caring for the environment

# Design manual

# AD evaporative coolers

Revision: C

Code: D-MNL053EN

# INDEX OF CONTENTS

# 1 PREMISE

The purpose of this Design manual is to provide a first set of information on the operation, design and characteristics of cooling systems with evaporative coolers Robur AD.
Robur also provides a spreadsheet for a preliminary design of cooling systems with Robur AD units.
The Robur technical service is always at your disposal for any further technical information on the application and use of these appliances.

# 2 COOLING AND VENTILATION

The evaporative cooling system is the most modern technology for cooling and ventilation of large rooms:
- production and crafts premises
- commercial premises and warehouses
- sports premises in general

This system allows you to equip even large rooms with summer ventilation and cooling system to improve the comfort of people, increase their well-being and productivity, without committing large capital for plant expenses, without incurring high operating costs for energy consumption, without producing environmental impact and without the risk of power blackouts for over-demand.

## 2.1 MICROCLIMATE WITHIN THE ROOM

Inside a large room, such as an industrial building, a microclimate is established during the hot seasons that is difficult for the people who work there to endure.
The heat input of process plants, electrical power plants and building structures which, when hit by the sun, transmit a high level of thermal energy to the internal air, often cause an unbearable thermal condition in the environment.
Furthermore, during the night, when the room is closed, the heat stagnates inside the room, creating already in the morning conditions of poor comfort.
In addition to all this, there is usually a lack of proper air renewal necessary for the disposal of exhaust air, sometimes harmful to the health of workers.

## 2.2 SAFETY, HEALTH AND PRODUCTIVITY

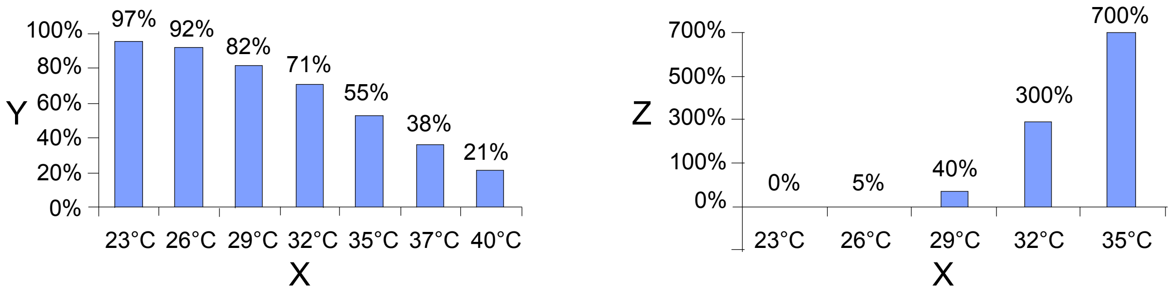
The conditions of discomfort caused by high temperatures within an industrial environment cause operators to experience the so-called "heat stress", which begins to be effective above 27 °C causing:
- Lowering of morale, delays and absenteeism
- reduced attention to safety, increase in the percentage of injuries
- potential health issues
- reduced productivity, reduced production quality

Research has shown that this working condition adversely affects productivity and production quality, as shown for example by a NASA report:

**Table 2.1** *NASA Report CR-1205-1*

| Ambient temperature | 23 °C | 26 °C | 29 °C | 32 °C | 35 °C | 37 °C | 40 °C |
|---|---|---|---|---|---|---|---|
| Loss in productivity | 3% | 8% | 18% | 29% | 45% | 62% | 79% |
| Loss in accuracy | - | 5% | 40% | 300% | 700% | - | - |

**Figure 2.1** *NASA Report CR-1205-1*




X = internal temperature Y = productivity Z = loss of accuracy

NASA Report CR-1205-1 shows for example that when temperatures inside the building rise over 29 °C, productivity drops by 18% and quality decreases by 40% due to increase in working errors.

# 3 THE TECHNICAL SOLUTION

To improve the summer microclimate inside a large room and reach an adequate level of well-being, the environment must be ventilated with cooled air and many new air changes must be granted to neutralize all heat supply.
The continuous renewal of the ambient air prevents the accumulation of heat inside the building and prevents the excessive increase of the internal temperature.
The air renewal also allows to improve the level of environmental hygiene, to dispose of any smells or hazardous gases and to improve productivity and safety of people.
A ventilation and cooling system with AD units consists of evaporative coolers that cool the air with a natural principle and not through a refrigeration cycle.
The evaporative cooler is an appliance that cools the air by reducing the sensible heat contained in it.
The reduction of the sensible heat is due to the evaporation

process of the water that comes into contact with the treated air: the air taken from the outside passes through cellulose panels of particular structure wet with water, gives up part of its heat during the process of evaporation of the water and lowers its temperature.
A fan, incorporated in the cooler, provides for the supply of the cooled air into the room.

## 3.1 THE RESULT AND THE ADVANTAGES

The absence of refrigerating units reduces by 70% the system cost and by 80% the electrical energy consumption, which is reduced to that necessary for the fan operation, significantly reduces the size of the systems and simplifies installation, operation and maintenance.
In general, the advantages that can be obtained with this solution are:

- treatment of large volumes of air to achieve many hourly air renewals
- air cooling
- possibility of ventilation only in the less hot seasons
- possibility of partial or differentiated management for different areas of the room
- low cooling system costs, low running costs, low maintenance costs
- no use of environmentally harmful refrigerant gases (such as CFC/HFC and greenhouse gases)
- improvement of hygiene in the room
- increase of the productivity, quality and safety of internal staff

## 3.2 SYSTEM OPERATION

### 3.2.1 Ventilation and cleaning of the room

The evaporative cooling system is a system that works dynamically and works on the basis of a natural principle: it introduces large quantities of cooled external air into the room and extracts the exhausted hot air through doors, windows and other evacuation openings that are left open.

**Figure 3.1** *Air flow in the room*

The operating principle is very simple: if the system expels all the introduced air, the system produces maximum efficiency, grants all the planned air renewals and cools the environment under the design conditions.
It is also possible to have a slightly lower extract air flow than the supplied one (but not less than 80%), which allows the room to be kept slightly overpressurised compared to the outside, preventing the outside hot air from re-entering the room through the natural openings.
The ideal condition is to place the air diffusers away from the openings (windows, doors, etc.) and distribute them evenly inside the room. By opening a window away from the diffusers, the air passes through the room cooling it before being extracted.
By calculating the correct dimensions of the evacuation openings the maximum efficiency of the system is reached. The system must be able to extract the large volume of air supplied so as not to reduce the effectiveness of the system.
If the available openings are not sufficient, it is necessary to add forced air extraction systems (extraction towers).
Failure to comply with these conditions precludes the planned air renewal, reduces the cooling effect and increases the relative humidity inside the room.

## 3.3 PERFORMANCES OF THE SYSTEM

The evaporative cooling system exploits the air adiabatic saturation process: the unsaturated humid air is saturated by bringing it into very close contact with water, so that heat exchanges take place only between air and water without other exchanges with the outside.
All the heat that the water receives from the air serves to evaporate part of it, so the enthalpy of the residual water remains unchanged as well as its temperature. It follows that even the enthalpy of air does not change.
The air temperature is therefore reduced, up to the maximum temperature of the water, while its humidity increases.
Since the enthalpy of the air is the sum of elements as a function of temperature (sensible heat) and of an element as a function of humidity (latent heat), if its temperature decreases and the humidity increases, it means that the sensible heat has decreased and the latent heat has increased (unchanged enthalpy). Of course, the system increases its air cooling capacity as the relative humidity of the outdoor air decreases: the drier the outside air is, the higher its possibility of saturation, the higher the reduction of the sensible heat contained in it, therefore the greater the decrease of the obtainable air temperature.
The cooling capacity of the air is also due to the technical characteristics of the exchange device (the evaporator) or to its saturation efficiency: in fact, the longer the time and surface contact between air and water, the more the water evaporates and the air temperature (sensible heat) decreases.
The AD evaporative cooler is equipped with a high saturation efficiency evaporating unit which produces a good level of cooling even at relative air humidity values of around 70%.
The temperature of the air supplied to the room is a function of the different conditions of the outside air, according to Table 3.1 *p. 5*.

