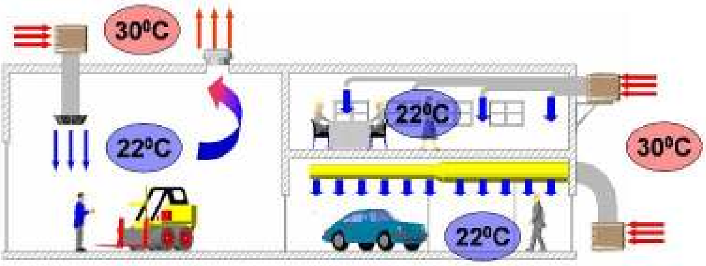
EcoCooler Legionella Risk Assessment Information Pack

Purpose of Document

This information in this document is intended to provide a basis for the understanding of the risk of Legionnaires' disease in EcoCooling evaporative cooler.

An EcoCooler is typically employed as part of a balanced ventilation system and, as such, is subject to all UK legislation including that relating to Legionnaires' disease.



The Health and Safety Commission Approved Code of Practice and Guidance (ACOP) ***Legionnaires' Disease: The control of legionella bacteria in water systems L8*** requires a risk assessment to be performed on any water based system.

The structure of risk assessment is based on the pathway of a legionella infection of a human being:

- Presence of legionella bacteria in a water system
- Growth of legionella bacteria to a concentration level capable of infection
- Dissemination of droplets or aerosols contaminated with legionella
- Infection of a susceptible host by these droplets or aerosols

The design, process control and operation of an EcoCooler are explained to enable each stage to be examined and a risk assessment made.

The key principles to be considered in the prevention of Legionnaires' disease recommended by ACOP L8 are:

- Avoidance of stagnant water
- Low water operating temperature
- Avoidance of corrosion and scaling
- No production of aerosols
- Maintenance

Reference will be made to each of these principles as the pathway is examined.

Alan Beresford 2014

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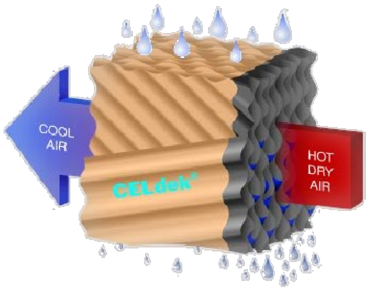
1.0 EcoCooler Design, Process Control and Operation

An EcoCooler cools air using the principle of adiabatic (evaporative) cooling. It is a 'wetted media' evaporative cooler which means that the air stream is in contact with a filter media which is saturated in water.



1.1 Filter Media Design

The filter media in an EcoCooler is Munters CELdek 5090. This is a cellulose based media with the following specification.

Appendix 1: Munters Humicool CELdek Specification
Appendix 2: Munters CELdek 5090 Specification

The cooling efficiency of an evaporative cooler is dependent upon the pad thickness and the face velocity. An EcoCooler is designed with a 100mm pad thickness at a face velocity of 1.6m per second. In addition to efficiency the face velocity is important regarding droplet formation. If this velocity exceeds 3 m per second then the air flow can draw water from the pads.

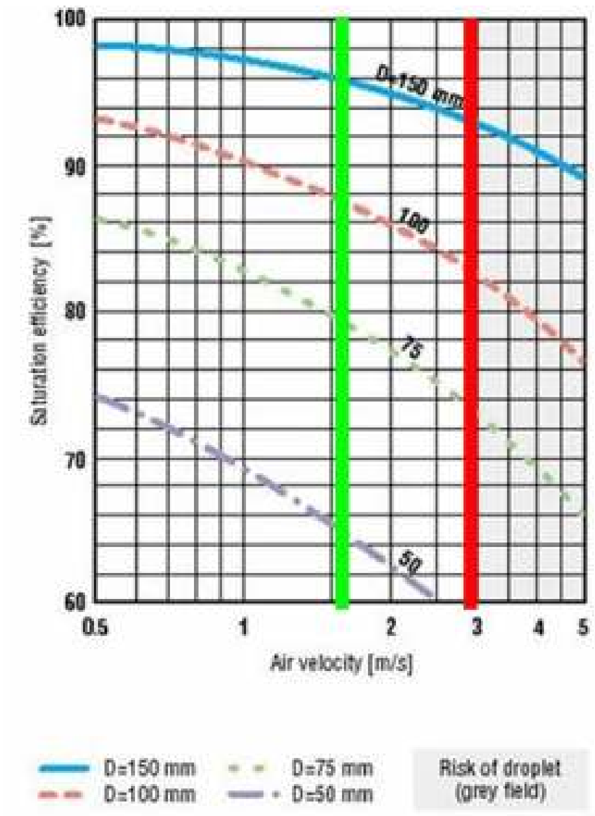
A key factor in the design of the EcoCooler is a pad face velocity which avoids droplet formation

