10-POINT GUIDE TO SPECIFYING DEHUMIDIFIERS

Humidification, Dehumidification
and Evaporative Cooling

condair

GUIDING YOU THROUGH DEHUMIDIFICATION

Key to delivering a successful dehumidifier project is knowing what questions to ask at the outset. There are many variables in reducing humidity. Poor planning can not only lead to the required humidity levels not being achieved, but also the temperature control of an area being compromised, or the system not being used due to excessive energy use.

This guide provides an overview of the most important elements to consider when planning a dehumidifier project. It will enable a HVAC consultant, facilities manager or contractor to gather the information needed to design and install an effective dehumidification system.

This will include making informed decisions on technology selection, calculating the required dehumidifier capacity, overall system design and energy considerations. It presents some useful rules of thumb and gives prompts to review important aspects of a project that may not be immediately obvious.

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1 WHY DEHUMIDIFY?

There are many different reasons to lower an indoor humidity level, but the three main applications for commercial dehumidifiers are to improve manufacturing efficiency, to preserve artefacts and buildings, and to protect human health.

Process applications
Many manufacturing processes benefit from consistent environmental conditions, including accurate control over humidity. A low humidity may be needed to dry a product more rapidly and increase production speed. Humidity may be controlled to prevent the moisture in the air from reacting with a material and causing a chemical reaction.

Frequently optimal manufacturing processes need to maintain an equilibrium between air humidity and materials being used. Moisture naturally migrates from a point of high humidity to a point of low humidity, and moisture migration can reduce a product's quality, shelf-life or increase production waste.

Understanding the "equilibrium relative humidity" of a material will help a manufacturer keep the production environment in an optimal condition to prevent moisture movement from material to the atmosphere, or vice versa.

Non-process applications
High humidity or rapid fluctuations in humidity can be very damaging to a building's interior and contents.

Museums and galleries need to keep humidity consistent to prevent the damaging effects to exhibits of expansion and contraction through the gain and loss of moisture. Excessive humidity can cause condensation to form on cool surfaces, which can lead to damage from mould, corrosion and water on floors. This is particularly relevant in buildings such as water treatment plants or military storage areas, where rust can cause major damage to expensive hardware.

Storage areas for materials that are hygroscopic, particularly in the food and beverage sector, frequently need to maintain low humidity to prevent a food stuff taking on moisture from the environment, or condensation forming on elements such as bottles.

Example process application ideal humidity levels:	
Pharmaceutical	10 – 60%RH
Electronics	45 – 55%RH
Plastic injection moulding	25 – 30%RH
Automotive	45 – 55%RH
Food manufacturing	30 – 65%RH

Example non-process application humidity levels:	
Museums / archive stores	45 – 55%rH
Energy plants / turbines	<60%rH
Food storage	40 – 60%rH
Military hardware storage	30 – 45%rH

Swimming pools
The constant evaporation from the pool's surface can create excessively high indoor humidity levels. This in turn will cause discomfort for people and corrosion of the building fabric, fixtures and furniture. Condensation will particularly occur on any cold surface, such as on windows, metal objects and the inner face of external walls.

When air is in close proximity to these cold surfaces, its temperature drops. If the dew point (the point at which the air is saturated) is reached in this micro-climate, then condensation will form. So it's vital to maintain an air humidity that avoids this and create a safe and healthy environment, and ensure longevity for the property.

During the summer, when windows and surfaces aren't so cold, the indoor humidity can be allowed to rise higher without issues of condensation, thus saving energy.

Swimming pool humidity levels:	
Summer	60%RH
Winter	50%RH

"improve manufacturing efficiency, to preserve artefacts and buildings, and to protect human health"