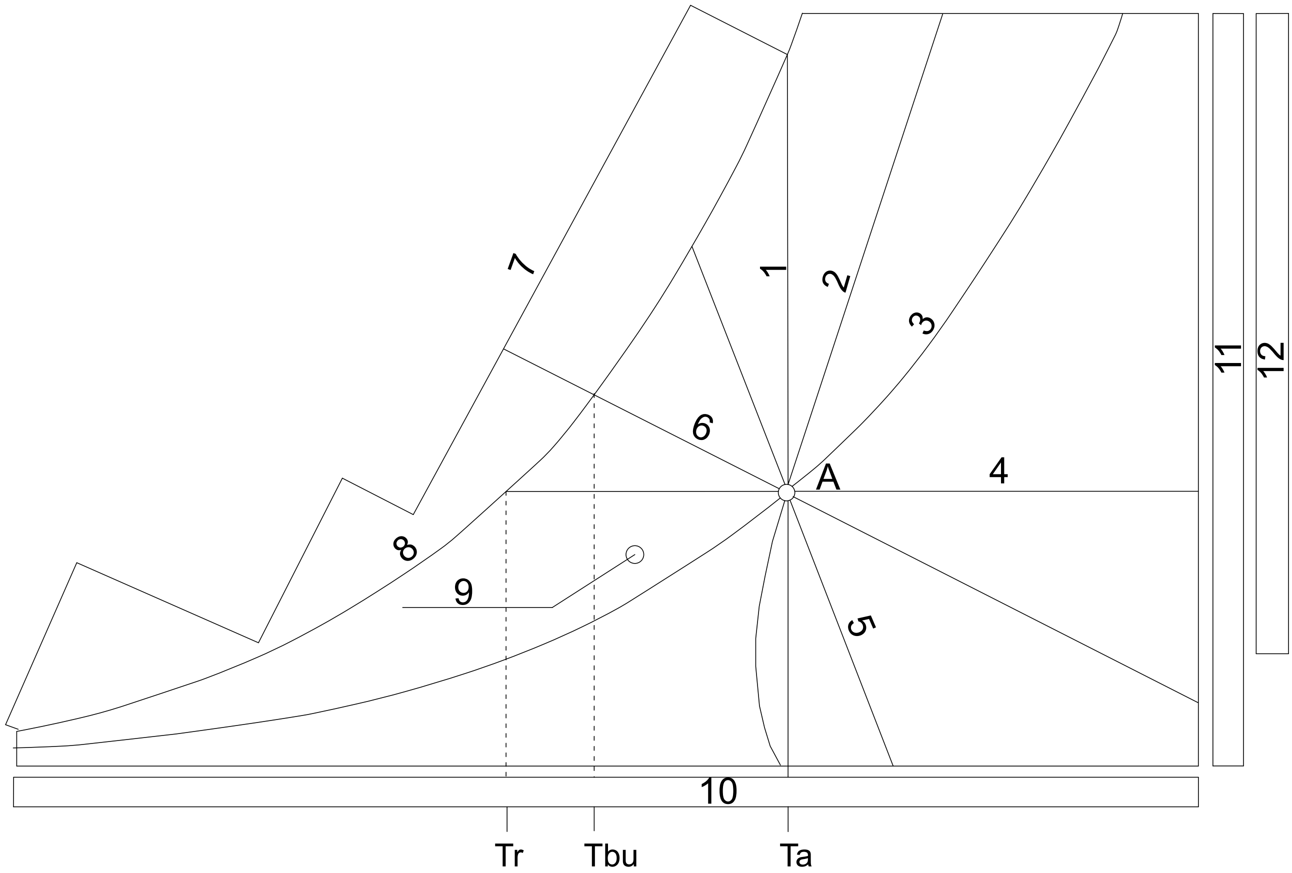
**Table 3.1** *Temperature of the air supplied to the room*

| External temperature | Relative humidity of the inlet air | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20% | 30% | 40% | 50% | 60% | 70% | 80% |
| 25 °C | 13,7 | 15,4 | 17,0 | 18,6 | 20,0 | 21,3 | 22,6 |
| 30 °C | 17,0 | 19,1 | 21,0 | 22,8 | 24,4 | 26,0 | 27,4 |
| 35 °C | 20,4 | 22,9 | 25,1 | 27,1 | 29,0 | 30,6 | 32,1 |
| 40 °C | 23,0 | 26,0 | 29,0 | 31,5 | 33,5 | 36,5 | 38,0 |

# 4 AIR PSYCHROMETRIC CHART

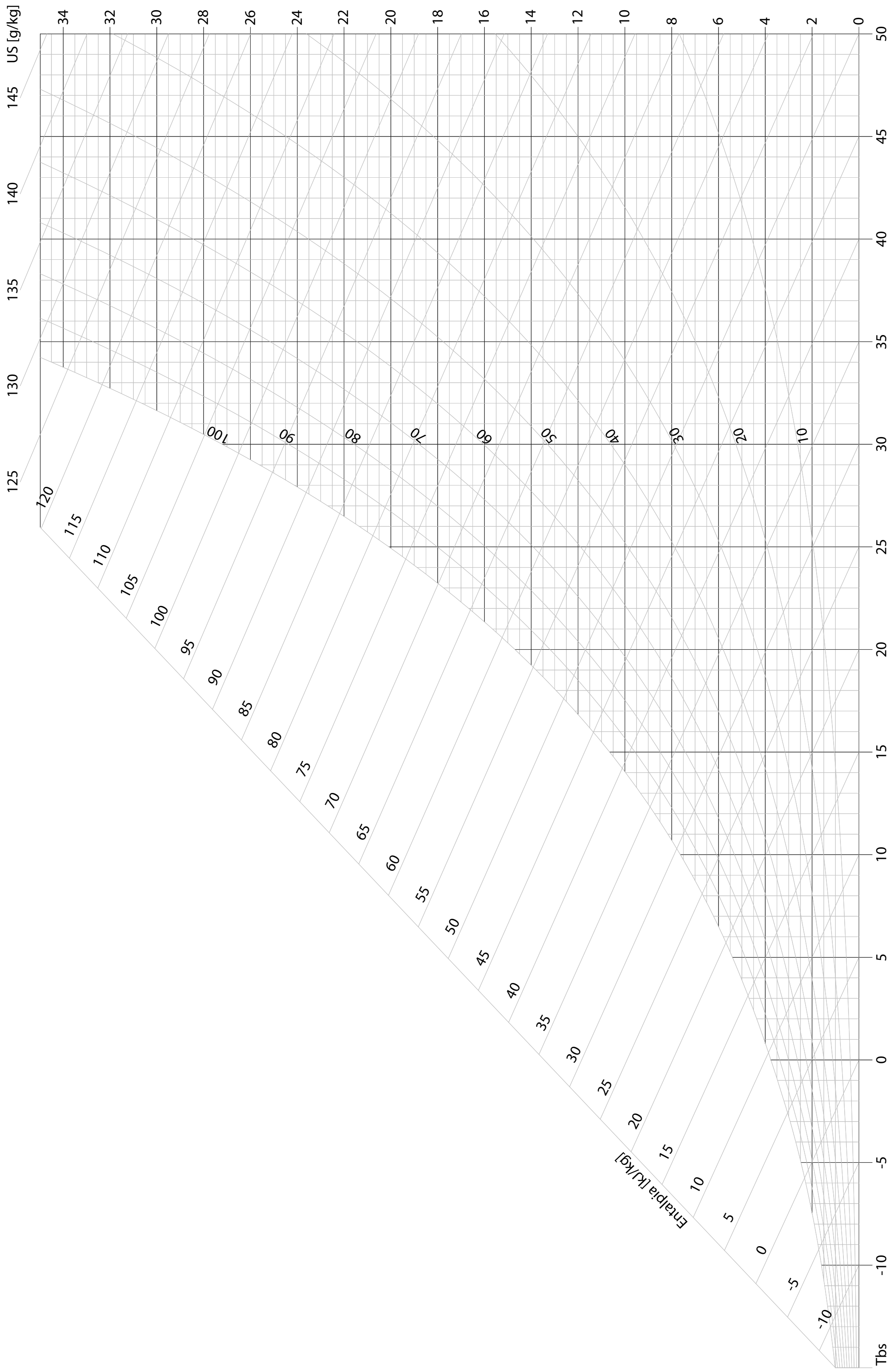
The performance of an evaporative cooling system varies according to the physical conditions of the treated air, they depend on the saturation efficiency of the evaporative pack and can be obtained using air psychrometric chart.

**Figure 4.1** *Air psychrometric chart - legend*




| | | | | | |
|---|---|---|---|---|---|
| 1 | Dry temperature | 6 | Wet temperature | 11 | Specific humidity |
| 2 | Deviation of the enthalpy | 7 | Enthalpy | 12 | Thermal factor |
| 3 | Relative humidity | 8 | Saturation curve | Ta | Ambient temperature |
| 4 | Specific humidity | 9 | Pole | Tr | Dew temperature |
| 5 | Specific volume | 10 | Dry bulb temperature | Tbu | Wet bulb temperature |

**Figure 4.2** *Air psychrometric chart*




It should therefore be specified that the evaporative cooling system provides a different degree of comfort to the environment as the physical conditions of the outdoor air change, and cannot guarantee constant and predefined temperature and humidity conditions.