The design criterion for an EcoCooler is shown below

Pad Area

W m	H m	Area sqm	No	Area sqm
.86	.68	.58	4	2.34

Flow cm/hr	Flow Cm/s	Face Velocity m/s	Droplet factor of safety
14000	3.9	1.66	180%



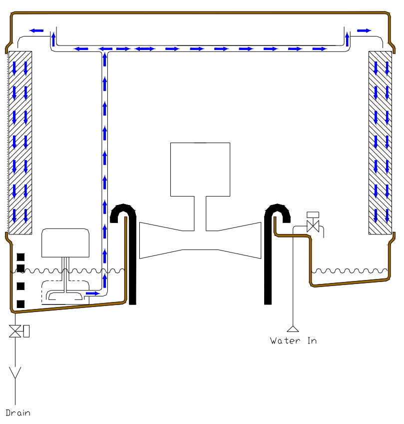
The net result of this is an adiabatic cooler with 90% efficiency and a droplet factor of safety of 180%.

Note that these design criteria are related to the absolute maximum flow rate conditions. In the majority of cases the system pressure losses result in lower flow rates and hence a lower face velocity and an improved droplet factor of safety.

EcoCooling supplies 'wet boxes'. These are coolers without fans. A separate system calculation is carried out to validate both the performance and droplet factor of safety.

1.2 Water Circulation System

When the EcoCooler is in cooling mode the filter pads are kept wet using a water circulation system as shown below



Water, controlled by a solenoid valve and a level probe, is circulated over the pads by a centrifugal pump. A drain valve empties the cooler at the end of cooling mode or as part of the scale control system.

The rate of water flow is determined by the Munters specification.

The key to legionella control in the water circulation system is the low water temperature and the avoidance of stagnant water.

Water Process Control

Water Level Probe

Central to the process control is a water probe with four level sensors. This is used to control the water and provide feedback to the control system to identify any fault conditions. It is located in the base of the water tank of the EcoCooler

Its key functions are:

- Prevention of stagnant water
  - Validated the sump is empty
  - Identifying a slow fill of water
  - Identifying s slow drainage of water
  - Identifying circulation pump failure
- Scale control
  - By volumetrically measuring the quantity of water added to the sump the water can be drained before the scaling point is reached

Its operation is as follows:

Drain operation

When the cooler is switched on it automatically checks the low level. If this shows water present then the cooler drains. If there is insufficient water to operate the level probe the cooler will still enter a 2 minute drain sequence. This is followed by a 6 second water purge and a further 20 second drain.

If the low level probe does not clear within 10 minutes a 'Slow Drain' fault is indicated.

The water sump has a slope. Water enters the sump at the high side and the drain is positioned at the lowest point. The pulse of water helps clear any residue which may have collected in the base of the sump. The system is designed to be fully self draining with no dead legs.

Cooler stopped

The water is always drained when the cooler is stopped or in vent mode. Level probe 1 is continuously monitored. If water is detected the EcoCooler goes through the drain cycle.

Start Up of Cooling Mode

The lowest level is validated to ensure there is no water in the sump. If no water is detected then the cooler drain valve opens for two minutes, the sump is flushed with fresh water, a further short drain period follows and then the cooler is considered ready for cooling mode. This flush also purges the water supply line of water which may have been subjected to higher temperatures or stagnation on a roof installation.

Filling of cooler with water

After the initial validation of the empty sump the water, controlled by a solenoid valve, fills the sump. At level 2 the circulation pump starts. It is not possible to absolutely assure a completely dry cooler at the start of operation. By delaying the pump until this point approximately 15 litres of water has been added to the sump. This will dilute any liquid which was present in the cooler. The water filling is stopped by level 3 sensor.

Should the cooler not fill to the upper level within 20 minutes a 'Slow Fill' fault will be indicated.

Evaporation

Whilst the EcoCooler is in cooling mode water is being continuously evaporated. The water level then falls from level 3 to level 2. At level 2 the cooler then re-fills by opening the water solenoid valve. If the water level does not fall to the second level within 12 hours then a 'Slow Evaporation/ fault is indicated. This is an indication of a fault, typically a circulation pump failure, and there may be a stagnant water situation.

24 hour dry cycle

Some organisms, which are present in the water and can proliferate at the operating temperatures of the EcoCooler, cannot tolerate desiccation. An option exists in the software to enable a '24 hour dry cycle'. When this is enabled the cooler will, after 24 hours of continuous operation in cooling mode, go into a forced ventilation period for 30 minutes to dry the pads. Additionally, the EcoCooler will be forced into a drying period of 30 minutes after water recirculation in cooling mode.

Scale Control

During cooling mode only pure water is evaporated from the pads. The magnesium and calcium salts, together with any particles filtered from the air, gradually concentrate. If no action was taken the salts would then form scale.

The EcoCooling control system counts the number of times the fill cycle operates. This is actually volumetrically measuring the amount of water being added to the tank. When a set number of fills has been reached the cooler fully drains.