Condair offers free expert advice on any dehumidifier application

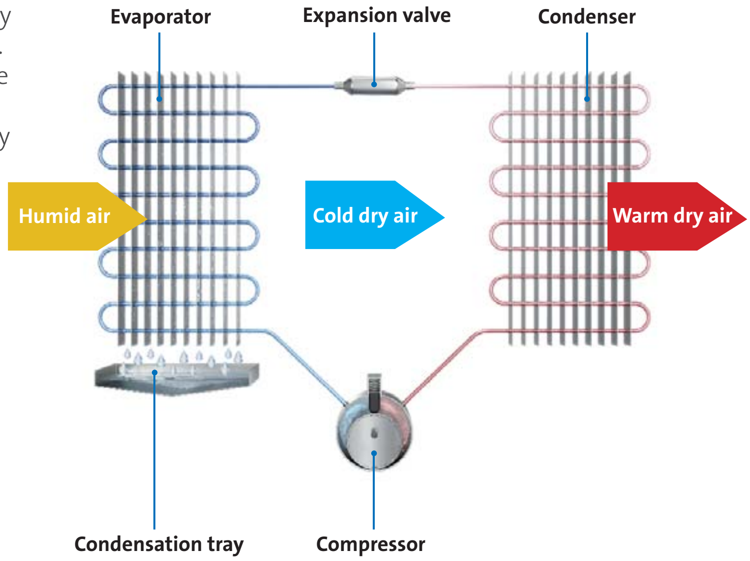
2 WHAT IS A CONDENSING DEHUMIDIFIER AND WHEN SHOULD YOU USE ONE?

A condensing dehumidifier removes moisture from the air by creating a cold surface upon which water vapour condenses. It chills the air below its dew point, using the evaporator side of a standard refrigerant circuit. It reheats the dried air with the hot condenser side of the circuit before supplying the dry air to the room and sending the condensation to drain.

As the process relies on condensation forming, the lower the temperature of the ambient air, the less condensation forms in the dehumidifier. This means that condensing dehumidifiers operate most efficiently in temperatures of around 20°C and above.

The performance of the drying process in a condensing dehumidifier is limited by the cooling coil's ability to condense moisture in a liquid state without freezing it. This means the level of humidity typically achievable with a condensing dehumidifier is around 50%RH or more.

During the drying process there is a latent heat gain of around 0.63kW per kg of moisture removed. As moisture turns from vapour to liquid, latent heat energy is released. This energy is then transferred back to the air, as the air passes through the condenser. This results in the dry air leaving the dehumidifier being significantly warmer than the wet air entering the dehumidifier, and this should be taken into account during the design process (see point 6).



> "ideal for mid-range temperatures and humidity above 50%RH"

Condensing dehumidifier	
Dehumidification principle	Refrigerant circuit
Effective operating temperature	15°C to 36°C
Achievable %RH	>50%RH
Control tolerance	±10%RH
Power consumption per kg removed	0.5 – 1.5kW
Room heat addition	Moderate
Ducting required?	No
Typical installation type	Mobile or fixed

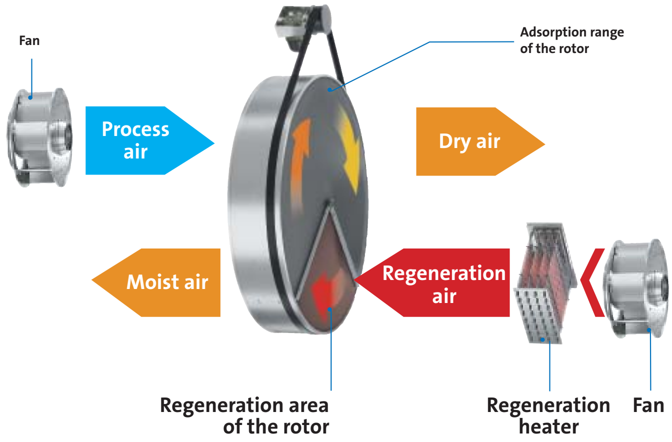
3 WHAT IS A DESICCANT DEHUMIDIFIER AND WHEN SHOULD YOU USE ONE?

A desiccant dehumidifier removes moisture from the air by adsorbing it in a slowly turning desiccant wheel. Similar to a sponge literally soaking up water, the desiccant wheel adsorbs moisture from the air passing through it.

To avoid saturation, very hot air is forced through a section of the wheel, during its rotation. This process is called regeneration. The hot air has a very low relative humidity and draws water from the desiccant wheel, as it slowly rotates through the regeneration area. This hot, wet air is then vented externally, rejecting the moisture and ensuring the system can continuously dry the air.

Desiccant dehumidifiers can be placed in series, enabling them to provide humidity levels as low as 1%RH. They can also effectively dry at extremely low temperatures.

