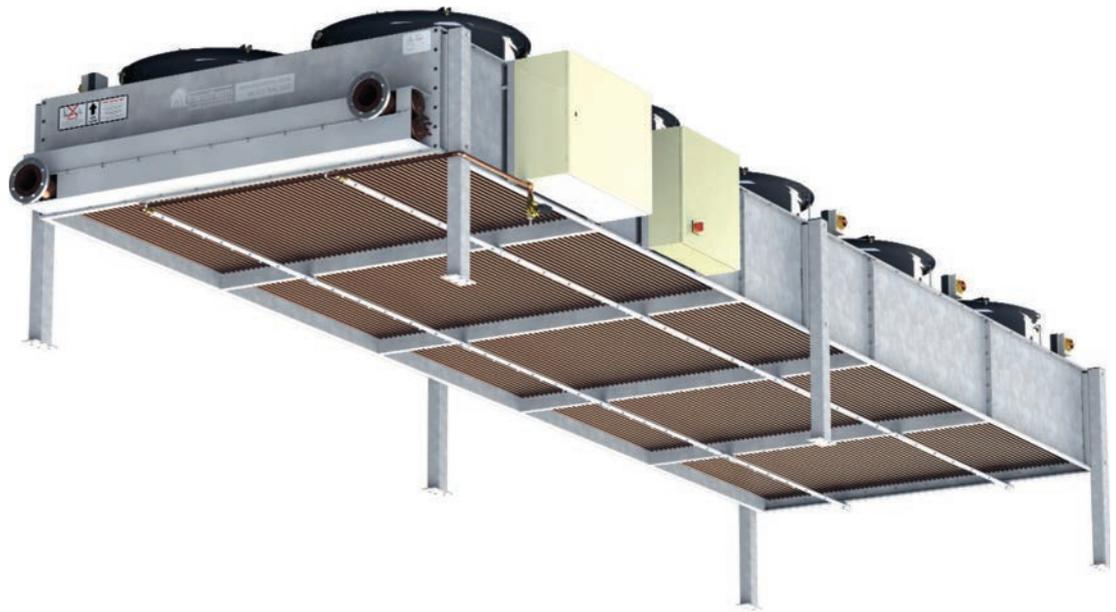


Adiabatic Cooling System



Operation and Safety Features

The following document, relevant to Aqua Cooling's adiabatic coolers and condensers, gives details on technical and safety features, designed to improve the reliability and safety of the adiabatic process, in line with current thinking. The British Health and Safety Executive (HSE) has confirmed that it is satisfied that the safety features and adiabatic system operation provides 'very effective' management of Legionella risk. HSE has also confirmed that Aqua Cooling's coolers do not require registration under the Notification of Cooling Towers and Evaporative Condensers Regulations 1992.

Introduction

Aqua Cooling adiabatic coolers are designed for use in high ambient/low water temperature applications. The range is the product of years of development and evolution, implementing the most modern technology to ensure a long and efficient product life with low operating and maintenance costs.

The 'TA' range of adiabatic coolers retains all the advantages that our 'TD' dry coolers offer, with the additional benefit of being able to cool the process water to temperatures lower than the design ambient dry bulb.

Our adiabatic coolers operate with the use of fans only for a high percentage of the year. The spray system will only operate in high ambient temperatures where the fans alone cannot cope.

Process water temperature is controlled within tight tolerances by the use of an electronic thermostat. This thermostat pulses the sprays to give only the minimum of adiabatic cooling required for any given load and ambient condition. Additionally, an air stat is used to lock out adiabatic operation at ambient temperatures below the design figures.

All design features are in place to minimise water consumption and running costs and to provide a long product life.