The concentration factor at which water forms scales varies according to its chemical composition. Munters recommend the following indices to predict scaling:

Recommended Values for Common Indices
for Maintaining Recirculating Water Systems

Langlier Saturation Index (LSI) 0.5 + 0.25
Ryznar Stability Index (RSI) 6.0 + 0.5
Puckorius Stability Index (PSI) 6.5 + 0.5

Ref: Appendix 3 – Munters Engineering bulletin EB-HWT-309

An EcoCooler can be configured to give a concentration factor between 2.2 and 5.7.

Level Probe Design

The level probe is based on magnetic reed switches.

The switches are normally closed. As the water level rises the polystyrene floats, which contain magnets, rise and the switches clear. The control system continuously monitors the logical sequence of the probe. If an error is detected the 'Probes out of Sequence' fault is indicated.

The EcoCooler cannot operate without a probe as the system expects to see closed contacts at start-up.

1.3 Installation and Commissioning

The installation of an EcoCooler should take into consideration the quality of the supply water and the ambient air quality. Appropriate controls shall be identified if there is a possibility of contaminated water or air.

The commissioning of an EcoCooler consists of:

- Validating the operation of the control system
- Configuration of the control system

A commissioning sequence is built into the process control software. This validates all of the components operate.

With regard to legionella control there are a number of configurations which can influence performance.

Configuration parameters are set by a number of dip switches on the main control panel which allow the following:

- 24 hour dry cycle. An option exists to dry the pads out for 30 minutes every 24 hours. In some cases this is believed to improve pad hygiene
- Scale control. The maximum water concentration factor can be varied from 2.2 to 5.7. On commissioning this is set according to local water quality.

It is possible to sanitise the system on commissioning but this has only a short term effect. The amount of air and water being processed result in any sanitising agent is rapidly dispersed.

1.4 Maintenance

All water systems should be maintained. An EcoCooler is typically maintained every 6 months but this is dependent upon air contamination, water quality and usage. A maintenance program includes the following:

- Remove side panels
- Remove insect screens and clean
- Clean filters with low pressure cold water
- Clean inlet water filter
- Replace filter pads as necessary
- Clean sump using Clean Routine
- Clean all other cooler parts
- Run Test Routine
- Check dipswitch configuration
- Replace insect screens and replace panels
- Check wall control operation

In addition to the above the scale prevention configuration is reviewed and adjusted after inspection for any scale formation.

2.0 Factors to be taken into consideration when performing a risk assessment

The structure of risk assessment is based on the pathway of a legionella infection of a human being:

- Presence of legionella bacteria in a water system
- Growth of legionella bacteria to a concentration level capable of infection
- Dissemination of droplets or aerosols contaminated with legionella
- Infection of a susceptible host by these droplets or aerosols

These stages shall be analysed in detail and reference made to process control, operating conditions and practical experience.

2.1 Presence of legionella bacteria in the water system

The 'seeding' of the water system in an EcoCooler could come from legionella being present in the:

- Feed water
- Air borne particles
- Engineering components of the EcoCooler

Feed Water

It is a firm recommendation than only clean, potable water is used in an EcoCooler. Any other form of water, e.g. from rainwater harvesting or water recovered from other processes, should be subject to separate analysis and appropriately treated. Whilst a town mains water supply is not sterile the microbiological loading is very low and consequently presents low seeding of legionella or other bacteria into the system.

Although options do exist in the pre-treatment of water it is not recommended using water which is so highly contaminated that these are required.

Air Borne Particles In the majority of installations ambient air does not contaminate the system.

Where an EcoCooler is processes air contaminated with both bacterial and organic matter then it is normal to use a biocide to control bacteria growth. Typical conditions requiring this are internal evaporative coolers in the print industry.

A contribution to reducing contamination is the fitting of insect screens as standard to EcoCoolers. This reduces the possibility of insects reaching the filter material.

2.2 Growth or legionella bacteria to a concentration level capable of infection

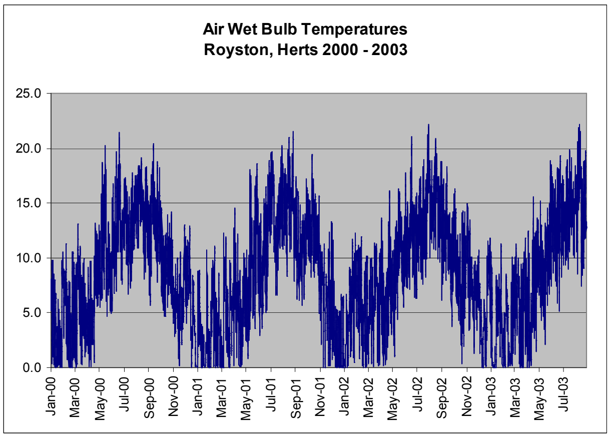
The rate of legionella growth is dependent upon

- Temperature
- Nutrients
- Stagnant water

Water Circulation Temperature

The water in an evaporative cooler circulates at the wet bulb temperature of the air. Different climates have different wet bulb temperatures. In the UK the wet bulb temperature of the air rarely exceeds 20C and never exceeds 25C.