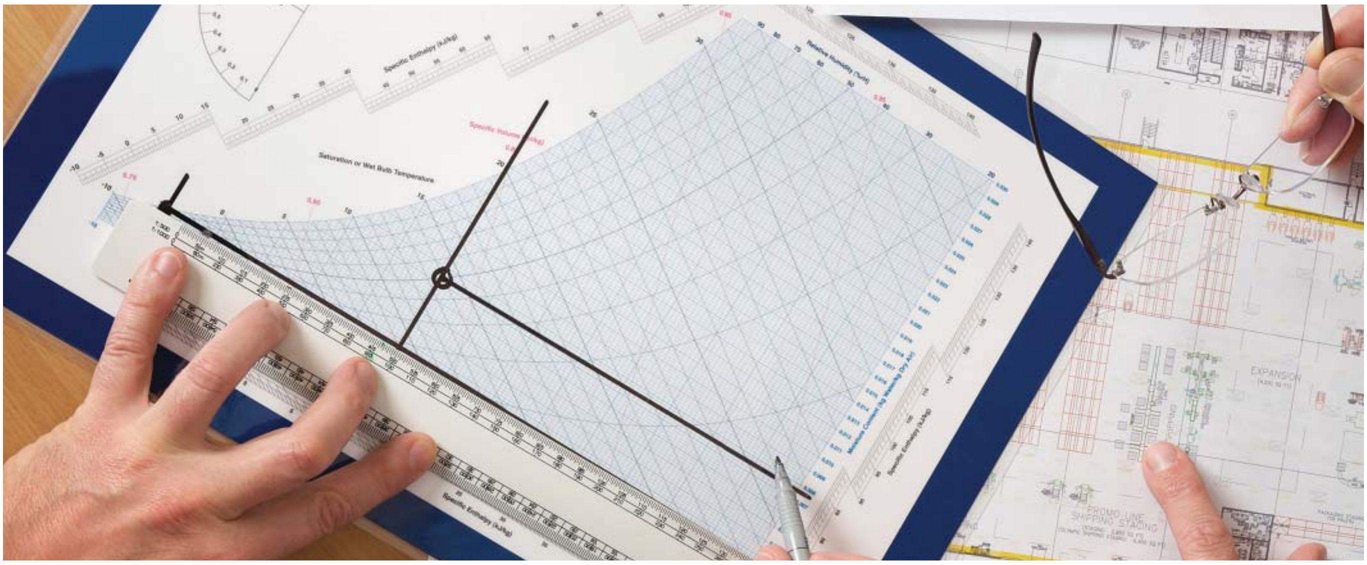
The regeneration process has a high energy consumption, so from an operating cost perspective, condensing dehumidifiers are frequently the first choice, if the project conditions allow. However, projects that require low temperature operation, close control of humidity or a humidity level less than 50%RH, benefit from the performance a desiccant dehumidifier can provide.



“projects that require low temperature operation, close control of humidity or a humidity level less than 50%RH”

	Desiccant dehumidifier	
	Sorption wheel	**Dehumidification principle**
	-30°C to 40°C	**Effective operating conditions**
	1%RH	**Achievable %RH**
	±2%RH	**Control tolerance**
	1.0 – 3.0kW	**Power consumption per kg removed**
	High	**Room heat addition**
	Yes	**Ducting required?**
	Fixed	**Typical installation type**

4 WHAT ARE THE PSYCHROMETRICS OF CONDENSING AND DESICCANT DRYING?



A psychrometric chart shows the relationship between air temperature, air moisture content and relative humidity. It is typically used in a dehumidifier project to calculate the amount of water extraction needed from a single kg of humid air, in order to reach a required lower level of humidity. This can then be multiplied by the total amount of air in an area, to determine the capacity of dehumidifier that would be capable of maintaining the desired humidity level.

The chart also shows the temperature changes resulting from the drying process, and any subsequent impact on humidity this will have. Understanding these factors allows decisions to be made on which type of dehumidifier is most suitable, and the need for pre- or post-cooling equipment to reach the required supply air temperature, alongside the required humidity level.

Processes (see fig. 1)

A Isothermal humidification – the addition of steam increases the moisture content and relative humidity with minimal increase in temperature.

B Heating – the addition of heat energy increases temperature, reduces relative humidity without affecting moisture content.

C Dehumidification – the removal of moisture, reduces relative humidity with an increase in temperature from the heat released during the dehumidification process.

D Cooling – the removal of heat energy decreases temperature, increases relative humidity with the possibility of a reduction in moisture content through condensation during the cooling process.

E Adiabatic humidification/cooling – the evaporation of cold water increases moisture content and relative humidity, whilst the use of heat energy for the evaporation process reduces the air temperature.