# 5 THE EVAPORATIVE COOLER

The AD evaporative cooler is an appliance powered by electricity and mains water, which is installed on the roof or on the external wall or in correspondence with a window of the room to be ventilated and cooled.
Ducts and air diffusers are connected to it to distribute the cooled air in the room.
The coolers are equipped with an external load-bearing structure in ABS that guarantees protection from the weathering and a particular lightness, a very important aspect in relation to the limited load-bearing capacity of the roofs and walls of the buildings.
The coolers are equipped with:
- low consumption electric fans
- water loading system with solenoid valve
- water distribution system with electric pump
- evaporation panels with high saturation efficiency
- automatic water drainage system
- automatic periodic cleaning for the whole hydraulic circuit and the evaporating panels
- electronic control and operation panel

## 5.1 EVAPORATIVE COOLER OPERATION

Each cooler is equipped with a remote electronic control and operation panel for adjusting the air speed and for choosing the various functions:
- ventilation only
- ventilation and cooling

The panel contains the logic unit for setting the functions necessary for the operation of the cooler, including the periodic washing of the evaporating panels and the washing and the drainage at the end of the cycle; these functions are essential for maintaining high performance over time and for preventing the proliferation of bacterial forms.
Depending on the remote control chosen and used, it is also possible to adjust the microclimate in each zone according to the real needs of the time and season or according to the personal perception of the operator directly concerned, thanks to the weekly and daily timer, to the maximum percentage of relative humidity required and to the fan speed.
- When the machine is started, the water discharge valve (normally open) closes, the water loading valve opens and allows water to enter the collection tank. A level switch limits the water load up to the amount required for the cooling cycle.
- An electric recirculation pump lifts the water up to the distributor circuit which wets the evaporating panels.
- The electric fan starts and sucks in the outside air through the wet evaporating panels and feeds it into the room through the delivery outlet.
- The water that evaporates during the cycle is replenished on command of the level switch of the collection tank.
- By acting on the control panel, it is possible to interrupt the cooling function and operate the appliance in ventilation mode only, granting in any case the required air renewal.
- By acting on the fan speed regulator it is possible to customize the flow and the quantity of air introduced into the room.

## 5.2 DESCRIPTION OF THE AUTOMATIC CLEANING SYSTEM

The cooler is equipped with an automatic washing system for the evaporative pack and the water collection tank which, at programmable intervals, is automatically activated to maintain a high level of cleanliness and saturation efficiency.

There is an automatic washing cycle every 3 hours (standard): the appliance suspends its evaporation cycle for a few minutes, the water contained in the tank is discharged and replaced with clean water that is circulated through the evaporative packs in order to wash out the residues of mineral salts and any other deposits.
The repetitiveness of these washes prevents the crystallization of minerals and other elements on the evaporative packs and throughout the circuit, guarantees a long life and maintains a high saturation efficiency.
Each time the unit is switched off, a final wash cycle is performed. At the end, the cooler discharges all the water contained in it to prevent water stagnation from causing the development of bacterial forms and the formation of limescale deposits.

**Figure 5.1** *Cellulose evaporating panels*

**Figure 5.2** *Recirculation pump and water distribution system*

**Figure 5.3** *Automatic washing and emptying device*

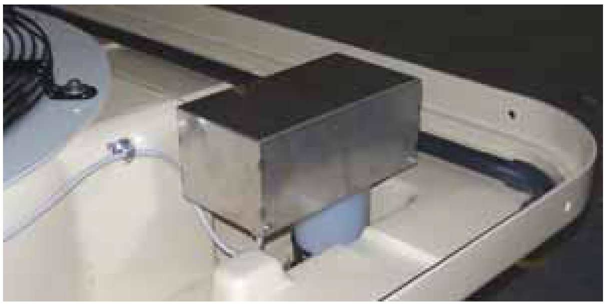


**Figure 5.4** *Water drain device*

### 5.3 ROUTINE MAINTENANCE

Routine maintenance of the evaporative cooler is limited to end-of-season cleaning, which includes washing the water distribution circuit, the evaporative packs, the recirculation pump and the water collection tank.
In the winter season it is necessary to drain all the water contained in the supply system to avoid damage caused by freezing.
The cooler can be covered with a winter cover (optional OCPR003 for AD14, optional OCPR004 for AD20) to protect it from weathering and to prevent the intrusion of cold air into the room.
Every three to four years it is recommended to replace the evaporative packs.

## 6 DESIGN OF A COOLING AND VENTILATION SYSTEM

The purpose of the system is to cool and ventilate a large room during the hot seasons, lowering the temperature of the indoor air compared to the outdoor air and making the necessary air changes to improve the microclimate inside the room.
The lowering of the internal temperature will help to neutralize the heat contributions coming from the structures of the building, from the sun's rays, from the process plants inside.
Air renewal will help to dispose of the exhausted air and any fumes, vapours, smells or other aeriforms, often harmful to the health of workers.
The cooling efficiency is not only related to the efficiency of the appliance, but also to the design of the ductwork and the installation. Insulated ceilings will decrease the internal temperature significantly compared to non-insulated ceilings. The same concept is applicable for air ducting.
In order to size the plant we must take into account four fundamental elements:

1. the outdoor summer design conditions
2. the installation height of the air diffusers in the room
3. the number of air changes required according to the type of activity carried out in the room
4. evacuation of exhaust air

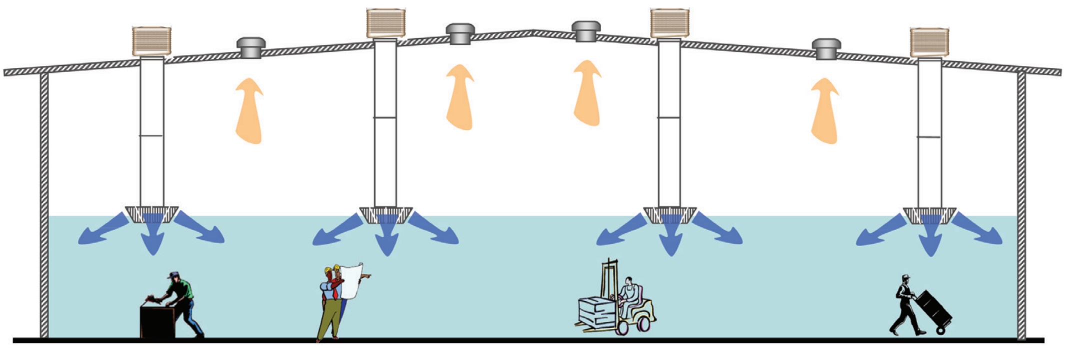
### 6.1 OUTDOOR SUMMER DESIGN CONDITIONS

As already seen, the AD evaporative cooler is a system that works dynamically and operates on the basis of a natural principle: it introduces large quantities of external and cooled air into the room and expels the exhausted hot air through doors, windows and other exhaust openings.
The cooling of the air taken from the outside and introduced into the room is a function of the outdoor conditions (Table 3.1 *p. 5*).

### 6.2 AIR DIFFUSERS INSTALLATION HEIGHT IN THE BUILDING

The air coming from the coolers tends to descend towards the floor and to push up the warmest one. The area of influence that interests us is the one where people work, so the volume to be cooled is that between the floor and the height of diffusion of the cooled air.
To allow normal operation, the air diffusers must be installed no less than 4 metres above the ground and, in order not to unnecessarily cool the upper part of the room, it is recommended not to exceed 6 metres in height.
It should be noted that the higher the installation height of the diffusers, the lower the cooling effect near the floor.
The volume to be treated is therefore equal to the surface area of the area concerned multiplied by the height from the ground of the diffusers.

**Figure 6.1** *Positioning of diffusers and extractors*



### 6.3 NUMBER OF REQUIRED AIR CHANGES DEPENDING ON THE TYPE OF ACTIVITY IN THE BUILDING

Once the volume to be cooled has been identified, it is necessary to multiply it by the number of air renewals per hour required according to the type of activity. The quantity of air to be supplied to the room is thus obtained to grant the required air renewal and the cooling of the environment.
Table 6.1 *p. 10* indicates the minimum suggested air renewal for different activities.

**Table 6.1** *Air renewal according to the activity*

| Activity | Air renewal | |
|---|---|---|
| Offices and shops | v/h | 8 ÷ 10 |
| Light processing (warehouses, storage areas) | v/h | 10 ÷ 15 |
| Medium processing (production and assembly areas) | v/h | 15 ÷ 20 |
| Heavy processing (presence of ovens, equipments with moderate heat development) | v/h | 20 ÷ 30 |
| Extreme conditions (foundries, furnaces with high heat generation) | v/h | 30 ÷ 40 |

v/h = volumes/hour.

### 6.4 EXHAUST AIR EVACUATION

Once the quantity of air to be supplied to the room has been identified, the size of the openings required for exhaust air extraction must be calculated.
The system involves the introduction of cooled air into the room and the extraction of at least 80% of it through natural openings or forced extraction systems.
The extraction of at least 80% of the air introduced is essential to grant the planned renewals, to grant the cooling effect and to avoid an increase in the percentage of relative humidity in the room.
The extraction of a quantity of air slightly lower than the one introduced (but not less than 80%) allows to keep the cooled room in a slight overpressure compared to the outside, preventing the outside hot air from re-entering the room through the natural openings.
The air produced by the coolers contains a percentage of relative humidity higher than that of the external air and that of the air in the building: this is precisely the characteristic that produces the cooling effect. For this to be effective, however, it must pass through the room and then leave. In this way, the percentage of relative humidity in the room will not increase and the cooling effect will be granted.
To extract the exhaust air, natural openings of about 1 m$^2$ per 1000 m$^3$ of air are required.
If it is necessary to evacuate 10000 m$^3$ of air it will take about 10 m$^2$ of natural openings.
It is important that the openings (windows, doors, gates, skylights, ...) are not concentrated in a single position or only on one side of the room, but that they are distributed throughout the building to allow ventilation and cooling of the whole room and not only of a part of it.
The best result is obtained when there are also openings on the roof, such as skylights or natural extractors: through these openings it is possible to evacuate the mass of hot air that is underneath the roof and usually stays there for a long time.