A detailed analysis of data from the Iceni (www.iceni.org.uk) weather station at Royston in Hertfordshire is typical of UK weather.

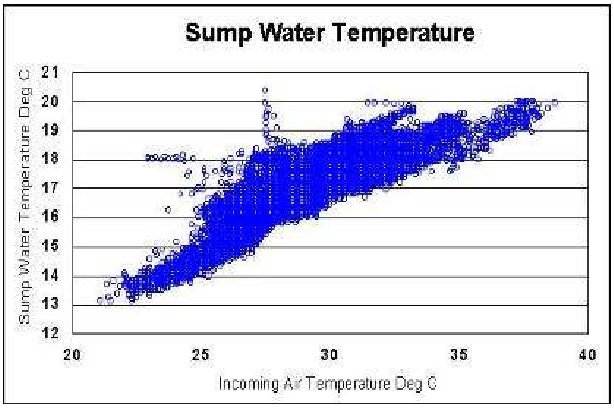


A statistical analysis of the 50399 hours of weather data shows the following cumulative data.

	Ambient C		WBT C	
35	2	0.0%	0	0.0%
34	4	0.0%	0	0.0%
33	11	0.0%	0	0.0%
32	15	0.0%	0	0.0%
31	17	0.0%	0	0.0%
30	34	0.0%	0	0.0%
29	64	0.1%	0	0.0%
28	119	0.1%	0	0.0%
27	194	0.2%	0	0.0%
26	318	0.3%	0	0.0%
25	548	0.5%	0	0.0%
24	790	0.6%	0	0.0%
23	1222	1.0%	0	0.0%
22	1674	1.0%	2	0.1%
21	2448	1.8%	28	0.2%
20	3202	1.7%	130	0.6%
19	4271	2.4%	332	1.4%
18	5395	2.6%	886	3.1%
17	7109	3.9%	1844	5.6%
16	8704	3.6%	3148	9.0%
15	10470	4.0%	4966	13.7%
14	12698	5.1%	7032	18.8%
13	14618	4.4%	9619	24.9%
12	17171	5.8%	12201	31.1%
11	19317	4.9%	14754	37.0%
10	21963	6.0%	17684	43.9%
Below 10	21864	50.1%	24070	56.1%
	50399		**50399**	

From this is can be seen that an evaporative cooler operates below 20C for over 99% of the time.

Monitoring of an evaporative cooler showed the following.



When the EcoCooler is not in cool mode the water system drains and so avoids any increase in water temperature due to stagnation.

With reference to ACOP L8 paragraph 9:
'*Temperatures may also influence virulence; legionella bacteria held at 37C have greater virulence than the same legionella bacteria kept at a temperature below 25C'*

From this data it can be seen that the water temperature is completely safe for 99% of the time and only presents a poor growth conditions for low virulence legionella bacteria for the remainder of the time.

Nutrients to Support Legionella Growth

An EcoCooler is designed with all non filter media water contact surfaces constructed of either plastic or stainless steel. CELdek evaporative media is made from a specially engineered cellulose paper that is chemically treated to resist deterioration. The structure therefore will not break down or corrode to provide nutrients.

A potential source of nutrients is from the air which is being cooled. Particles are washed from the air stream as it passes thought the filter media. As part of the scale control system the tank is flushed to remove these particles. If contamination levels are high then a biocide can be used to prevent growth. This is not normally necessary on externally mounted coolers taking in fresh air. The effects fo grossly contaminated air should be given special consideration during a risk assessment. Biocideds should only be used with caution.

The drain cycle constantly purges the system of contaminants. The drain cycle is invoked at:

- Start up
- Scale control cycle
- End of cooling

By allowing the cooler to drain fully and then purging the sump with fresh water removes debris. Any bacterial growth is also diluted during this process.

Scale is prevented by the control system as described in the water circulation control section. The problems associated with scale are therefore removed.

Stagnant water presents a risk for legionella growth. The EcoCooler design and process control avoids stagnant conditions through:

- Fully self draining design
- No dead legs
- Slow fill fault identification
- Slow drain fault identification
- Slow evaporation fault identification
- Cooler immediately drains fully when not in cooling mode

2.3 Dissemination of droplets or aerosols contaminated with legionella

The key to avoidance of droplets is the face velocity of the air over the filter pads. The design criteria are detailed in the **EcoCooler Design, Process Control and Operation** section. The EcoCooler operates with an air flow rate such that only pure evaporation occurs. Droplets, and aerosols, are avoided.

Independent research has shown that Munters evaporative cooling systems do not provide a transmission mechanism for bacteria from water to air. A study at Aachen University showed that when water which had been inoculated with bacteria was circulated in the system no bacteria were found in the air stream. The same study also showed a 70% reduction in particles entrained in the air in the range 5um to 10um as the air passed through the pads.

