ROBUR®

caring for the environment

Evaporative cooler AD 14

Cool, natural, simple air distribution system

Robur turns the love for BEAUTY AND WELL-MADE THINGS
into innovative heating and cooling systems
that are especially designed and developed to answer the
specific Man needs.

Robur Vision

Robur is dedicated to dynamic progression in research,
development and promotion of safe,
environmentally-friendly, energy-efficient products,
through the commitment and caring
of its employees and partners.

Robur Mission

Robur, founded in 1956, researches, develops and produces natural gas heating and air conditioning systems with high efficiency and low environmental impact.
An exclusive feature of Robur products has always been their use of natural, renewable energy sources, to reduce emissions of pollutants into the atmosphere and to ensure a rational use of energy.

Robur's key values

Innovation
in researching and developing technologically advanced products and in offering qualified services, directed towards total customer satisfaction

Corporate social responsibility and industrial vocation
in developing and manufacturing safe, environmentally-friendly and energy-efficient products

Value of human resources
in involving all of its human resources, both inside and outside the company, so that they are aware and motivated, throug a constant process of ongoing training and the sharing of dreams, strategies and goals

Value statement

"Robur wishes to be a place of work which is stimulated by Progress, sustained by Passion, vitalised by Humanity, guided by Justice, guaranteed by Quality and inspired by Beauty."

Robur in numbers

37 million euros sales 2006
243 employees
450 authorised service centres nationwide
7% investment dedicated to Research & Development and product industrialisation

Quality certification and Robur's most recent awards

1995 - ISO 9001 Certification
2000 - Regional First Prize, Qualità Italia
2001 - First in Europe to gain ISO 9001: 2000 (Vision 2000) quality certification in the air conditioning and heating sector
- National First Prize, Qualità Italia
2003 - Special Prize Winner, "European Quality Award"
- Robur's gas-fired absorption heat pumps are one of the projects singled out at the Amica dell'Ambiente (Friend of the Environment) Innovation Award
- Robur wins the Technology Innovation Award for its reversible gas-fired absorption heat pump
2004 - Benito Guerra, Robur's president, is nominated as finalist in the "Quality of life" category of the National Businessman of the Year Award promoted by Ernst & Young
2005 - ISO 14001: 2004 certification
- The K series of warm air heaters and the GAHP-W series of gas-fired heat pumps are given an honourable mention in the HVAC&R Innovation Award promoted by Costruire Impianti
2006 - Honourable mention at AHR Expo Innovation promoted by ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers - USA)

Simple air distribution systems deliver cool, fresh air to provide complete building coverage or spot cooling.

AD 14 evaporative cooler

evaporative cooling is a completely natural way of producing refreshing cool air

Ad 14 evaporative coolers, offer a completely natural way of producing refreshing cool air. Our Evaporative cooling units have been specifically designed for the cooling of industrial and commercial buildings. Sophisticate process controls together with naturally low water operating temperatures assure a hygienic and safe cooling unit

At 25% of the installed cost and 15% of the running cost of air conditioning, the AD 14 evaporative cooler is a truly low cost cooling system.

Application

- industrial buildings and warehouse;
- commercial buildings, shops and showrooms;
- fitness center.

The AD 14 evaporative cooler characteristic

- **Low energy consumption.** The only electrical consumption is given by the fan (5 speed) and a small water circulation pump. The cooling obtained by the unit is almost all natural.
- **No refrigerants.** The performance of the unit given by the physical characteristics of water and air, so no refrigerants are used, so it is not necessary to replace or fill up with refrigerants the system.
- **Modular and adaptable system.** Each unit can operate independently or can be integrated with other units, even afterwards, to build a more complex system, without affecting simplicity and effectiveness.
- No specialized maintenance. The only maintenance needed is the cleaning of the filters of the evaporative pads and other simple steps, that do not require expensive maintenance.
- **Electronic control of the system to grant efficiency and hygiene.** Even if simple in the function side, the system is kept efficient and hygienic thanks to a sophisticated electronic control system, that controls every functioning condition.

The AD 14 evaporative cooler technology

As warm air passes over wet filter pads water naturally evaporates into the air. The output air is cooled, as it gives up the heat required to evaporate the water.
AD 14 has special evaporative pads which are kept saturated with water from the sump that is pumped over the pads via an internal water distribution system.
An axial fan draws the air through the pads and then into the air distribution system.
The special evaporative pads, cellulose based, are protected from impurities and insects by a removable screen inserted into the side panel, this keeps the system clean and hygienic.