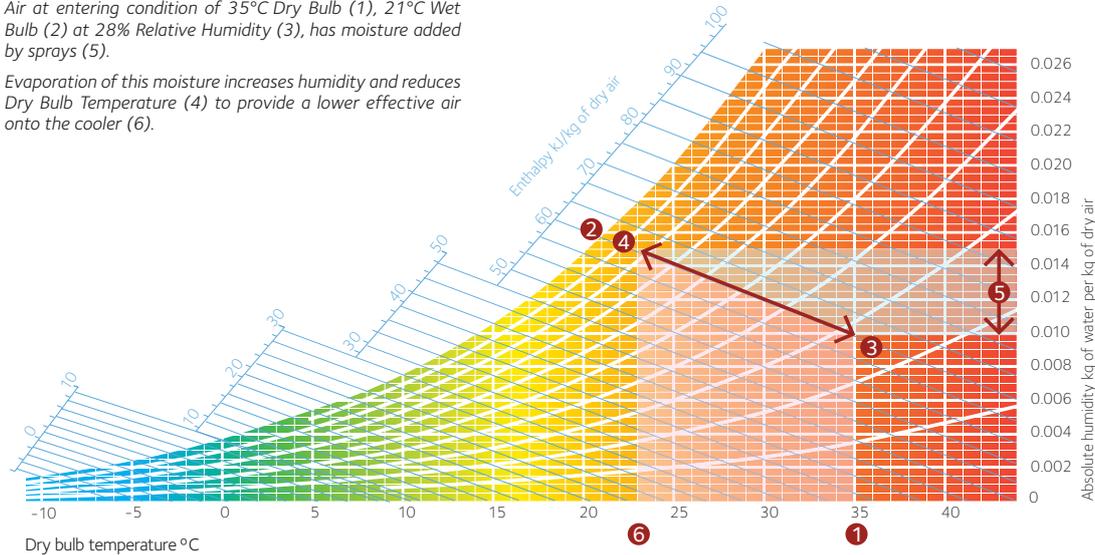
Adiabatic Cooling System

Key features include:

- Counter flow spray nozzles for even spray coverage across the entire coil surface area.
- Spray booster pump to give up to 6 bar G of water pressure at the nozzles, giving a fine mist.
- UV lamp UV sterilisation treatment for adiabatic water feed.
- Pulsed adiabatic spray operation to minimise water usage.
- Adiabatic system purge/drain timer ensures that stagnation of water cannot take place.
- Air thermostat locks out adiabatic usage in ambient temperatures below design figures.

Air at entering condition of 35°C Dry Bulb (1), 21°C Wet Bulb (2) at 28% Relative Humidity (3), has moisture added by sprays (5).

Evaporation of this moisture increases humidity and reduces Dry Bulb Temperature (4) to provide a lower effective air onto the cooler (6).



Guidance on the Control of Legionella and Legislation

There is currently no legislation specifically covering adiabatic coolers. One important document, which refers to the control of Legionella bacteria in water systems, states that whilst adiabatic coolers aren't covered, each system should be considered on its own merits. On the basis that different levels of system are available, ranging from basic sparge pipes across the top of units through to a sophisticated system such as ours, this is definitely the case.

Another important guideline document gives more in-depth information which offers suggestions for design of equipment which will help avoid the proliferation of Legionella. These include:

- Avoid dead-end piping, low spots and other areas in the water distribution system where water may stagnate during shutdown (our system avoids these and also incorporates an auto drain down feature for periods where adiabatic usage is not necessary).

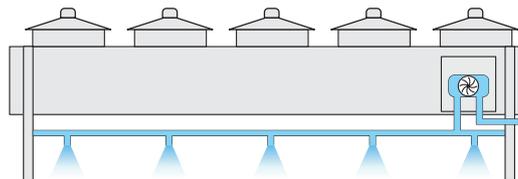
- Avoiding the use of materials such as rubber (our equipment uses copper piping and avoids the use of rubber hose as it could be a natural breeding ground for Legionella).
- Avoiding wetted media cooling as they have potential for bacteria growth where dirt, scale or biological matter can accumulate (our system is designed to give adiabatic cooling, where the moisture is mostly evaporated into the air prior to the air reaching the coil or air inlet filters).
- Avoid water droplet sizes between 1-5 microns as this is the size of droplet necessary to carry Legionella bacteria far enough into the human body for Legionnaire's disease to be contracted (our nozzles are designed to give droplet sizes of between 50 and 100 microns depending on the cooler model).