If the natural openings are larger than the amount required to evacuate the exhausted air, or if the extracted air flow rate is greater than 80% of the supplied air, there is a risk of attracting more hot air from outside and reducing the cooling effect.

If there are already forced extraction systems in operation in the room, their capacity must be taken into account and subtracted from the calculation of the necessary openings.
It is necessary to ensure that there is a correct balance between the amount of air entering and leaving the room.

## 7 CHOICE OF MODELS AND NUMBER OF COOLERS TO BE INSTALLED

The choice of models and the number of AD coolers to be installed depends on the customer's needs, on the different possibilities of positioning the coolers and the air ducts, considering that the installation quota of the air diffusers should not exceed 6 m from the ground.
The ideal choice is to install the coolers on the roof of the building and enter with the ducts through the skylights.
The quantity of coolers to be installed depends on the calculated intake air flow rate:
Number of coolers = total air flow (m$^3$/h) / air flow of the selected coolers (m$^3$/h).

It is important to distribute the air in the room as evenly as possible.

### 7.1 AVAILABLE RANGE

The AD evaporative coolers are available in two models, which differ in the maximum air flow that can be delivered:
- AD14 with air flow up to 13000 m$^3$/h
- AD20 with air flow up to 20000 m$^3$/h

Three different versions are available for each model, two of which are equipped with an independent basic (ECO) or advanced (EVO) remote control for each unit, and the third (SC) is suitable for the centralised management of a system composed of a maximum of 30 units, to be associated with a centralised control system, supplied by Robur.
The three versions can be summarized as follows:
- AD14/AD20 ECO: equipped with the basic ECO remote control (Paragraph 10.1 *p. 13*).
- AD14/AD20 EVO: equipped with the advanced EVO remote control (Paragraph 10.2 *p. 14*).
- AD14/AD20 SC: without individual remote control, but designed for a centralised control (Paragraphs 10.3 *p. 14* and 10.4 *p. 16*).

### 7.2 SIZING EXAMPLES

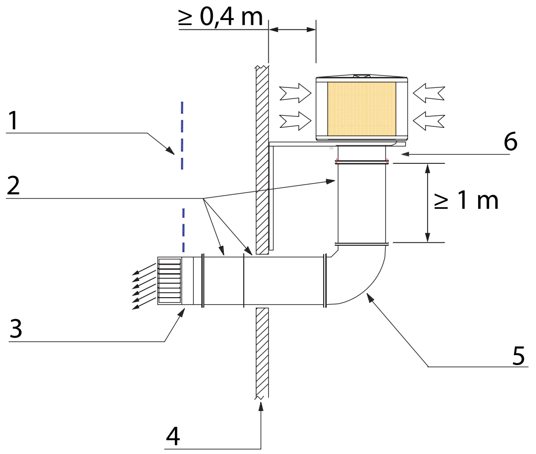
Surface area of building to be cooled: 2000 m$^2$
Building height: 8 m
Height of the cooled air diffusers: 5 m
Type of activity carried out inside: medium processing
Expected air changes: 15 v/h
Net volume to be cooled: 2000 x 5 = 10000 m$^3$
Total required air flow: 10000 x 15 = 150000 m$^3$
Single cooler air flow rate: 20000 m$^3$/h (model AD20)
Number of coolers to be provided: 150000/20000 = 8 AD20

### 7.3 EVAPORATIVE COOLER INSTALLATION

The installation works are very simple and consist of clamping

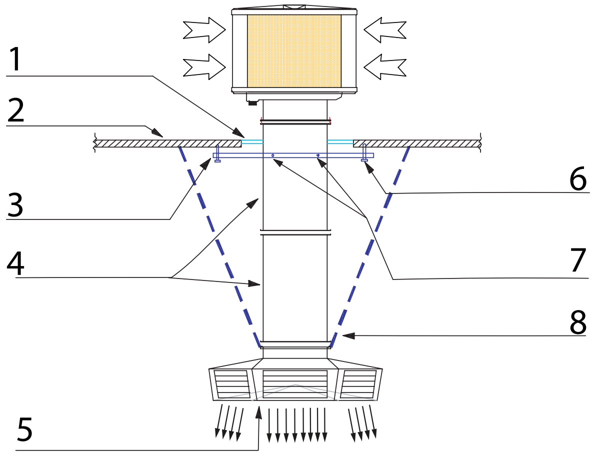
the machines in the chosen position, connecting the ducts and air diffusers, the construction of the water supply and drainage network and the power supply network and the connection of the electronic control.
The following Figures show installation examples.

**Figure 7.1** *Installation example*



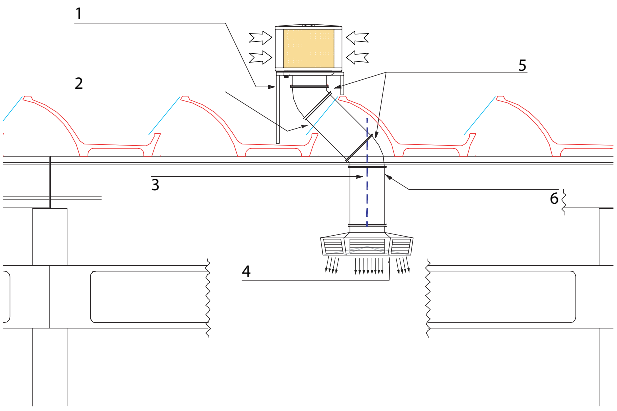

1 Galvanized or stainless steel chains for fixing the ducts to the ceiling
2 Duct with flanges and neoprene gaskets
3 2-way diffuser with adjustable louvres
4 Wall
5 90° curve with flanges and neoprene gaskets
6 Support frame

**Figure 7.2** *Installation example*




1 Skylight
2 Coverage
3 Stainless steel brackets
4 Duct with flanges and neoprene gaskets
5 6-way diffuser with adjustable louvres
6 Dowels to secure the brackets to the ceiling
7 Screws to secure the duct to the brackets
8 Galvanized or stainless steel chains for fixing the ducts to the ceiling

**Figure 7.3** *Installation example*




1 Support frame
2 Duct with flanges and neoprene gaskets
3 Galvanized or stainless steel chains for fixing the ducts to the ceiling
4 6-way diffuser with adjustable louvres
5 45° curve with flanges and neoprene gaskets
6 Duct with flanges and neoprene gaskets

# 8 HYDRAULIC AND ELECTRICAL SYSTEMS

## 8.1 HYDRAULIC SYSTEM

The water necessary for the cooler operation can be drawn directly from the local water mains.
It is recommended to use drinking water, of hardness not exceeding 27 °f and not less than 7 °f.
Do not use demineralised water, as it is potentially aggressive towards some materials in the appliance.

The distribution network must be equipped with a suitable filter to prevent the passage of solid elements, such as sand and dirt.

**The water supply system must grant a minimum flow rate of 7 l/min for each unit at a pressure of 1,5÷3 bar**

**(maximum allowed pressure: 6 bar).**

It is advisable to install the water supply network inside the building to protect it from freezing in the winter season and from the sun's rays during the summer; otherwise, it is recommended to install a suitably insulated pipe.

The AD evaporative cooler is equipped with a water supply connection located in the lower part of the external structure (detail A Figure 12.1 *p. 20* and 12.2 *p. 20*).
It is recommended to install an isolation valve at the inlet of the unit and make the connection to the water supply with a flexible stainless steel pipe.