See Appendix 4 – Aachen University Hygiene Test

2.5 Infection of a susceptible host by these droplets or aerosols

It is not normally possible to control the population who may be exposed to the output from an EcoCooler. It is therefore assumed that all prevention and control methods must be in place prior to this stage in the infection pathway.

3.0 Application of the Key Principles of the Prevention of Legionnaires' disease

ACOP L8 gives clear guidance on the controls which may be used in the preventions of Legionnaires' disease. These are examined and their application to the design and operation of an EcoCooler is demonstrated.

3.1 Avoidance of stagnant water

An EcoCooler drains when not in cooling mode. It is designed to be fully draining. A level probe validates the cooler is empty and a fault is indicated if the cooler does not empty in accordance with the control system.

Separate faults are identified by the control system relating to potential stagnation. A slow evaporation alarm identifies a circulation pump failure. A slow fill alarm identifies a failed or weak supply water.

3.2 Low water operating temperature

The operating temperature of an EcoCooler is determined by the wet bulb temperature of the air being cooled. In the UK this temperature is below 20C for 99% of the time and never goes above 25C. At high temperatures the rate of evaporation is high and the cooler will be drained, flushed and replenished with fresh water approximately every two hours.

3.3 Avoidance of corrosion and scaling

All water contact surfaced, except the filter media, are plastic or stainless steel to avoid corrosion. The cellulose based filter media is chemically treated to resist degradation.

Scale is automatically prevented by the EcoCooling control system. The volume of water added to the tank is added until a set point of water concentration is reached. At this point the EcoCooler fully drains, the tank is flushed and then replenished with fresh water.

3.4 Use of a biocide

It is not normal to use a biocide in a standard externally installed EcoCooling system using clean potable water with clean ambient air. Where contamination levels are high then great care should be taken during a risk assessment biocides used with caution.

Note that oxidising biocides in the recirculating water may result in the discharge air causing corrosion in sensitive equipment.

UV systems can be used to treat the incoming water but it is NOT recommended they are used on the circulation loop. UV systems require filtration to protect the lamp quartz and the system needs to be designed to be self draining and the filters to be backwashed. It is possible to increase the level of risk with UV rather than reduce it unless very careful consideration is given to its installation.

3.5 No production of aerosols

A wetted media evaporative cooler should produce no droplets or aerosols. The maximum design speed of Munters CELdek filter media is 3m/s. The EcoCooler has a design speed of 1.6m/s giving a factor of safety of 180%

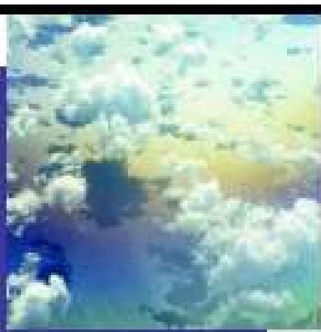
3.6 Maintenance

The maintenance frequency of an EcoCooler is determined by the water quality, air quality and usage. An element of self cleaning is incorporated as part of the drain and scale control cycle. A routine maintenance program, typically every 6 months, involving inspection, cleaning and validation of operation and control parameters will ensure a hygienic and efficient cooler.

Appendix 1 – Munters Humicool CELdek Specification

HUMICOOL DIVISION

CELdek with MI-T-edg



ENGINEERED TO PROVIDE MAXIMUM COOLING AND HUMIDIFICATION, LOW PRESSURE DROP AND YEARS OF RELIABLE SERVICE

CELdek FEATURES:

- **High Cooling Efficiency**
  Exceptional cooling rates are achieved due to the design, manufacturing and materials used in CELdek.
- **High Face Velocity**
  The shallower angle of Munters unequal flute design allows high velocity air to travel through the pad without water droplet carryover.
- **Self-Cleaning Design**
  The steeper angle of Munters unequal flute design flushes dirt and debris from the surface of the pad. This cleaning action directs water toward the air entering face of the pad where it is needed most.
- **Low Pressure Drop**
  The shallow angle of Munters unequal flute design allows high velocity air to travel through the pad without significant resistance or water droplet carry over.
- **Simple to Maintain**
  In most cases, routine maintenance can be performed while systems are still operating. When properly maintained, Munters CELdek pads will provide many years of highly efficient cooling and humidification.

MI-T-edg PROTECTION

- **Protective Edge Coating**
  Munters MI-T-edg is a tough and resilient edge treatment applied to the air entering face of a CELdek pad. It has been formulated to withstand repeated cleaning without damaging the pad.
- **Algae and Weather Resistant**
  Munters MI-T-edg is nonporous and quick drying. It prevents algae and minerals from anchoring themselves into the substrate of the pad, so they slough off when dried. MI-T-edg also protects CELdek pads from the damaging effects of severe weather and long term exposure to UV light.
- **Extends the Service Life of Evaporative Pads**
  Munters MI-T-edg protective edge coating extends the life of the pad over that of non-treated pads.