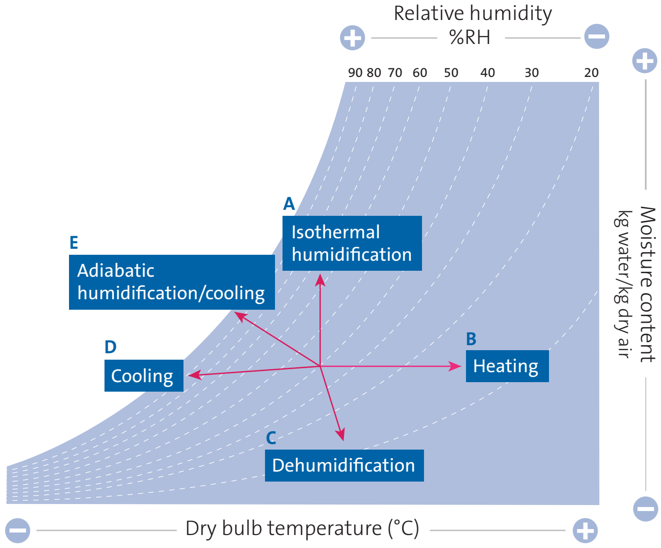
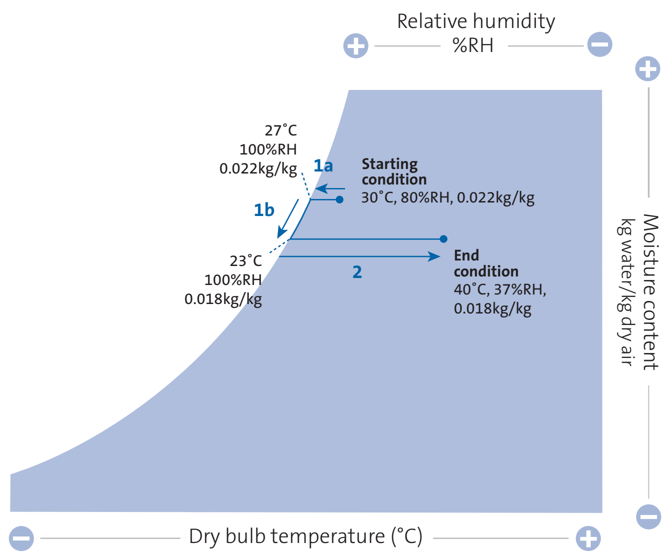


Fig. 1 – the five main psychrometric processes.

> the relationship between air temperature, air moisture content and relative humidity

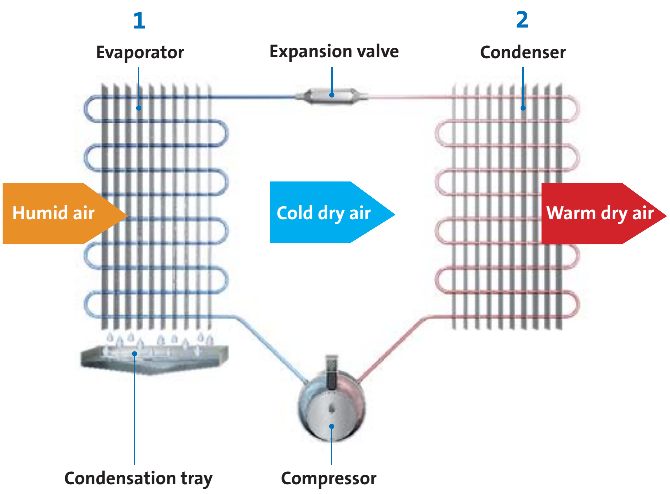
Typical condensing dehumidification process



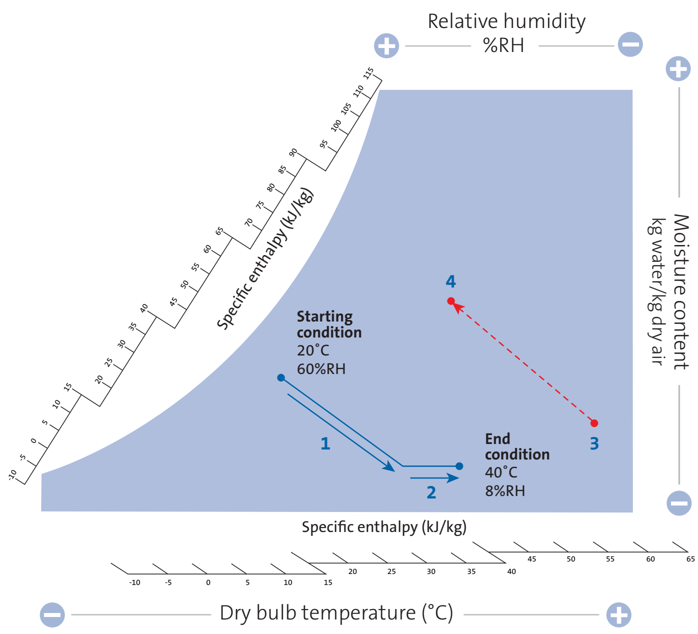
1a – Sensible cooling on the evaporator heat exchanger surface. Temperature reduces by 3°C to 27°C and humidity increases to 100%RH (reaches dew point). No moisture quantity reduction yet.