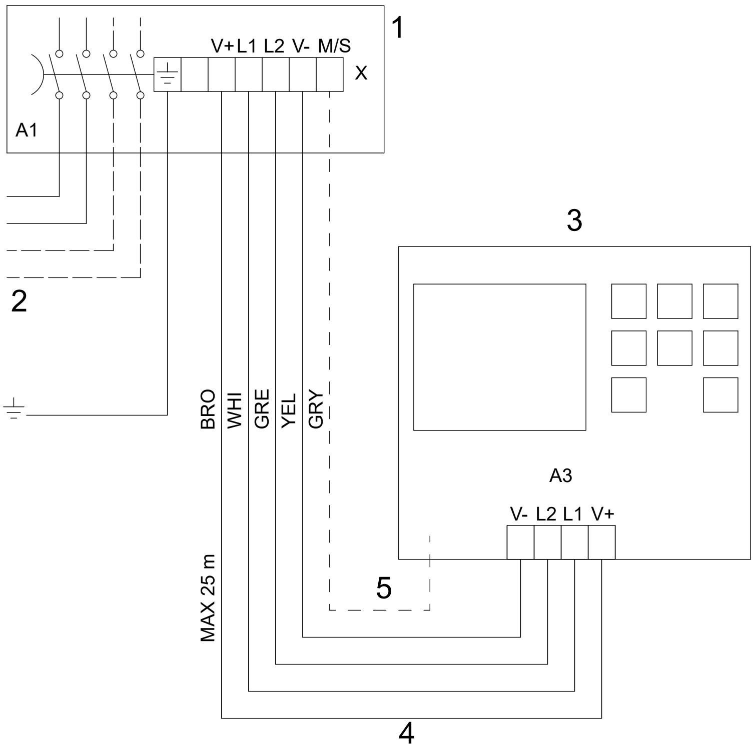
It is recommended to provide for the possibility of emptying the entire water supply system before the start of the winter season to avoid damage due to freezing.

The evaporative cooler is equipped with a sleeve located on the bottom of the external structure for the connection of the water discharge pipe of the periodic washes.
Refer to Table 12.1 *p. 19* for water connection dimensions and water consumption.

## 8.2 ELECTRICAL SYSTEM

The supply voltage of AD appliances is 230 V - 50 Hz.
The electrical system must be constructed according to the regulations in force in the country where the machine is installed.

**Figure 8.1** *Electrical wiring diagram*




1 Onboard electrical panel
2 Power supply 230 V - 50 Hz
3 Remote control
4 20 AWG 5x0,5 mm² shielded cable
5 Do not connect
A1 Main switch onboard the appliance
BRO Brown
WHI White
GRE Green
YEL Yellow
GRY Grey

The cooler must be connected to the selected remote control (Paragraph 10 *p. 13*), which is normally installed in the cooled room.
To connect the remote control use a shielded cable 20 AWG 5x0,5 mm² with a maximum length of 25 meters.
When using the OCDS010/OCDS011 centralised control (Paragraph 10.3 *p. 14*) or the ODSP035 router (Paragraph 10.4 *p. 16*) the network connection must be made using a shielded cable capable of ensuring double insulation to live parts, with a minimum cross-section of 0,5 mm². We recommend the use of Belden cable model 8762 with PVC sheath, 2 poles plus braid, 20 or 22 AWG, nominal capacitance between conductors 89 pF, nominal capacitance between conductor and braid 161 pF or an equivalent cable for RS485 networks with the following characteristics:

- 20 or 22 AWG
- twisted copper conductors
- characteristic impedance 120 Ω
- braided shield

The maximum network length is 1000 m and 30 network cards connected to the centralised control, or 150 m per section and 4 coolers connected to the ODSP035 router.

# 9 EVALUATION OF THE EFFECTIVE EFFICIENCY OF THE COOLERS

## 9.1 WATER CONSUMPTION IS SYNONYMOUS WITH EFFICIENCY

These appliances base their operating principle on the ability to evaporate water using the heat contained in the air treated by the cooler. In other words, the higher the water consumption, the greater the cooling effect.

Using the parameters of Table 9.1 *p. 13* we can estimate that for every liter of water evaporated from 1000 m³ of air, there will be a reduction in air temperature of about 2 ° C.

**Table 9.1** *Air and water parameters*

| | | |
|---|---|---|
| **Latent water evaporation heat** | J/kg | 2260000 |
| **Water density** | kg/m³ | 997 |
| **Air specific heat** | J/kg @40 °C | 1005,5 |
| **Air density** | kg/m³ | 1,14 |

In the case of an AD14 cooler we have:

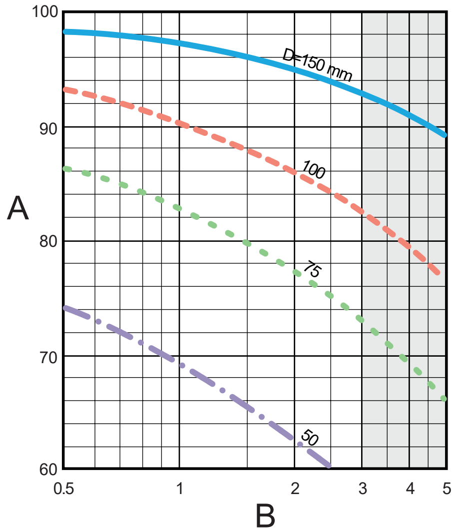
- air flow: 13000 m³/h
- water consumption: 43 l/h
- temperature gradient of the outlet air: 6,5 °C

In general, if you want to make a comparison with other types of coolers, the lower the declared water consumption, the lower the cooling effect that can be obtained.

## 9.2 EVAPORATIVE PACKS CROSSING SPEED

The crossing speed of the evaporative packs of the treated air also contributes to the efficiency of the appliance as a whole. In fact, the producers of the exchange packs usually provide a graph in which it is possible to deduce the exchange efficiency in relation to the air speed (and therefore the air flow rate of the cooler): the higher the speed, the lower the exchange efficiency (Figure 9.1 *p. 13*).

**Figure 9.1** *Evaporative pack saturation efficiency diagram*




A Saturation efficiency (%)
B Air speed (m/s)
The grey area shows the conditions in which condensation forms.

Moreover, if the crossing speed approaches 3 m/s, the droplets of water present on the edge of the evaporative packs may be subject to entrainment, with the consequent introduction of water into the cooled room.

In the case of an AD14 cooler we have:

- Net exchange area: 2,7 m²
- air flow: 13000 m³/h
- speed: 1,33 m/s

The crossing speed designed for the Robur AD units allows a good exchange efficiency of the evaporative pack and a sufficiently low speed to avoid dragging phenomena of water droplets in the cooling air.

# 10 CONTROL AND REGULATION SOLUTIONS

The evaporative coolers are available in three different versions, two of which are equipped with an independent basic (ECO) or advanced (EVO) remote control for each unit, and the third (SC) suitable for the centralised management of a system composed of up to 30 units, to be associated with a centralised control system, supplied by Robur.

The three versions can be summarized as follows:

- AD14/AD20 ECO: equipped with the basic ECO remote control (Paragraph 10.1 *p. 13*).
- AD14/AD20 EVO: equipped with the advanced EVO remote control (Paragraph 10.2 *p. 14*).
- AD14/AD20 SC: without individual remote control, but designed for a centralised control (Paragraphs 10.3 *p. 14* and 10.4 *p. 16*).

## 10.1 ECO BASIC REMOTE CONTROL

**Figure 10.1** *ECO basic remote control*

The ECO basic remote control is the basic control system for AD evaporative coolers.

The features of the ECO basic remote control are:

- Turning the appliance on and off.
- Cooling/ventilation selection.
- Ventilation speed selection (3 levels).
- Diagnostics of any faults.

All settings must be made manually, as there is no time programming for this control.

Refer to Figure 8.1 *p. 12* for the wiring diagram.

**Table 10.1** *ECO control technical specifications*

| | |
|---|---|
| **Enclosure** | plastic box, dimensions: 120x82x30 mm |
| **Mounting** | on the wall |
| **Data retention** | on EEPROM memory |
| **Protection** | IP00 |
| **Operating conditions** | ambient temperature -10 ÷ 60 °C<br>storage temperature -20 ÷ 70 °C |
| **Relative environment humidity** | 20 ÷ 80%, non condensing |
| **Connections** | screw terminals for wires with a maximum section of 2,5 mm$^2$ |
| **Display** | 4 digits display + 4 icons + LED |
| **Serial communication** | 1 TTL serial iFS interface |

## 10.2 EVO ADVANCED REMOTE CONTROL

**Figure 10.2** *EVO advanced remote control*

The EVO advanced remote control is the advanced control system for AD evaporative coolers, which includes a humidity and temperature probe already installed and connected to the control.

The features of the EVO advanced remote control are:

- Automatic/manual operation selection.
- Cooling/ventilation selection.
- Automatic or manual selection of the ventilation speed (3 levels).
- Room temperature detection by integrated thermostat.
- Ambient humidity detection by integrated humidistat.
- Automatic operation based on the setpoint.
- Daily programming of the operating time schedule.
- Diagnostics of any faults.

The EVO control can guarantee automatic regulation of the cooler, thanks to the temperature and humidity probe, being able to adjust the fan speed accordingly on the 3 available levels. With the EVO control, it is also possible to set a daily time program, being able to set the cooling or fan-only mode.

Refer to Figure 8.1 *p. 12* for the wiring diagram.