So whilst there is no legislation specifically covering the equipment, we take great care to ensure the most up-to-date generic information is considered and taken into account.

Technical Specification

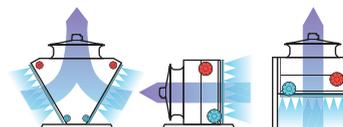
Standard Specification

Fins	Aluminium
Tubes	Copper
Headers	Flanged PN16 – screwed BSPM
Casing	Galvanised steel
Fan impeller	Plastic or aluminium
Fan motors	IP55 – 2 speed/variable speed capable
Spray pump	IP55
UV system	UV lamp – optional
Scale control	Magnetic
Unit range	From 25kW upwards



Model orientation

Maximum flexibility: models can be mounted in a choice of orientations.



Inactivation of Legionella Using UV System

To prevent the system from producing or transmitting Legionella, it includes the following safeguards:

The mains water feed supplied to our adiabatic system should be a clean one but, should it for any reason be contaminated, we supply a UV system as standard. This system is extremely effective at killing Legionella bacteria (99.99+%).

The UV water disinfection units supplied are designed to give a dosage of 30 mJ/cm² at the end of the lamps life. This is enough for the UV system to be 99.999% effective at killing Legionella bacteria (assuming that the water has a UV transmission of more than 95% in a 10mm cell at 254nm).

The UV system has a design life of 8,000 hours.

Ultraviolet energy at 253.7nm wavelength required for 99.9% inactivation.

For equivalent figures in $\mu\text{WS}/\text{cm}^2$ [microwatt seconds/cm²], multiply by 1000

Bacteria	UV Dose
Legionella bozemanii	3.5
Legionella gormanii	4.9
Legionella micdadei	3.1
Legionella longbeachae	2.9
Legionella pneumophila (Legionnaire's disease)	12.3

UV Dosage and Dosage/Kill Relationship

Doubling the dose required for 90% destruction will produce 99% destruction of the target organism. Tripling the dose will produce a 99.9% destruction of the target organism and so on.

Opposite is an example of the Dosage/Kill relationship for a typical microorganism (Legionella pneumophila).

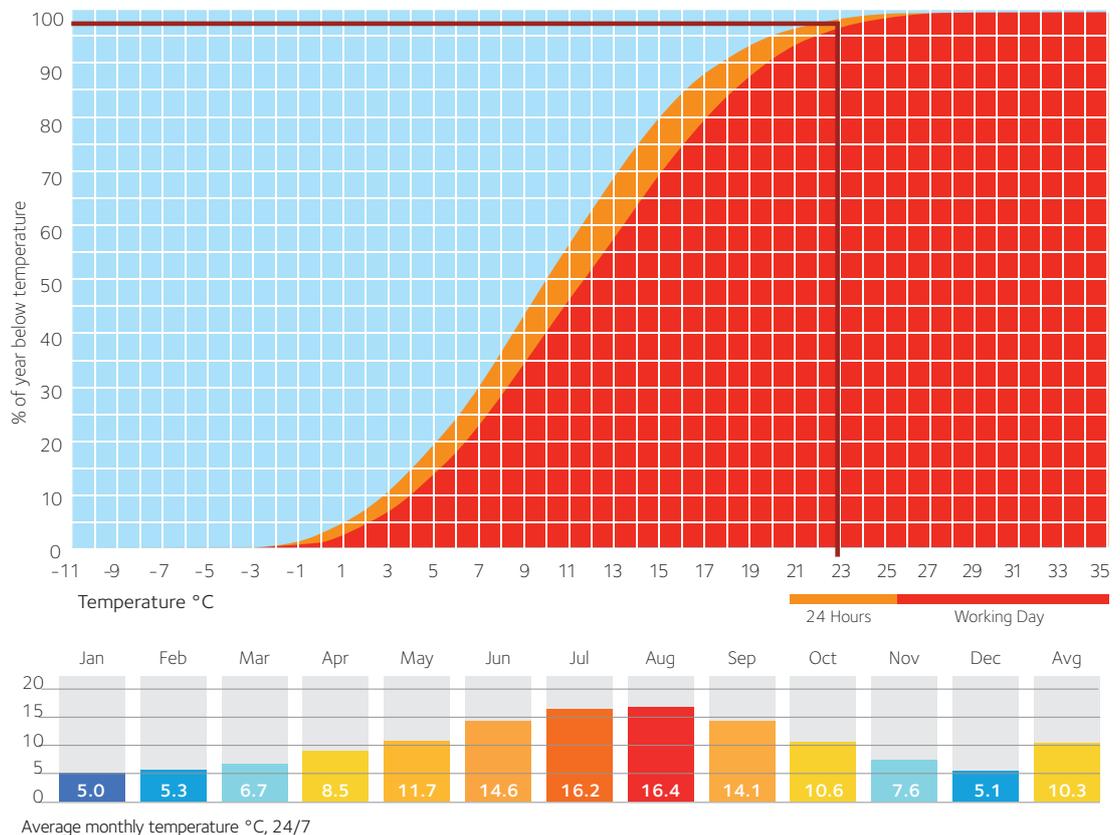
Applied UV Dose mJ/cm ²	Reduction in live micro organisms
4.1	90.000%
8.2	99.000%
12.3	99.900%
16.4	99.990%
20.5	99.999%