1b – Latent cooling on the evaporator surface. Temperature reduces by a further 4°C to 23°C, humidity remains at 100%RH, and the moisture quantity reduces by 0.04kg/kg dry air.

2 – Air heating from the compressor and condenser. Temperature increase by 17°C to 40°C, and humidity reduces to 37%RH. No change in moisture content.



Typical desiccant dehumidification process

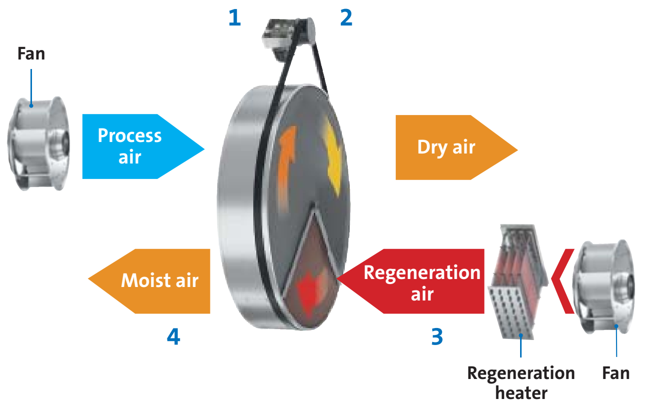


1 – Air is drawn in and passes through the desiccant rotor, where moisture is adsorbed. The temperature increases by 13°, due to the latent heat of vaporisation (see point 6), and the relative humidity drops by 49%RH (from 60%RH to 11%RH). Moisture reduction by 0.05kg/kg dry air (0.009 to 0.004kg/kg).

2 – The air increases temperature further due to the residual heat in the revolving desiccant rotor from the hot regeneration process. The temperature increases another 7°C and the relative humidity drops from 11%RH to 8%RH, but the moisture content remains constant.

3 – Air is heated to around 90-120°C (chart shows indicative start and end condition, to illustrate rise in temperature and drop in relative humidity), to dry out the rotor and extract moisture.

4 – Hot wet regeneration air is vented externally.



To use a psychrometric chart, you will need to know the:

1. The air's starting temperature and relative humidity.
2. The air's desired final relative humidity, and maybe temperature if that is also relevant to the process (see point 6).

5 WHAT SIZE DEHUMIDIFIER DO I NEED?

Dehumidifiers are sized on their capacity to remove moisture from the air in kg per hour. In order to determine what size dehumidifier is needed for a project, a load calculation must be performed. This is a two-part process and takes into account the amount of moisture being introduced from ventilation plus the moisture being introduced from internal sources.

Firstly, to calculate the moisture load from ventilation, a psychrometric calculation is performed (see point 4). This determines the amount of water extraction needed from 1kg of air at the starting (outside) condition to reach the desired end (inside) condition, then multiplies it by the overall volume of air being treated.

External load

You will need to know:

A. Outside air conditions (°C, %RH) – typically from the highest absolute humidity condition, eg. summer

B. Room set point (°C, %RH) – desired room condition

C. Moisture differential ΔM (kg/kg dry air) – difference in absolute moisture between A. and B. calculated from a psychrometric chart (see point 4)

D. Air volume/room volume (m^3/h) – taking into account room volume and air exchange rates

E. Specific volume (m^3/kg) – from the psychrometric chart based on B. (the room set point)

Secondly, the internal load takes into account any moisture evaporation from materials, people or processes in the area.