**Table 10.2** *EVO control technical specifications*

| | |
|---|---|
| **Enclosure** | plastic box, dimensions: 180x150x65 mm plus humidity sensor |
| **Mounting** | on the wall |
| **Data retention** | on EEPROM memory |
| **Protection** | IP54 |
| **Operating conditions** | ambient temperature -10 ÷ 60 °C<br>storage temperature -20 ÷ 70 °C |
| **Relative environment humidity** | 20 ÷ 80%, non condensing |
| **Connections** | screw terminals for wires with a maximum section of 2,5 mm$^2$ |
| **Display** | 4 digits display + 10 icons + LED |
| **Inputs** | digital temperature and humidity probe (0 ÷ 99 RH accuracy at 25 °C: ± 3% F.S.), already connected and wired |
| **Serial communication** | 1 TTL serial iFS interface |

## 10.3 OCDS010/OCDS011 CENTRALISED CONTROL

**Figure 10.3** *OCDS009 network board*

**Figure 10.4** *OCDS010/OCDS011 centralised control*

The OCDS010/OCDS011 centralised control allows centralised management of systems consisting of several SC version cooling units (up to a maximum of 30).
The functions of the centralised control are:

- Display and setting of date and time on network boards.
- Display of temperature and humidity measured by network boards.
- Display and change of temperature and relative humidity setpoints for each network board.
- Display and change network device parameters (network boards and coolers).
- Switching on/off of each individual network board.
- Daily programming of the operating time schedule of the whole system.
- Selection of automatic/manual/off operation for each individual cooler.
- Cooling/fan-only/off selection for each individual cooler.
- Diagnostics of any faults.
- Keyboard lock via key (supplied).

Each cooler must be in SC version (without individual control) and must be equipped with a network board (optional OCDS009, with temperature and humidity probe already mounted and connected to the board), which communicates with the centralised control panel via SC bus (OCDS010) and possibly provides an additional Modbus interface (OCDS011).
OCDS010 is the version of the centralised control that communicates exclusively via SC bus, suitable if the centralised control is not connected to other external supervisory devices.
OCDS011 is the version of the centralised control that communicates with the network boards via SC bus, but has an additional Modbus interface, suitable for connection to external supervision systems (e.g. a BMS).
Figure 10.5 *p. 16* below shows the wiring diagram for connecting the network cards to the control panel (OCDS010 or OCDS011).

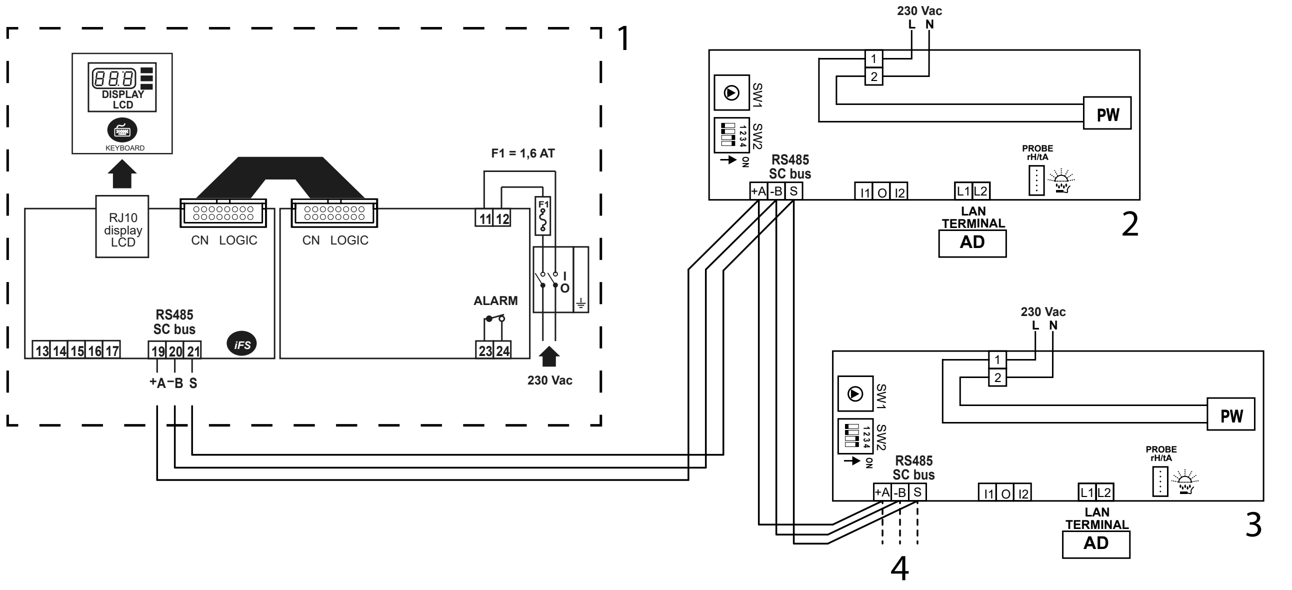
**Table 10.3** *OCDS009 network board technical specifications*

| | |
|---|---|
| **Power supply** | 230 V AC ± 10% |
| **Consumption** | 5 VA |
| **Enclosure** | plastic box, dimensions: 180x150x65 mm plus humidity sensor |
| **Mounting** | on the wall |
| **Data retention** | on EEPROM memory |
| **Protection** | IP54 |
| **Operating conditions** | ambient temperature -10 ÷ 60 °C<br>storage temperature -20 ÷ 70 °C |
| **Relative environment humidity** | 20 ÷ 80%, non condensing |
| **Connections** | screw terminals for wires with a maximum section of 2,5 $mm^2$ |
| **Inputs** | digital temperature and humidity probe (0 ÷ 99 RH accuracy at 25 °C: ± 3% F.S.), already connected and wired |

**Table 10.4** *OCDS010/OCDS011 centralised control technical specifications*

| | |
|---|---|
| **Power supply** | 230 V AC, protected by 1,6 A delayed fuse (T) |
| **Operation field** | -50.0 ÷ 150.0 °C |
| **Consumption** | 7 VA |
| **Enclosure** | plastic box, dimensions 300x220x120 mm |
| **Mounting** | on the wall |
| **Data retention** | on EEPROM memory |
| **Protection** | IP00 |
| **Operating conditions** | ambient temperature -10 ÷ 50 °C<br>storage temperature -20 ÷ 70 °C |
| **Relative environment humidity** | 20 ÷ 80%, non condensing |
| **Connections** | screw terminals for wires with a maximum section of 2,5 $mm^2$ |
| **Display** | LCD display |
| **Keyboard lock** | Keyboard lock via key (supplied) |
| **Outputs** | ALARM SPST relay 3(1)A 250 V AC |
| **Serial communication** | 1 RS485 serial port for SC bus. The maximum allowed length of the network connection is 1000 m<br>1 TTL serial iFS interface for keyboard lock, already connected and wired on display board<br>1 TTL serial iFS interface for expansion key. It allows:<br>• device FW update<br>• quick parameter configuration (copy/paste)<br>**only for OCDS011**: 1 RS485 serial port for Modbus |

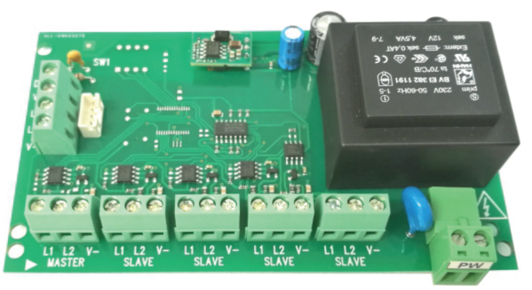
**Figure 10.5** *Connection of OCDS009 network boards to OCDS010/OCDS011 centralised control*




1 OCDS010/OCDS011 centralised control
2 OCDS009 network board
3 OCDS009 network board
4 Possible next OCDS009 network board