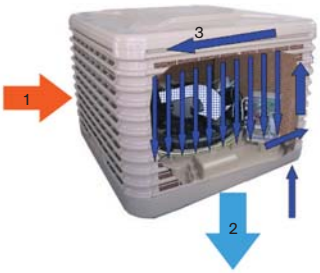


Fig. 1

1 Hot dry air
2 Cool air
3 Water circulation

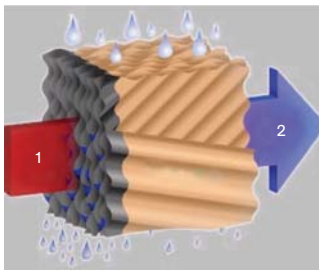


Fig. 2

1 Hot dry air
2 Cool air

Fig. 3

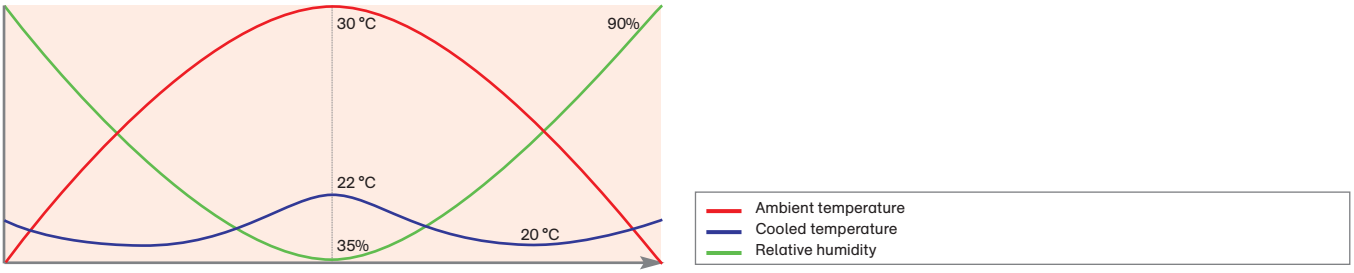
(1) Electrical energy price considering: 0.12 €/kWh, water price: 1.00 €/m³.

Performances

The performance of the AD 14 is dependent upon the temperature of the air and its relative humidity (RH). Higher temperatures give greater cooling. Low RH gives greater cooling.
In a temperate climate hot weather coincides with low RH. Detailed information about local weather can be found on www.wunderground.com
The diagram below shows the typical profile for temperature and humidity on a very hot day. It is very rare for the cooled air temperature to exceed 22°C. As it results, the relative humidity is low when the temperature is high. This means that the cooling effect is useful and efficient during the high temperatures.
From the performance chart for Milan in July 2007 shown on page 2 it can be seen that the combination of temperature and RH levels meant that the maximum air output temperature would be not higher than 21.5°C.
In April and October we often see days with the air at 20C and RH over 90%. An AD 14 takes July and August weather conditions and transforms them into April or October conditions.
The AD 14 evaporative cooler can operate in 2 modes, depending on the climate conditions:

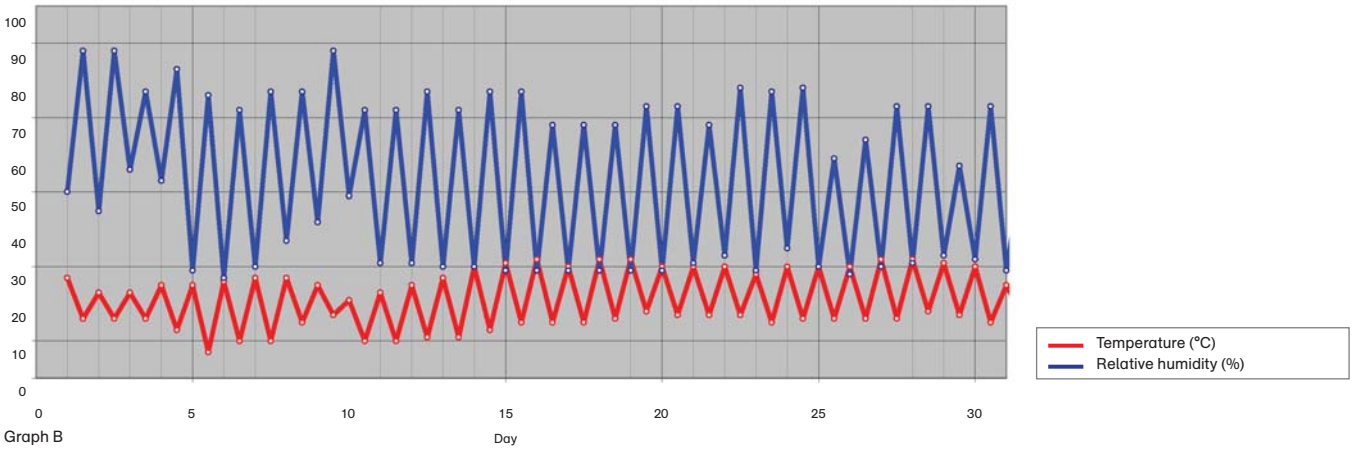
- Cooling mode, when the external air is hot and not particularly humid
- Ventilation mode, when the external air temperature is not too high but some ventilation in the building is still needed.