Internal load

You will need to know:

A. Number of occupants

B. Occupant working intensity (see working intensity Table 1)

C. Additional sources of moisture – eg product moisture content, open sources of moisture

Occupant working intensity	Moisture addition per person, per hour @20°C
Low (eg sitting at a desk)	35g
Medium (eg working in a factory)	110g
High (eg exercising in a gym)	185g

External load calculation is:	Internal load calculation is:
Duty = $\frac{\text{C. (Moisture difference) x D. (Air volume)}}{\text{E. (Specific volume)}}$	**Duty =** A. (No. of occupants) x B. (Working intensity) + C. (Additional moisture)
Total Duty = External Load + Internal Load	

Swimming Pools

In addition to the external and internal load calculations, swimming pool areas will need additional consideration to determine the rate of evaporation from the pool itself.

Internal load

You will need to know:

A. Room volume in m³
B. Pool surface area in m²
C. Water temperature
D. Room temperature (typically be at least 2°C higher than water temp. to minimise evaporation)
E. Room humidity set point
F. Daily hours of operation in hours
G. Type of usage

The type of use has a significant influence on the movement of the water surface and thus on evaporation, e.g. therapy pool, jacuzzi, public leisure pool. This is taken into account in the calculation through a corresponding activity index.

To calculate the amount of water vapor emitted by a still, open surface of water through evaporation the calculation is:

mVPRpool = E x A x (pS – pP)

Where:

E = empirically determined evaporation coefficient for still evaporation of an open, still water expanse in g / (h x mbar x m2)
A = Pool water surface in m2
pS = Saturation vapor pressure in mbar, related to pool water temperature
pP = Partial pressure of water vapor in mbar, related to ambient air temperature

"the amount of moisture being introduced from ventilation plus the moisture being introduced from internal sources"

6 HOW CAN EXCESS HEAT BE MANAGED?

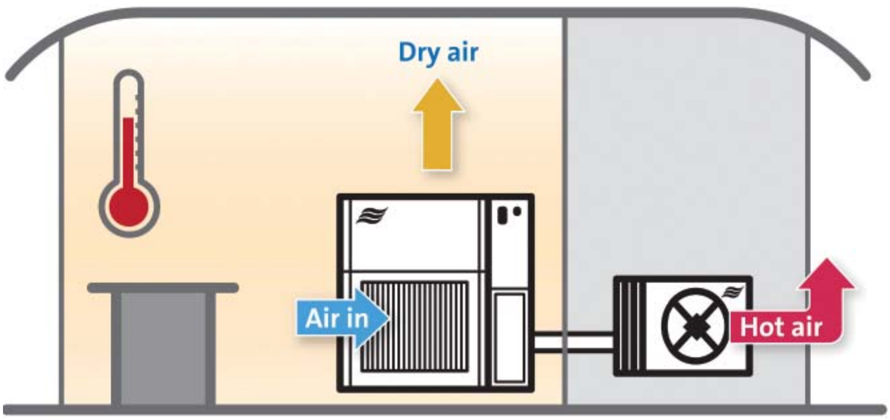
When water is condensed or adsorbed from its gaseous state to a liquid state, to remove it from the air, heat is produced. This is referred to as the latent heat of vaporisation and is approximately 0.63kW per kilo of water removed.

In addition to this heat, a desiccant dehumidifier will add significant temperature gain from the dehumidification process, as residual heat will pass into the process airflow from the regeneration portion of the rotor (see point 3).

Air dried through dehumidification can frequently be very warm and can cause an area to overheat. When this happens, all too often people in the area will open windows to ventilate, but this has a detrimental effect on the humidity control.

To correctly manage the temperature of a sealed, dehumidified environment, condensing dehumidifiers can be fitted with an external condenser. Locating a condenser away from the area being dried, allows the heat produced by the refrigerant circuit to be exhausted externally. Air can then be delivered to the application at a precise humidity and temperature.

For temperature management with desiccant dehumidifiers, additional cooling modules can be fitted after the desiccant rotor. However, cooling the air will alter its relative humidity, so this will need to be factored into the psychrometric calculation for the project (see point 4).



“condensing dehumidifiers can be fitted with an external condenser”

7 WHAT ENERGY EFFICIENCY OPTIONS ARE AVAILABLE?

As a rule of thumb, dehumidification with condensing systems will consume between 0.5-1.5kW of electricity to remove 1kg of water. A desiccant system's consumption is higher at 1-3kW per kg of moisture.