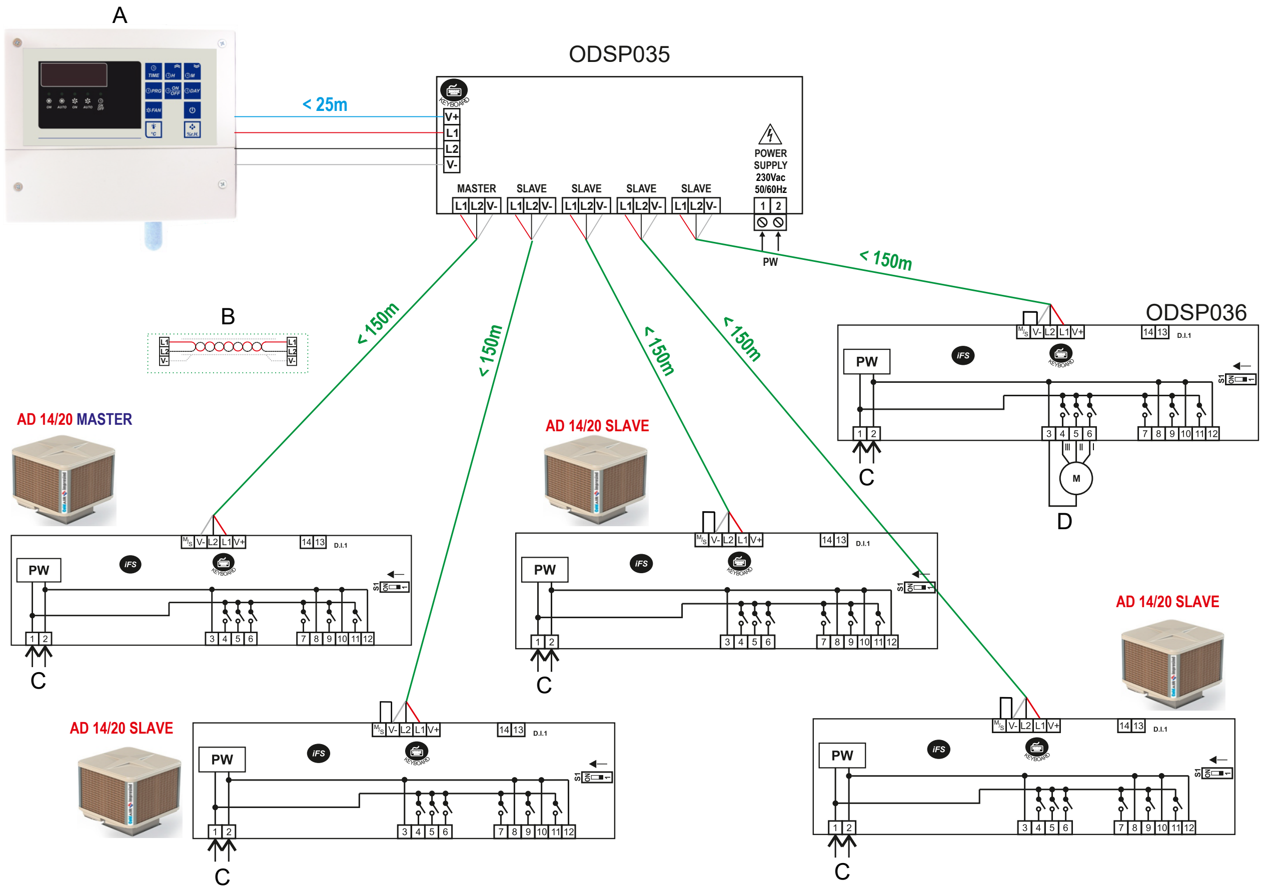
## 10.4 CENTRALIZED CONTROL WITH ROUTER

**Figure 10.6** *ODSP035 router*




The purpose of the ODSP035 router is to replicate, on several AD coolers, the commands from a single ECO/EVO control, which normally controls only one AD.
The AD cooler used as master will be of the ECO or EVO type, while the other AD coolers must be of the SC type, i.e. without control.
The ODSP035 router can manage a maximum of 5 AD coolers, divided between a master and 4 slaves.

**Figure 10.7** *Connection diagram for ODSP035 router*



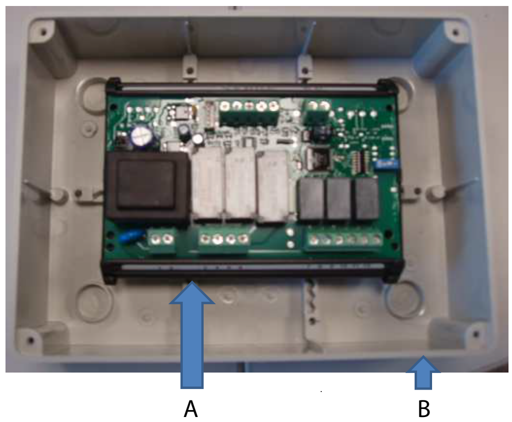

| | |
|---|---|
| A | ECO/EVO control |
| B | RS485 network cable |
| C | Power supply 230 V AC |
| D | 3-speed motor connection (e.g. air extractor) |

**Notes**

- The ODSP035 router can be fixed to the bottom of the EVO control box using 4 screws. If an ECO control is used, it is necessary to provide a protection box suitable for the environment in which it is installed.
- In this configuration, do not connect the V+ terminal on the AD14/20 boards.

## 10.4.1 Extension board

**Figure 10.8** *ODSP036 extension board*




A Extension board B Plastic box

The ODSP036 extension board is an electronic control board, functionally identical to the one onboard the AD coolers, provided with the relative plastic housing box.
The extension board is used to control the operation of devices other than coolers, typically air extractors, so that they can be operated in a similar way to coolers.
The ODSP036 extension board must necessarily be combined with the ODSP035 router or the OCDS009 network board, available as optional.

# 11 DIFFUSION PLENUMS

For a more homogeneous diffusion of the cooled air in the room, diffusion plenums are available as an option:

- 4-way diffusion plenum for AD14
- 6-way diffusion plenum for AD20

## 11.1 DIMENSIONS

**Figure 11.1** *4-way plenum ODFF002 dimensions*

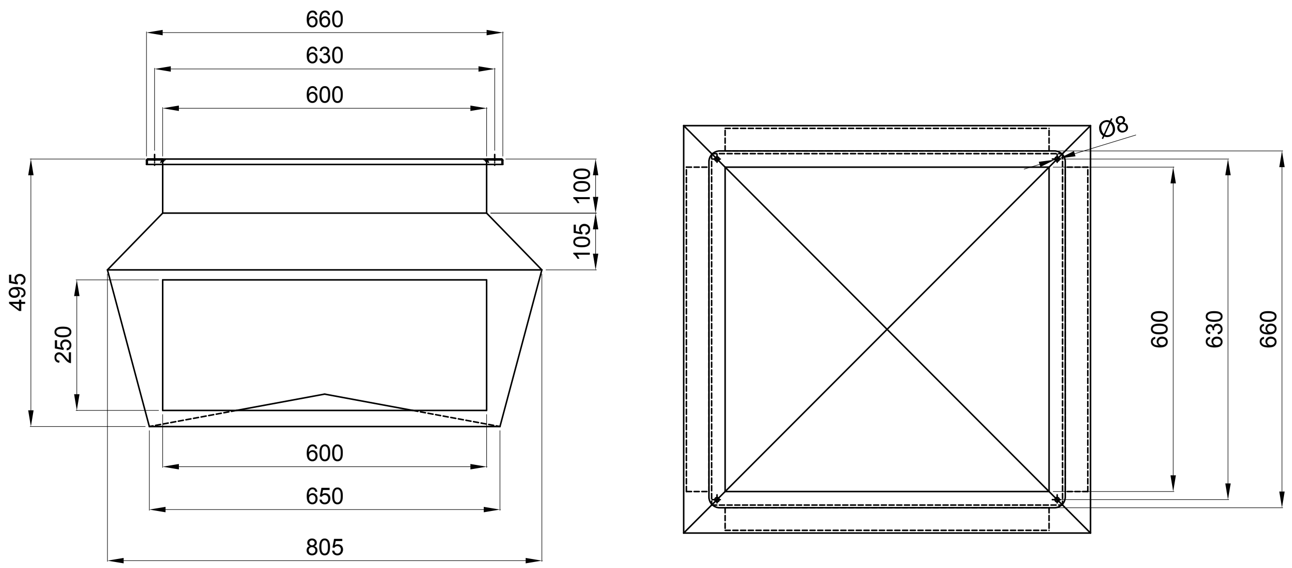
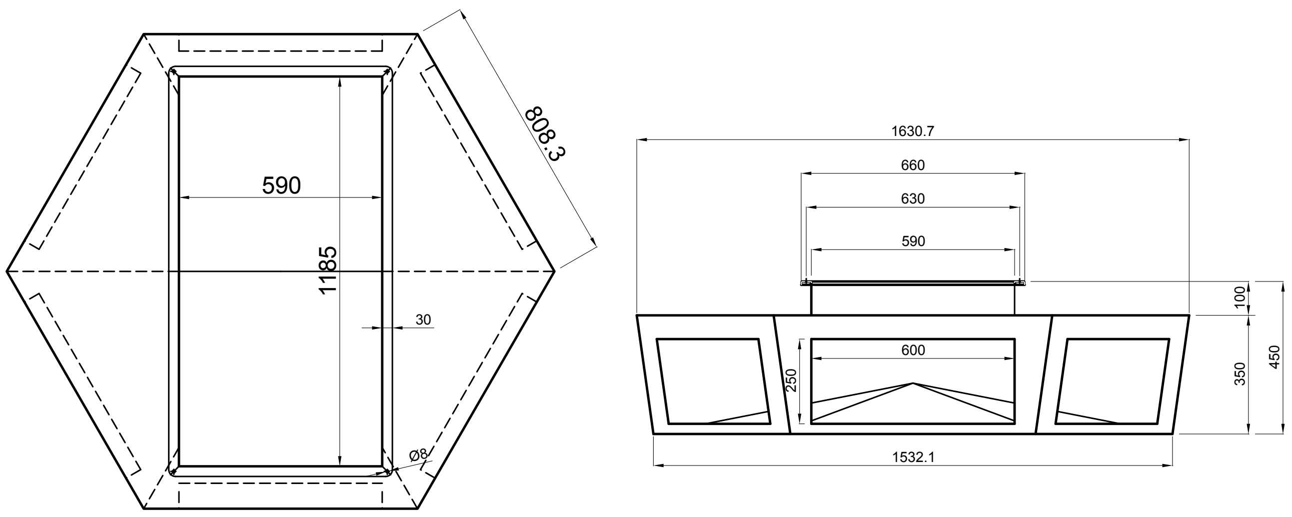