Munters

CELdek evaporative media is made from a specially engineered cellulose paper that is chemically treated to resist deterioration. Our cross fluted, unequal angle pad design promotes the highly turbulent mixing of air and water for optimum cooling and humidification. This unique design also functions to continually direct more water to the air entering face of the pad, where the air is hottest, driest and dirtiest, and the most intense evaporation occurs.

DESIGN CONSIDERATIONS

- **Water Distribution**
  Water flow rates vary based on the depth of the media. CELdek requires 1.5 gallons per minute of water per square foot of horizontal (top) pad surface area. For installations that have intense evaporation or pad walls taller than 72", an additional 10-20% of water should be used.
- **Supply**
  The gutter and sump should be sized to supply the system with enough water to operate at its maximum flow rate and not overflow when the system is shut down.

OPTIONS

- **Protective Edge Coating**
  MI-T-edg algae resistant edge coating is available for all sizes of CELdek evaporative cooling media for longer pad life and easier cleaning.
- **Distribution Pads**
  CELdek is designed to distribute water from the front to the back of the pad. For lateral distribution, a 2" or 3" distribution pad should be used. These specially designed pads are also protected with Munters patented edge treatment.

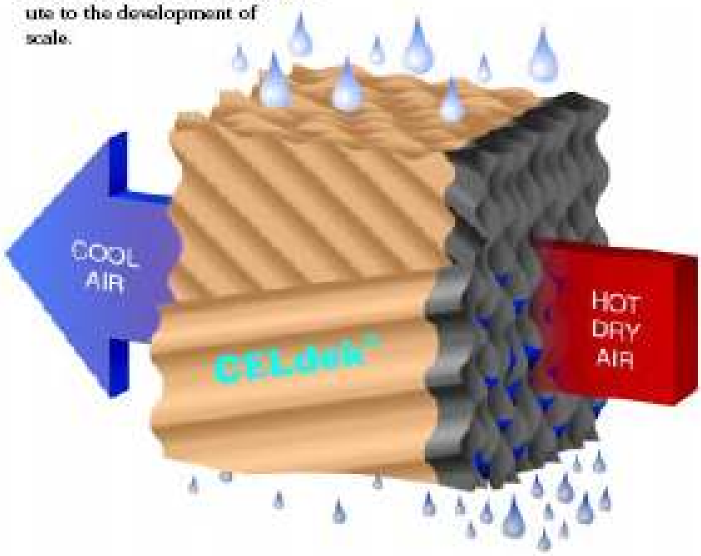
CELdek Standard Sizes:	
Depth:	4", 6", 8", 12", 24"
Height:	48", 60", 72"
Width:	12"

MAINTENANCE

- **Scale**
  Mineral deposits can be minimized by maintaining a continuous water bleed-off or by periodically dumping the sump. The methods and/or quantity of bleed-off may vary depending on the pH and hardness of the supply water, and Munters can assist you by recommending individual bleed-off rates.
  Note: Fractional timers should not be used. These timers do not enhance the performance of a cooling pad and actually contribute to the development of scale.
- **Algae**
  If algae is allowed to grow freely on a CELdek pad it may eventually clog the flutes and inhibit the flow of air. This increases the static pressure and reduces the efficiency of the pad. Algae growth can be controlled by early implementation of simple maintenance techniques.
  Munters maintenance bulletins provide information to help maximize the efficiency and life of CELdek evaporative pads.

SELECTION

The depth and height of media varies depending on the application. Call Munters for help in determining the requirements of specific installations. CELdek may also be cut to fit smaller equipment. Call Munters for more information.



The steeper angle directs more water to the air entering side of the pad, where it is needed the most.

Munters

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Appendix 2 – Munters CELdek 5090 Specification

CELdek® 5090-15 Evaporative Cooling Pad

CELdek® 5090-15 evaporative cooling pad is used in systems where high efficiency cooling is required. It can be used for many different cooling purposes but is particularly suitable for evaporative coolers for commercial and domestic use.

The Green stripe pad consists of specially impregnated and corrugated cellulose paper sheets with different flute angles, one steep (60 deg) and one flat (30 deg) that have been bonded together. This unique design yields a cooling pad with a high evaporation efficiency while still operating with a very low pressure drop. In addition scaling is kept to a minimum and no water carry-over occurs due to the fact that the water is directed to the air inlet side of the pad. This is where most of the evaporation takes place.

The impregnation procedure for the cellulose paper ensures a strong self supporting product, with high absorbance, which is protected against decomposition and rotting and therefore increaseing longevity.

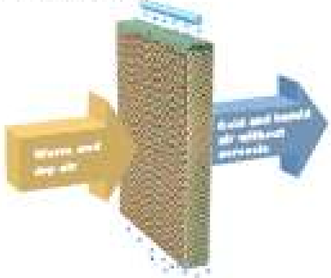
The distribution pad constitutes a vital part of a complete system and should always be ordered in combination with CELdek evaporative cooling pads. Placed on top of the cooling pad it ensures a uniform supply of the water to the cooling pad and minimises the risk of dry spots.