A control system can automatically set the fan speed to constantly minimise the electricity use of the fan.



Graph A

TEMPERATURE AND AIR HUMIDITY GRAPH, MILAN, JULY 2007



Graph B

OUTLET AIR TEMPERATURE BASED ON OUTSIDE TEMPERATURE AND RELATIVE HUMIDITY

Temperature (°C)	Relative humidity						
	20%	30%	40%	50%	60%	70%	80%
20	10.2	11.6	13.1	14.3	15.6	16.8	17.9
25	13.7	15.4	17.0	18.6	20.0	21.3	22.6
30	17.0	19.1	21.0	22.8	24.4	26.0	27.4
35	20.4	22.9	25.1	27.1	29.0	30.6	32.1

Electronic controller: a simple system managed under every point of view

Even if simple in the function side, the efficiency and hygiene of the system must be always kept at the maximum level. For this reason AD 14 is equipped with a control board governed by a microprocessor, that manages a series of periodical operations and system function controls.

- **Pre Cool Cycle.** This allows the pads to be saturated prior to the fan starting.
- **Water Bleed rate.** The water bleed rate, which prevents scaling, is set at 30%. This can be varied from 18% to 46% to accommodate different water properties.
- **Anti-legionnaires disease cycle.** Each time the cooler stops, the systems change completely the water in the sump. At each start of the unit the system will be drained and fresh clean water will be supplied.
- **24hr Dry Cycle.** The cooler will dry out for 30 minutes during every 24 hours of continuous operation. This can be used in certain circumstances to improve the hygiene of the cooler.
- **Maximum Speed Setting.** The fan speed can be limited on 5 levels (from 1340rpm to 1000rpm) to reduce the air flow or reduce noise levels.
- **Automatic function.** This function stops completely or reduces the fan speed, when reached a previously set temperature or humidity in the building.
- **System diagnostic.** The electronic board controls the unit for various malfunctions as slow evaporation, slow drain, slow fill of the sump, probe error.

Controls

The wall control box is supplied as standard with AD 14 coolers. This includes:

- power on-off switch
- fan speed control from 1 to 5
- cooling mode switch
- automatic mode switch
- warning light

Cooling mode

In cooling mode the cooler starts the fan and the circulation pump to supply the water to the evaporative pads. The speed of the fan can be adjusted by the remote control. In this mode there is not control from a thermostat or humidistat.

Automatic Mode

In automatic mode the control system monitors a thermostat periodically. If the thermostat shows a closed contact then the cooler will increase the speed of the fan till maximum speed with cool mode. If the thermostat shows an open contact then the cooler will decrease the speed of the fan till either speed 1 or shuts down completely according to the settings of the unit.

Other controls

The cooler can be equipped with other external controls that permit an advanced management system.

- **Humidistat:** There is an option to use a humidistat in Automatic Mode. This disables the water circulation when the set point is exceeded. All other functions are unaffected.
- **Timer:** a timer can be connected to start and stop the cooler when needed.
- **Alarm:** on the main control panel there is closed contact that can be used for any necessity when the cooler must be stopped.
- **Automatic Start of Extract Fans:** A contact is available in the main control panel to start automatically an extract fan when the cooler starts.
- **Drain Pump:** A 240VAC supply is available to power a drain pump where gravity drain is not possible.
- **LED Display:** A LED on the main control board gives the following information:
  - Alarm condition
  - Thermostat/Humidistat status
  - Timer Status
  - Test sequence status

External systems

The evaporative coolers AD 14 are supplied completely assembled and need only electrical, water supply, water discharge connections and the wall remote control (supplied as standard) connection.

Factors affecting the choice of an AD 14 are:

- Avoidance of roof penetrations
- Safe access for installation and maintenance
- Ductwork lengths

Down discharge

Top discharge

Side discharge

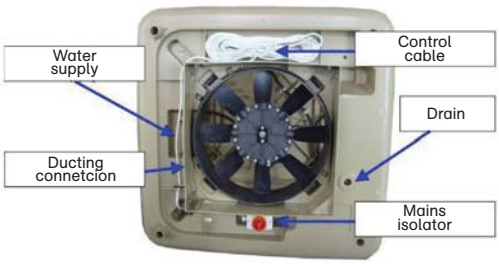
Services requirements

For the commissioning of the AD 14 cooler it is necessary to fulfill the following connections.

- **Water supply:** Supply minimum 1 bar max 7 bar. Minimum supply 500 L/hr. Sump Capacity 23L.

The unit is supplied with 300mm flexible connector pipe fitted with isolation valve and finishing in 15mm compression fitting.