**Figure 11.2** *6-way plenum ODFF003 dimensions*



# 12 TECHNICAL DATA AND DIMENSIONS

## 12.1 TECHNICAL DATA

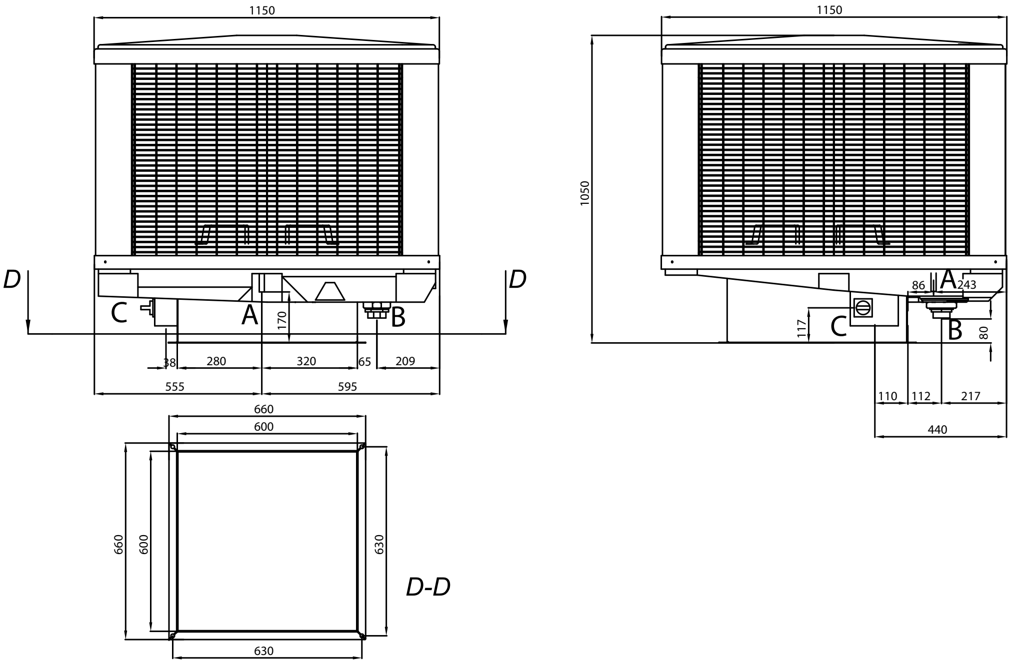
**Table 12.1** *Technical data*

| | | | | AD14 | AD20 |
|---|---|---|---|---|---|
| **Installation data** | | | | | |
| **Air flow** | at maximum speed | | $m^3/h$ | 13000 | 20000 |
| | at average speed | | $m^3/h$ | 9700 | 15000 |
| | at minimum speed | | $m^3/h$ | 6500 | 10000 |
| **fan type** | | | - | axial | |
| **maximum useful pressure head** | | | Pa | 80 | |
| **water consumption** | | | l/h | 43 (1) | 64 (1) |
| **Water inlet** | type | | - | M | |
| | thread | | " | 3/8 | |
| **Water drain** | type | | - | M | |
| | diameter (Ø) | | mm | 60 | |
| **Humidifying panel** | surface | | $m^2$ | 2,7 | 3,4 |
| | thickness | | mm | 100 | |
| | saturation efficiency | | % | 89 | 87 |
| **sound power $L_W$** | at maximum speed | | dB(A) | 94,0 | 90,0 |
| | at average speed | | dB(A) | 85,0 | 82,0 |
| | at minimum speed | | dB(A) | 80,0 | 77,0 |
| **sound pressure $L_p$ at 5 m** | at maximum speed | | dB(A) | 72,0 (2) | 68,0 (2) |
| | at average speed | | dB(A) | 63,0 (2) | 60,0 (2) |
| | at minimum speed | | dB(A) | 58,0 (2) | 55,0 (2) |
| **Dimensions** | width | | mm | 1150 | 1650 |
| | depth | | mm | 1150 | |
| | height | | mm | 1050 | |
| | Air delivery outlet | width | mm | 600 | 1185 |
| | | height | mm | 600 | 590 |
| **Weight** | weight | | kg | 67 | 120 |
| | in operation | | kg | 88 | 146 |
| **Electrical specifications** | | | | | |
| **Power supply** | voltage | | V | 230 | |
| | type | | - | single-phase | |
| | frequency | | Hz | 50 | |
| **Electrical power absorption** | nominal | | kW | 1,10 | 1,90 |
| **maximum power consumption** | | | A | 4,8 | 7,0 |

(1) Test conditions: outdoor temperature 33 °C, relative humidity 60%.
(2) Maximum sound pressure levels in free field, with directionality factor 2, obtained from the sound power level in compliance with standard EN ISO 9614.

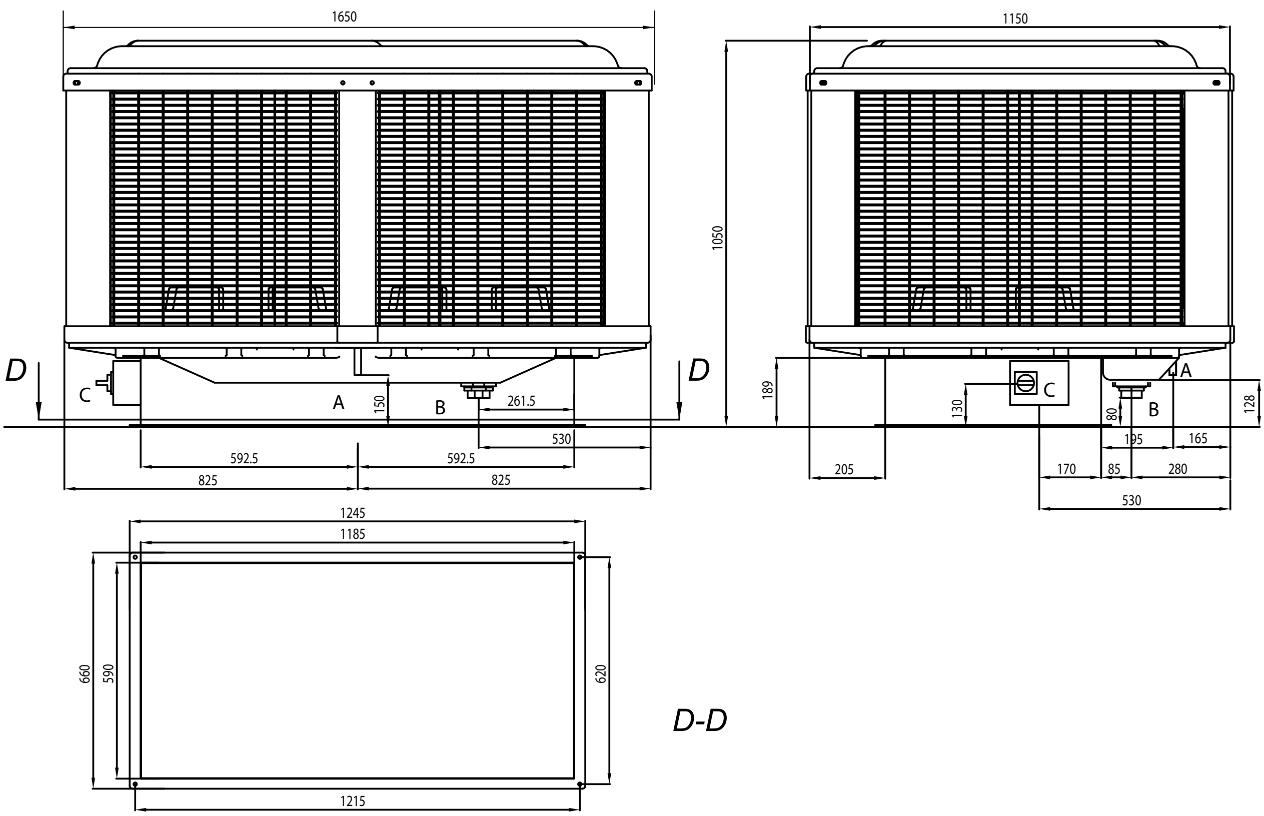
## 12.2 DIMENSIONS

**Figure 12.1** *AD14 dimensions*




A Water inlet 3/8" M
B Water drain 60 mm M
C Electrical panel

**Figure 12.2** *AD20 dimensions*




A Water inlet 3/8" M
B Water drain 60 mm M
C Electrical panel

## 12.3 INSTALLATION EXAMPLES

**Figure 12.3** *Installation example*


**Figure 12.4** *Installation example*


**Figure 12.5** *Installation example*

**Figure 12.6** *Installation example*

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## Robur mission

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