used by the Munters evaporation humidifiers, no aerosols containing legionella were identified, or *Legionella pneumophila* passed in any other way into the air, even at very high concentrations of legionella in the steam water and very high air speeds.

With the help of an experimental trial procedure, closely replicating practice, we were able to show that at legionella concentrations of up to 10,000,000 CFU/l no legionella were transmitted into the air by a Munters FA6 evaporative humidifier.

At the beginning of 2001, it is planned that a system control room of the air conditioning unit at the Universitätsklinikum in Aachen will be fitted with Munters FA6 evaporative humidifiers, in order to confirm these results in practice.

*S. Lemmen*

Dr S. Lemmen (MD)  
Specialist in hygiene and environmental medicine  
Specialist in microbiology and infection epidemiology

Aachen Certificate

March 18, 2002

## Hygiene Report on the Munters FA6 evaporative humidifier under operating conditions

The purpose of the investigation was to answer the question whether the Munters FA6 evaporative humidifier produces aerosols containing bacteria under operating conditions. In addition, its function as a filter was examined in respect of particles and the concentration of airborne organisms.

The water for the evaporative humidifier was enriched with the indicator organism *Flavimonas oryzihabitans* in a concentration of 10<sup>8</sup> CFU/ml. *Flavimonas oryzihabitans* is a physiological aquatic gram-negative organism with morphological characteristics comparable to *Legionella* spp. During the 12 hours of the experiment, a total of 25,000 l air was sampled and tested microbiologically for the indicator organism. The latter was not found in any of the measurements, and therefore it can be assumed that no aerosols containing bacteria are produced by the evaporative humidifier.

To enable us to document the function of the evaporative humidifier as a particle filter, 6 particle counts were made of the air in the room in which the humidifier was installed and also of the air discharged after the evaporative humidifier. A reduction of approx. 70% was found in the concentration of particles with the size of 5 µm and 10 µm, that is of relevance as far as bacteria are concerned.

In summary this study documents that the FA6 evaporative humidifier from Munters did not produce aerosols containing bacteria, and, in addition, functions as a filter reducing particles by approx. 75%.

*S. Lemmen*

PD Dr. S. Lemmen (MD)

Aachen Certificate

January 19, 2001

## Hospital hygiene technical report on the evaluation of the Munters FA6 evaporative humidifier

The objective of the study was to determine whether the Munters FA6 evaporative humidifier could give rise to aerosols containing human pathogen-like legionella spp. An experimental trial was used to try to answer this question.

By PD Dr. Med. Sebastian W. Lemmen  
Medizinische Fakultät RWTH Aachen

### Abstract

With the help of an experimental trial procedure, closely replicating practice, 21 different experiments were carried out with *Legionella pneumophila* in concentrations of 1,000 to 10,000,000 CFU/l at air speeds of up to 4.2 m/s. The following was proven:

By applying the principle of 'cold steam humidification' as used by the Munters evaporation humidifiers, no aerosols containing legionella were identified, or *Legionella pneumophila* passed in any other way into the air, even at very high concentrations of legionella in the steam water and very high air speeds.

With the help of an experimental trial procedure, closely replicating practice, we were able to show that at legionella concentrations of up to 10,000,000 CFU/l no legionella were transmitted into the air by a Munters FA6 evaporative humidifier.

At the beginning of 2001, it is planned that a system control room of the air conditioning unit at the Universitätsklinikum in Aachen will be fitted with Munters FA6 evaporative humidifiers, in order to confirm these results in practice.

### 1. Methodology

#### 1.1 Trial procedure

A measuring stand was set up to determine the volume flow, particle and growth parameters. The necessary measuring facilities for pressure and volume flows and an rpm-controlled radial fan

were integrated into the trial procedure for performance adaptation. Additional air filters were incorporated in order to create the air quality necessary for the hygienic measurements (see Figure 1).

As the air extraction outlet is located in the cellar of the clinic,

a class F9 fine dust filter was installed at this point. A hepa filter (class H13) was integrated in front of the FA6 evaporative humidifier, in order to generate, as far as possible, clean air. At the end an F9 fine dust filter was installed in the measuring room for staff protection.

March 12, 2002

## Expert Report on the evaluation of the Munters FA6 evaporative humidifier under operating conditions using the test organism *Flavimonas oryzihabitans*

By PD Dr. Med. Sebastian W. Lemmen  
Medizinische Fakultät RWTH Aachen

### Abstract

Preliminary trials under laboratory conditions with the FA6 evaporative humidifier documented that no aerosol containing *Legionella* spp. were generated even under extremely high *Legionella* spp. concentrations of up to 10<sup>8</sup> CFU/ml and air velocities of up to 4.2 m/sec. The objective of this investigation was to find out whether aerosols containing bacteria are produced by this evaporative humidifier under realistic operating conditions. The indicator organism used for this purpose was *Flavimonas oryzihabitans*, a physiological aquatic organism which, as a Gram-negative bacillus, has a morphology and size comparable to *Legionella*.

In addition, comparative measurements of particle counts before and after the evaporative humidifier were made to test its quality as particle filter.

### 1. Method

#### 1.1 Question: Were aerosols containing bacteria generated?

Experiments were conducted over periods of 6 hours each on 2 consecutive days.

The water in the humidifier was enriched with an extremely high concentration of 10<sup>8</sup> CFU/ml of the indicator organism *Flavimonas oryzihabitans*. The concentration in the humidifier water was checked and recorded on the two days of the experiment at 0.5 and 6 hours (see Table 1).

Throughout the 12-hour experimental period, a total of 100 counts of airborne organisms were

made (Royco Model 242A, HIAC/Royco) using commercial airborne organism indicator strips (airborne micro-organism indicator TC, Biotest HYCON); in the course of these 100 air aspiration tests (5 minutes at 250 l of air) a total of 25,000 l of air was sampled in; the airborne organism indicator strips were incubated under laboratory conditions and the cultures grown were differentiated biochemically by the conventional microbiological methods.

In addition to the counts of airborne organisms using commercial agar, a total of 10 measurements were made over five minutes each (2,500 l air) using specially prepared BCYA agar to detect *Legionella* spp.

Aachen Report

Aachen Report





## Munters Services – With you all the way

We are dedicated to providing the most reliable, efficient and innovative products, but we know that service is just as important. That is why we offer Global Services, which ensures you benefit from our expertise wherever you are in the world.

Our range of services includes:

- A global network of Munters Service Engineers
- Comprehensive commissioning service
- Training and competence development
- Preventive maintenance and spare parts
- Performance checks and optimization
- Munters Remote Assist – online service solution when on-site visits are difficult
- And much more...

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