UV System Fail-safes

Given a 23°C trigger point for the adiabatic system, we would expect it to only operate for approximately 3% of the year, (the unit would operate as a dry cooler for 97% of the year).

On this basis the UV lamp should, in theory, be good for 30+ years. However, in case of UV failure, the controls will switch off the adiabatic system and send an alarm signal.

The unit will continue to run as a dry cooler and the adiabatic system can only be restarted using a manual reset (by which point the repair should have been carried out in accordance with the O&M manual).



The complete solution to all your cooling needs

Energy Saving

Below: a photo of our adiabatic wet box showing the spray booster pump and UV system (amongst other items such as a double check valve, which is a safeguard to prevent water that has entered the adiabatic system flowing back into the mains supply, and a pressure regulating valve, which means that the correct pressure can be supplied to the spray nozzles regardless of varying mains water pressures).



Options

Our equipment is designed for outdoor use and therefore will get wet. However, if there are concerns over the atomised spray water not being fully evaporated into the air prior to entering the coil block (i.e. small amount of wetted surface cooling), we offer air inlet filters. Any moisture that is not evaporated into the air will collect on the filter material from which it will be evaporated and will not enter the coil (see photo below).



Adiabatic System Safety Features and Operation

During a large amount of the year where no adiabatic cooling is required our system has an auto drain down function where the system is emptied of water.

During periods where adiabatic cooling will be required the system has a pre-purge facility which flushes the system to drain prior to start or restart of adiabatic spraying.

All adiabatic pipe work is rigid copper (no rubber hose used anywhere) as this is now deemed best practice.

Even without the safety measures shown above and a contaminated water supply, the spray nozzle design is such that the risk to health is minimised as water droplet size is between 50 and 100 microns.

It is generally accepted that in order for a person to contract Legionnaire's disease the water droplet size would need to be between 1-5 microns in order for it to be carried far enough into the human system.

In addition to the safeguards shown above, we take the following measures to ensure minimal water usage:

- Adiabatic usage is locked out by a digital air stat for any temperatures below the adiabatic trigger point. Once this trigger point is reached the system only pulses for as long as is necessary in order to maintain the required process water temperature. Only when the maximum design dry bulb temperature is reached will the system operate continuously.
- In order to minimise the possibility of operating problems, we also monitor the inlet pressure to the adiabatic spray booster pump. Should the inlet pressure drop too low for correct functioning, the adiabatic system will be shut down and an alarm signal sent. This ensures that the system operates within design parameters and reduces the possibility of damage to the pump.