- **Electrical supply:** 240V 50Hz. External isolator fitted as standard.
- **Draining system:** Minimum capacity 2000 l/h to an appropriate effluent point in accordance with local water regulations. The drain valve is supplied with the unit.
- **Control:** Cooler is supplied with standard wall control with 30m control cable incorporating spare cores for timer, alarm, thermostat and humidistat. The control cable is fitted to the cooler and the wall control is separately packed in the cooler.



Installation

External installation

AD 14 cooler is designed to be installed externally to the building.

- **Down Discharge Coolers.** The down discharge cooler is designed to be supported by a 645mm square plain edged duct with a minimum up-stand of 250 mm. The cooler must be installed together with extract fans to provide a balanced ventilation system. There is a contact in the AD 14 control system to automatically start an extract fan.
- **Top Discharge Coolers.** Top discharge coolers offer a simple access solution. Note that the duct work must be completely self supporting - no weight must be carried by the cooler. The duct can be finished in either 630mm round or square duct which can be attached to the stainless steel top element.
- **Side Discharge Installation.** Side discharge coolers are supported from simple brackets.

Down Discharge Coolers

Top Discharge Coolers

Side Discharge Installation

Internal systems

Evaporative coolers can be installed internally where there is existing ventilation. The flow rate of ventilation should exceed the total flow rate of the installed internal cooler.

- **Internal Suspended Cooler.** The coolers can also be used indoor.

In this installation the coolers must be equipped with a diffuser for a correct distribution of the air.

When all the building surface must be cooled it is suggested to position the diffusers alternated to grant an even distribution of the air flow.

In more energy intensive operations, as near machinery that creates process heat, it is possible to identify 'corridors' between machines and direct the air to exactly where it will have most effect.

Even when installing the cooler indoor it is possible to connect it with an air ducting system.

Internal Suspended Cooler

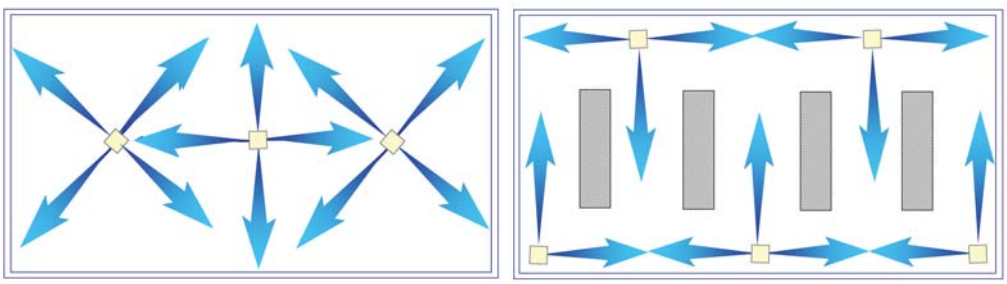


Fig. 4

Air distribution

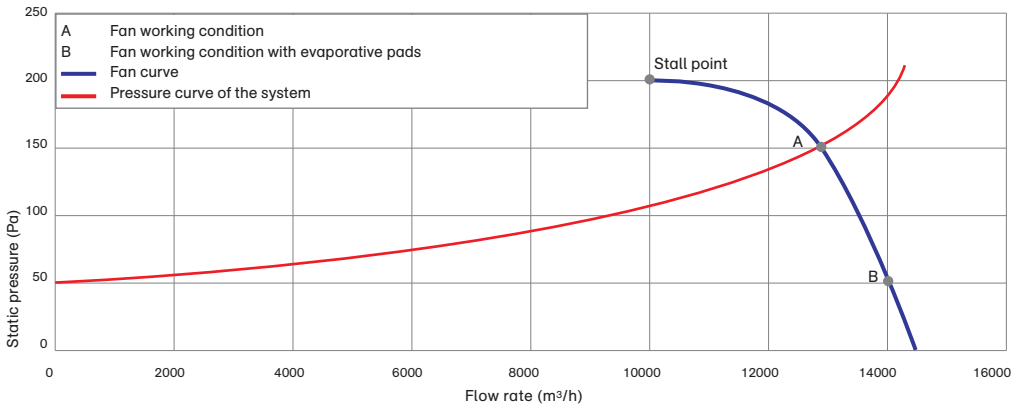
With careful design the optimum distribution can be achieved taking into account the following factors:

- Introduction of cooled air as low as possible
- Complete coverage or spot cooling
- Option of Draught free conditions

System Design

In all cases it is important that the systems are designed to fall within the performance of the fan.
The pressure loss of the evaporative pads supplied with the AD 14 cooler is 50Pa with an air flow of 14.000 m³/h.
The characteristic pressure curve of the system must fall below the stall point of the fan otherwise the flow will be unstable and the flow rate can drop considerably.

In all installations it is important to input the air in the building in the lowest point possible and extract it in the highest point possible, this will create an advantageous stratification in the building.