The evaporative cooling technology

Water is circulated through a pump station and supplied to the top of the cooling pad via a distribution manifold. A distribution pad on the top of the cooling pad ensures an even water distribution. The water flows down the corrugated surface of the CELdek evaporative cooling pad. Part of the water is evaporated by the warm and dry air that passes through the pad. The rest of the water assists in washing the pad, and is drained back to the pump station through a gutter system.

The heat that is needed for the evaporation is taken from the air itself.

The air that leaves the pad is therefore cooled and humidified simultaneously without any external energy supply for the evaporation process. This is natures own cooling process.

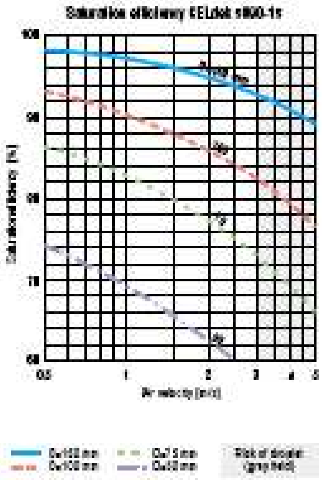


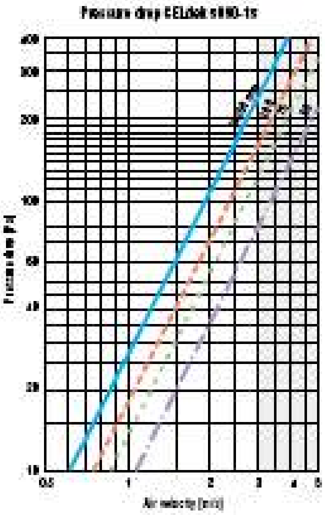
5090-15

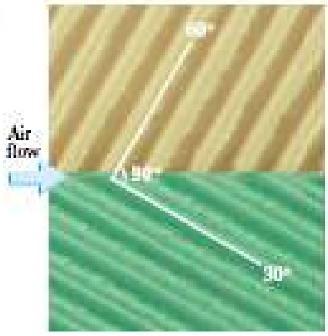
Equipment

- **High evaporation efficiency**
- **Superb wetting properties**
- **Low pressure drop when wet, leading to lower operating costs**
- **No water carry-over**
- **Low scaling**
- **Self cleaning**
- **Strong and self supporting**
- **Long life time**
- **Low running costs**
- **Quick and easy to install**
- **Environmentally friendly**
- **Consistant high quality**

Munters

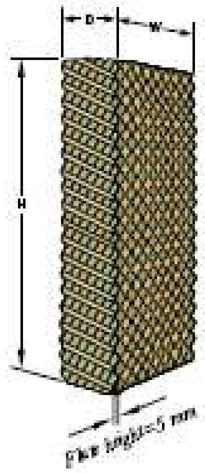






Performance curves

The pressure drop diagram shows the pressure-drop over the pad in the wet condition. With the pad in a dry condition the pressure-drop is <10% less. Therefore there is minimal loss of air-flow when the pad is wet compared to when it is dry.



Order information
Evaporative cooling pads

CELdek 5090-15-X-X-X

Height, mm
Width, mm
Depth, mm

e.g., CELdek 5090-15-1800-600-100

Standard heights,
H = 1000, 1500, 1800 and 2000 mm
Standard width,
W = 600 mm
Standard depths,
D = 50, 75, 100 and 150 mm

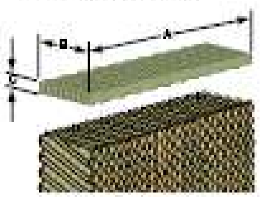
Order information
Water distribution pads

CELdek 70120-0-X-X-X

Width, mm
Depth, mm
Thickness, mm

e.g., CELdek 70120-0-600-100-30

Standard width,
A = 600 mm
Standard depths,
B = 50, 75, 100 and 150 mm
Standard thickness,
C = 30 and 50 mm



CELdek® is developed by Munters AB and produced worldwide.

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Munters

ENGINEERING BULLETIN
EB-HWT-309

HUMIDIFIER WATER TREATMENT

Most chemical treatment programs are designed to prevent precipitation of scale forming minerals in heat exchangers. The cooling of the water by evaporation/convection occurs at the cooling tower, not the heat exchanger. The fill in the cooling towers stay clean by flushing it with a sufficient flow of water to prevent deposits from developing. If you experience poorly wetted areas then deposition will occur in the tower.

With evaporative coolers, the evaporation occurs on the surface of the media. When mineral concentrations in the water are too high and/or insufficient water is in contact with media surface, mineral salts concentrate and deposit on the media face. Chemical treatment by use of scale inhibitors will have little or no positive effect in evaporative cooler applications. In essence, the scale inhibitors will become part of the scale deposit. Thus, conventional water treatment methods do not apply to evaporative coolers.