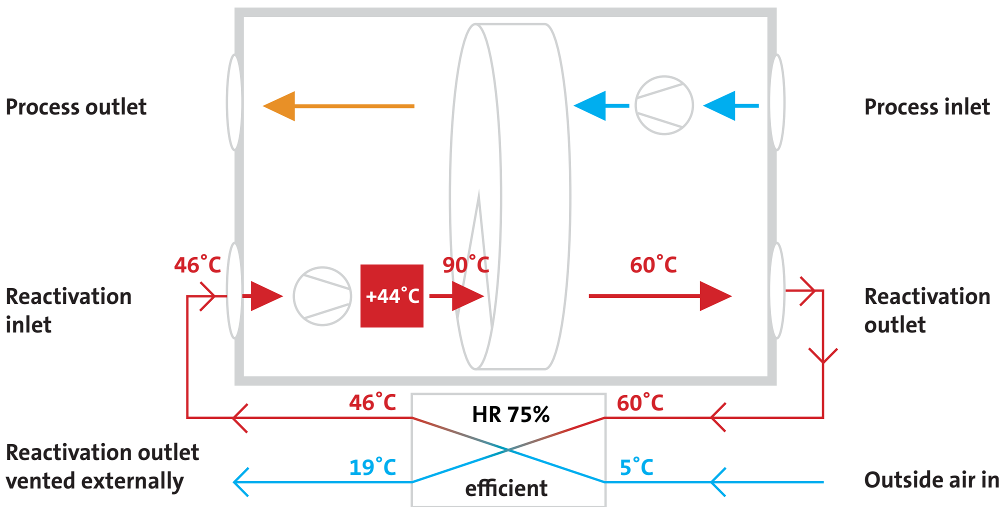
If a condensing system can deliver the drying performance, it is often a lower energy option than desiccant technology. However, there are many applications where only desiccant drying will provide the required conditions.

The main energy requirement in a desiccant dehumidifier is to heat the regeneration airflow to between 90 and 120°C. This is typically done with an electric heat exchanger, but a gas-fired heat exchanger or heat recovered from another process can also be used, to either fully heat or pre-heat the incoming regeneration airflow.

The outgoing regeneration airflow, after it passes through the wet desiccant rotor, can be up to 60°C. By passing this air through a heat exchanger, 75% of the heat can be recovered to pre-heat the incoming regeneration airflow. This can reduce the overall energy use by around 50%.

To further reduce the energy consumption of a desiccant dehumidifier, the size and speed of the rotor, and the temperature of the incoming regeneration air can be modified on a project-by-project basis. This optimisation can ensure the required drying performance is achieved with minimal energy use.

> "Heat recovery can reduce the overall energy use by around 50%."



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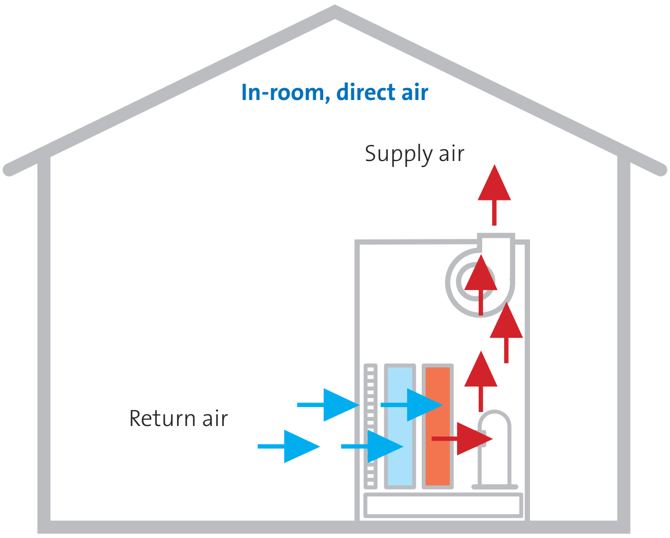
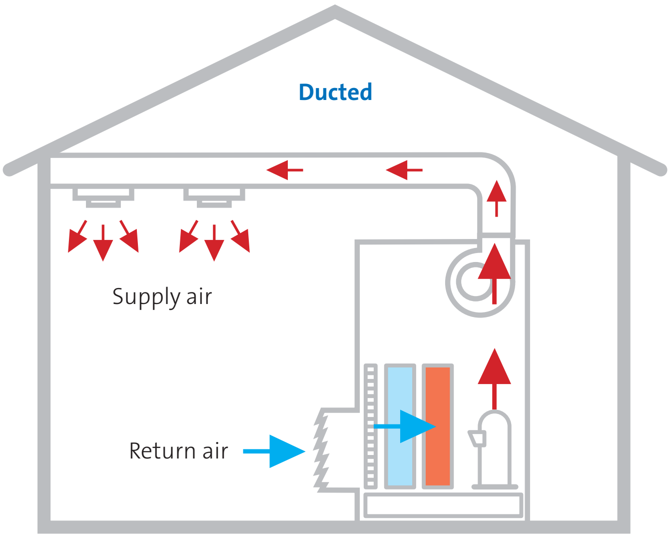
WHAT SHOULD BE CONSIDERED WHEN INSTALLING A CONDENSING DEHUMIDIFIER?