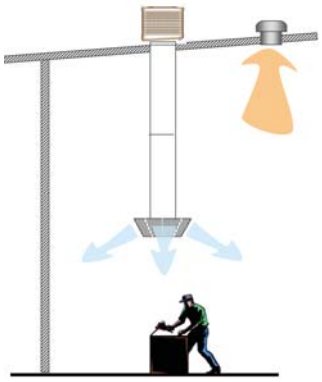


Fig. 5

Suspended Ceilings

If a suspended ceiling exists then it is possible to use the void as a plenum chamber. The cooled air pressurises this space and ceiling tiles are replaced by diffusers or grills to give the desired air flow. Windows are left open to provide natural extraction. Window openings can be fitted with limit switches which are linked to the timer control circuit. The cooler will then not run unless the window(s) are open.

Fabric Ducts

These can offer draft free conditions and are commonly used in leisure and commercial applications.

Fig. 6

Sizing of the system

Air Changes Method

This is a method based on principles of ventilation. The volume of the building is calculated and a multiplier applied. This gives an hourly flow rate required from the cooler. Typical air changes per hour are:

	AIR CHANGES PER HOUR
Offices and Shops	8/10
Light manufacturing e.g. Warehouse, packing area	10/15
Normal manufacturing e.g. Machine shop, assembly area	15/20
Heavy manufacturing e.g. Injection moulding, welding shop	20/30
Extreme conditions e.g. Bakery, forge	30/40

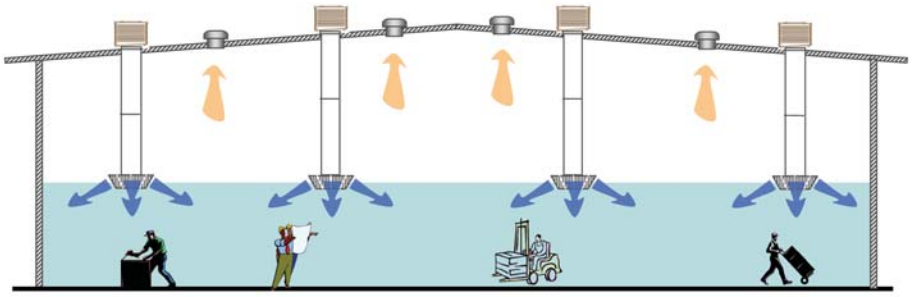


Fig. 7

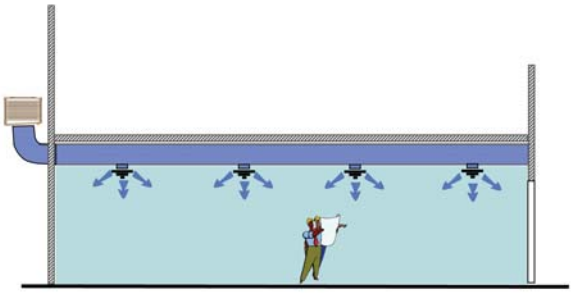


Fig. 8

Volume of working area	20x27x3.5	1890 m^3
Target acpr		20
Target air flow/hour	20x1890	37800 m^3/h
Air flow rate of AD 14		13000 m^3/h
Nominal number of coolers required	**37800/13000=2.9**	**3**

Spot Cooling

The effect of a single cooler can be explained using similar principles to the air changes method. The rate of air changes can be calculated by considering a set of concentric circles with the cooled air entering the centre.

Example

- Diffuser height: 4m.
- Air flow rate: 13.000 m^3/h

Cooled area based on air changes per hour.

	DIAMETER OF CIRCLE
5 ACPH	152.8 m
10 ACPH	38.2 m
30 ACPH	4.2 m
40 ACPH	2.4 m

Energy Balance method

If the cooling load is known within the building it is possible to calculate the mass flow rate of air, at a given temperature, required to maintain a set exhaust temperature.

Local weather conditions must be known to perform this calculation.
An allowance can also be made for stratification in taller buildings.

Installation and air distribution

With careful design the optimum distribution can be achieved taking into account the following factors:

- Introduction of cooled air as low as possible so you could reduce the volume to be cooled and extract as high as possible.
- Consider the possibility to maintain a small positive pressure inside the building.
- Evaluate the noise level acceptable in each installation. Both internal and external noise should be considered also if we have 5 fan speeds especially in commercial and residential installations.
- Consider roof access and weather proofing. Sometimes the only solution is to neter the side.
- Checks must be made that the roof or wall structure can support the full operating weight of the system plus ductwork and plenum chamber.
- If evaporative cooler is installed inside the building the ventilation system capacity must exceed the flow rate of the internal coolers.
- If a draught free environment is required consider the use of fabric ducts.
- Consider linking the extract fans to the AD 14 control system for automatic start.
- Do not place AD 14 close to the extraction fans to avoid re-circulation or close to any vents which may exhaust contaminated fumes.
- Consider equipment movement such as fork lifts and cranes in the building to avoid clashes with ductwork or plenums.