Similarly, the pretreatment of water using a water softener which converts the calcium and magnesium bicarbonates to sodium bicarbonates will also have little or no positive effect. Although the sodium bicarbonate deposits are softer and easily removed by washing down the media, they present the further problem of blowing off the media into the airstream when dry.

The removal of most of the mineral salts through demineralization, reverse osmosis, etc., will eliminate the scaling problem. However, these types of treatment methods requires major initial investments and high operating costs. Water treated in this manner is also very corrosive to common metals and may deteriorate the media by leaching out and degrading the stiffening agents and glue.

Water Flow Rates and Distribution

Using recommended water flow rates in conjunction with even water distribution across the entire media bank is the accepted, and most successful, means of minimizing or eliminating scale deposition. The constant washing of the face of the media with an acceptable volume of water will continuously clean the media surface.

The water should be supplied to each media bank distribution header at a rate of 1.5 gpm per square foot of media top surface area.

The evaporation rate changes little when more water is used. If less water is applied, two things occur, both of which have a negative affect. First, with lower water rates, concentrated mineral salts will accumulate faster due to there being less water volume to flush the face of the media. Secondly, there maybe insufficient water on the face of the media to provide the cleansing action that is desired and required.

Scaling Index

The water treatment industry uses several indices to determine the solubility of various minerals in water. These indices are referred to as scaling indices and take into consideration the following constituents; total dissolved solids, temperature, calcium hardness, total alkalinity and pH. Each constituent is used in a formula to determine if the water is scale forming or scale dissolving, as well as the severity of the reaction. For evaporative cooling and humidification, it is desirable to maintain a slightly scale dissolving index so that the recirculating water has the ability to dissolve mineral deposits. However, the water should not be so aggressive (scale dissolving) that it degrades the media.

Recommended Values for Common Indices for Maintaining Recirculating Water Systems	
Langlier Saturation Index (LSI)	0.5 ± 0.25
Ryznar Stability Index (RSI)	6.0 ± 0.5
Puckorius Stability Index (PSI)	6.5 ± 0.5

Maintenance levels are best controlled through bleed-off of system water at a predetermined rate. The preferred method for controling bleed off is through the use of a conductivity controller. Refer to Munters Engineering Bulletin EB-011-WTM for more details regarding scaling indices and bleed-off rates.

Once-Through Water

There are many humidification systems that use water on a once-through basis, reclaiming some of this water for other uses or dumping it to the sewer. Many of the surface and well waters used in once-through and recirculation systems are aggressive (scale dissolving) and will degrade the media. In these cases the best solution is to decrease the water flow rate to 1.0 gpm per square foot of top surface area. This will help extend media life and reduce once-through water costs.

The best guide in choosing the proper flow rate (1.0 vs 1.5 gpm/sqft) is to again use the scaling indices. Use the following table to help select the flow rate for a once-through system:

Water Flow Rates for Once Through Systems Based on Common Stability Indices

Index	1 gpm/sq ft	1.5 gpm/sq ft
Langlier Saturation Index (LSI)	< 0	0.5 ± 0.25
Ryznor Stability Index (RSI)	> 7.0	6.0 ± 0.5
Puckorius Stability Index (PSI)	> 7.5	6.5 ± 0.5

Biological Control

Uncontrolled growth of organic matter can result in plugged media, metal deterioration, media degradation, and undesirable odors downstream in the air supply.

There are many types of proprietary and commodity biological control agents on the market which are used in evaporative coolers/humidifiers.

The best control approach, however, is to allow the media pads to dry out completely on a weekly basis. This requires running the fans for a suitable period of time to permit complete drying of the pads. At an incoming ambient air temperature of 70°F, the following drying times should be used as a guide.

Drying Times for Various Media Depths

Media Depth	Drying Time
4 inches	30 minutes
6 inches	1 hour
8 inches	1 1/2 hours
12 inches	2 hours
18 inches	3 hours
24 inches	4 hours

Biocides

The commonly used proprietary non-oxidizing biocides that are sold by water treatment companies will have no adverse affects on the media when applied at EPA recommended dosages. EPA recommended dosage levels can be found on the drum label or furnished by the vendor.

Oxidizing biocides, such as chlorine and bromine can have a very detrimental effect on the media and should be avoided or used sparingly. If they are used, Munters recommends a biocide level be maintained at no more than 1.0 ppm, or less, of free halogen in the system.

Corrosion Control

The best approach to corrosion control in a humidification system is to fabricate the retaining system from non-corrosive metals or plastics.

If a corrosion inhibition program is required, as with large central recirculating systems, consult a reputable local water treatment company for their recommendations for your system. In doing so, be sure they provide an analytical monitoring program (such as corrosion coupons) to assure that the corrosion control of ferrous and non-ferrous metals is effective.

In all cases avoid programs which include phosphates. Phosphates will increase scale deposition and provide a nutrient for algae and bacteria.

Munters

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EB-HWT-309

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PD Dr. Med. Sebastian W. Lemmen

Faculty of Medicine RWTH Aachen

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 1×10^5 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%.

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