Maintenance, hygene and security

As every cooling system, the periodic maintenance of the units permits to obtain a better efficiency, longer lasting and a high hygiene of the system.
The maintenance regime for a cooler is determined by:

- The total running hours
- The air quality
- The water quality It is normal to maintain evaporative coolers twice per year.
- Remove the side frames, remove the insect screens
- Clean the pads using low pressure water (it is common to install a hose point on the cooler water supply so this can be done local to the cooler)
- Clean the insect screens
- Manually clean the sump and the water contact surfaces using the clean function. This is started by holding the 'test' button in for 10 seconds. The cooler then fills with water to level 3 and empties so providing a continuous supply of water for cleaning.

During the winter the water is normally turned off and drained.
Pad life is dependent upon the ambient air conditions. With clean air these have an average life of 3 to 5 years.
Particular attention has been put, during design of the AD 14 cooler, to maintain hygiene, resistance and security at high standards.

- **Avoidance of stagnant water.** No dead legs exist in the system no stagnation occurs during normal operation of the cooler. When a unit is switched off the system automatically drains.
- **Low water operating temperature.** The temperature of the water circulating in the evaporative cooler is approximately the "wet bulb temperature" of the air passing over the filters. In practice this means that, in a temperate climate, the water temperature rarely goes above 20C as shown even when the ambient air temperature exceeds 35C.
- **Avoidance of corrosion and scaling.** To prevent corrosion all water contact surfaces are plastic. To control scale a cooler measures the quantity of water supplied. When a concentration factor is reached the sump empties automatically and replenishes with fresh water. This has the effect of preventing scale and removing contaminants filtered from the air.
- **The control systems** have a comprehensive set of alarms to validate all of the key aspects of water process control in particular remove any possibility of stagnation.
- Slow water fill
- Slow drain
- Slow evaporation
- Water probe logic failure
- **Use of Biocide (optional).** Growth of organisms filtered from the air is suppressed by supplying the evaporative cooler with water with a low level of biocide from a brominator.
- **No production of aerosols.** The design of coolers is such that only pure water evaporation without any production of droplets occurs as the air passes over the filters. This removes the mechanism for the transmission of infections such as Legionnaires' disease.
- **Maintenance.** By the implementation of a programmed maintenance system, the standards of hygiene are continued to provide a safe and secure system

Comfort and humidity

The purpose of the AD 14 cooler is to improve the comfort of people. It is generally accepted that high temperatures lead to:

- Lower productivity
- Greater level of Errors
- Greater absenteeism

A correctly specified evaporative cooling installation will improve conditions and can contribute to reducing these problems.

The theory of comfort can explain why the AD 14 cooler can create comfortable conditions.

Comfort is affected by the following:

- **temperature:** an evaporative cooler reduces the temperature so improves comfort level;
- **relative humidity:** an evaporative cooler increases the humidity level but because of the low temperatures this does not offset the improvement gained from the temperature reduction;
- **Air movement:** an evaporative cooler increases air flow through a building and so improves comfort level.

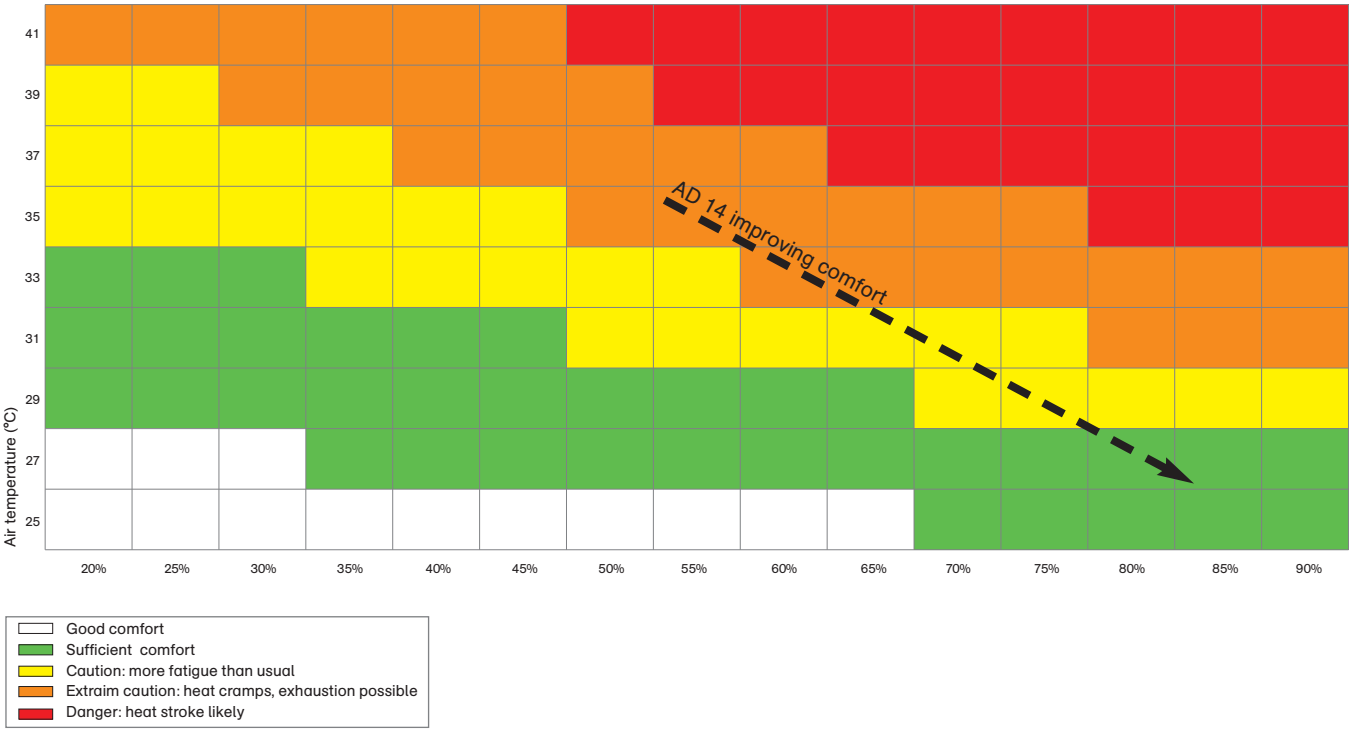
A common question is **'will the rise in humidity from the cooler make it uncomfortable?'**

The relationship between temperature and humidity can be explained using the concept of 'apparent temperature'. This is shown below. The arrow shows the change an AD 14 cooler makes

A clear conclusion is that at air temperatures below 25°C the RH has little effect on the apparent temperature. This is because the skin can sweat as normal. Higher temperatures together with higher RH can lead to stressful and even dangerous conditions.

An evaporative cooler creates more comfortable conditions by reducing the temperature. The increase in humidity levels does not create discomfort because the air temperature is below 25C.

HEAT INDEX DI STEDMAN (1979)



Condensation

When air is cooled to its 'dew point' condensation will occur. A correctly designed and controlled AD 14 cooler installation will not create condensation provided the following is adhered to;

- The ventilation system must be balanced. Air from an evaporative cooler must be ventilated fully either with mechanical extraction or appropriately sized vents.
- At the end of a period of cooling the system should run for a time in ventilation mode. In Automatic mode the last part of the sequence is always ventilation.
- Take care with buildings which have existing condensation problems. During hot periods an evaporative cooler produces air which is a similar temperature to ambient conditions in Spring and Autumn where the RH is routinely above 90%. If a building currently has no problems during these periods then evaporative coolers will not create condensation.

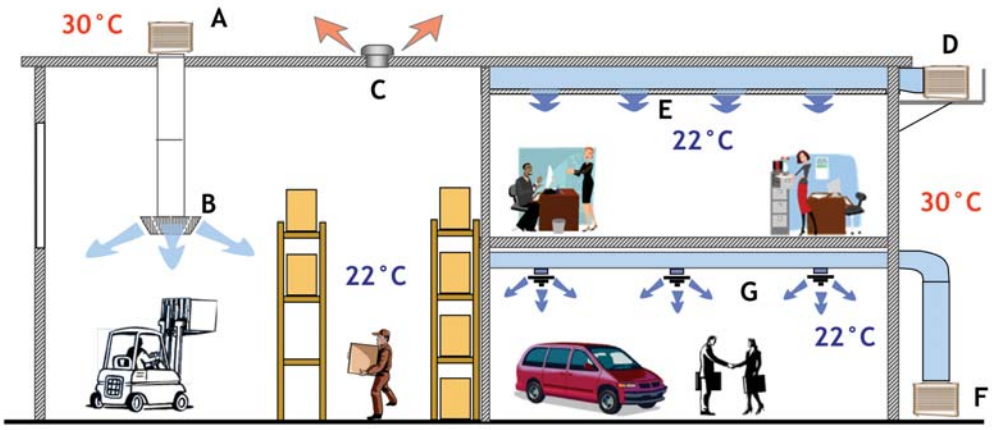
Sizing of the system

WAREHOUSE	
Down discharge AD 14	A
Plenum chamber	B
Extraction fan (80% to 90% of AD 14 flow rate)	C

Note: Doors can be left open because building is positively pressurised.

OFFICE	
Side discharge AD 14	D
Air distribution through suspended ceiling	E

CAR SHOW ROOM	
Top discharge AD 14	F
Sound attenuator (Silencer)	G

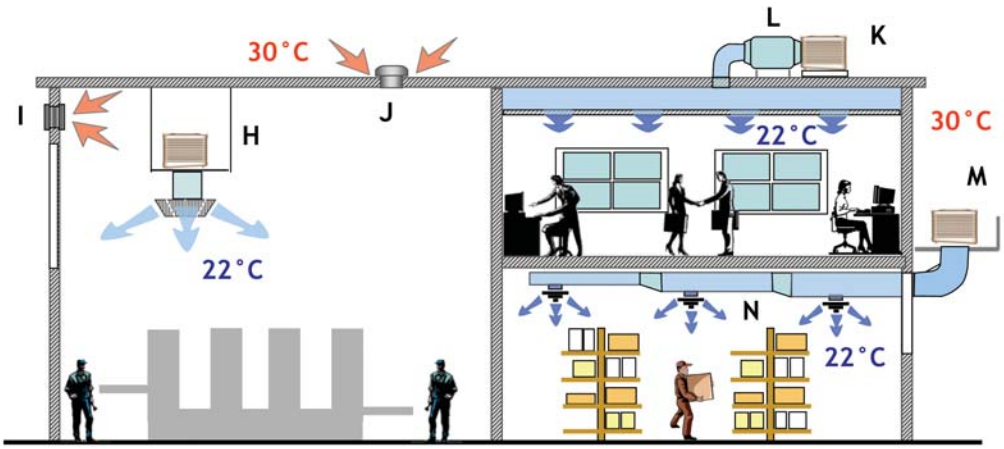


PRINTING WORKS	
Internal suspended AD 14	H
Extraction fan	I
Inlet fan	J

Note: total ventilation must exceed flow rate of AD 14.

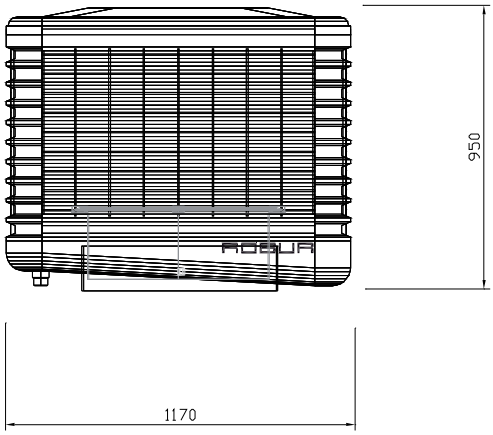
OFFICE	
Side discharge AD 14	K
Sound attenuator (Silencer)	L

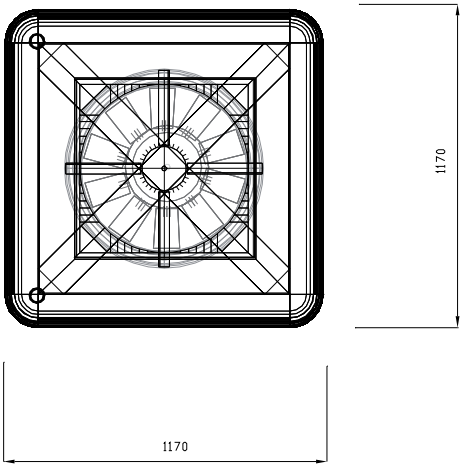
STORE	
Down discharge AD 14	M
Duct air distribution	N



Air flow		m³/h	14000
Water supply pressure	minimum	bar	7
	maximum	bar	1
Minimum water supply		l/min	8
Internal sump capacity		l	23
Avarage water consumption (1)		l/h	65.2
Voltage		230 V - 50 Hz	
Water supply connection		“	1/2
Water discharge connection		“	1
Ducting connection		mm	645x645
Electrical power	axial fan	kW	1.5
	circulation pump	kW	0.05
Sound pressure at 3 m	maximum speed	dB(A)	74
	minimum speed	dB(A)	64
Weight	without water	kg	55
	with water	kg	92
Dimensions	width	mm	1170
	lenght	mm	1170
	height	mm	950

(1) At 35 °C - U.R. 50%.





Hydronic heating systems with modulating condensing absorption heat pump, fired by gas and renewable energy. Available for geothermal installation too.

Absorption heat pumps, fired by gas and renewable energy, for heating, heating and cooling. Available for geothermal installation too.

Low electric consumption gas fired absorption chiller and chiller/heater for heating, cooling, refrigeration and process applications.

Gas fired condensing modular units for outdoor installation for heating.

Gas fired absorption chiller/chiller heater and handler package for cooling and heating.

Combined boiler-aerotermo gas heating systems, including condensation-based systems, for interiors subject to specific legislative requirements.

Gas-fired wall air heaters, available in condensing version too, for commercial and industrial environments.

Individual gas radiators for heating small and medium-sized interiors.

Air barrier to prevent heat dispersion from doorways of industrial buildings.

Codice: X-DPL208 - 06/2008

ROBUR®

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