Location
Most condensing dehumidifiers provide humidity control directly to a room's atmosphere. They are infrequently connected to an air handling unit, as dehumidification is a function of the AHU's cooling coil. Condensing dehumidifiers also have much less flexibility in their nominal airflow range, which is typically ±10%, whilst desiccant is ±50%, making them a better solution for AHU drying.

The supply air for a condensing dehumidifier is normally drawn from the area being dehumidified. This is to provide more accurate control than is possible with external supply air, which is affected by the seasonal climate.

When installing a condensing unit with an external, remote condenser, it's important to plan the refrigerant line with the manufacturer. They will be able to estimate the amount of refrigerant and oil charge needed for the project and advise on adequate drainage.

Units are available with wheels, enabling them to be easily relocated if a temporary drying solution is needed.

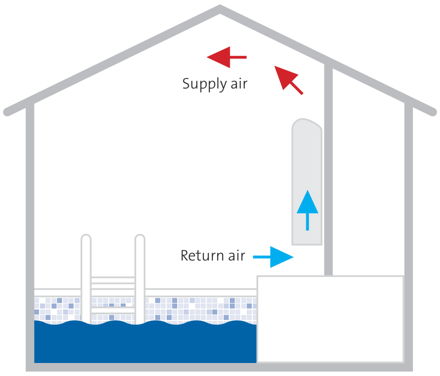
Ducting & airflow
Condensing dehumidifiers are simpler to install than desiccant units, as they only require connections for power and drain, without the mandatory need for ducting. Ducting can be used when necessary.

Airflow must be equal entering and leaving the dehumidifier and should not exceed the nominal airflow rates for the dehumidifier's fan. If the airflow is less than this, due to long duct runs or many duct corners, higher rated fans can be incorporated either in the unit or the duct.

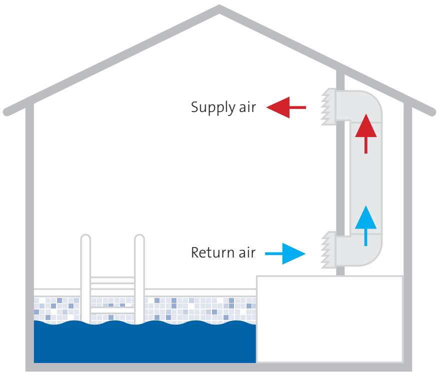
In order to limit noise, it is necessary that the air speed inside the duct should never exceed 4m/s. Greater speed could reduce the dehumidification capacity of the system.

Flexible hose should be used between the unit and the duct channel to reduce the transmission of vibrations.

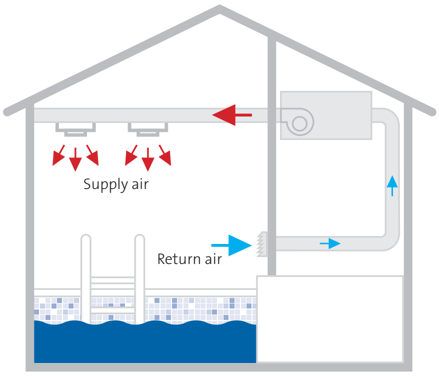
If the air circulation through the dehumidifier is less than three times the room volume, ducting on the process air outlet should be considered to disperse the conditioned air uniformly across the room.



Wall-mounted



Rear wall-mounted



Ceiling-mounted

Drain connection
This should be a flexible rubber pipe about 1m long, incorporating a water trap with a minimum height equal to the suction pressure of the fan, but never less than 35mm.

Sensors
Condensing dehumidifiers will normally incorporate a built-in sensor, unless the air circulation in the room is low. If the air circulation through the unit is less than three times the volume of the room, then a humidistat should be located remotely in the area itself, to provide a more accurate reading and better humidity control.

> "Condensing dehumidifiers are simpler to install than desiccant units"

Condair offers free, expert advice on dehumidifier installation and commissioning

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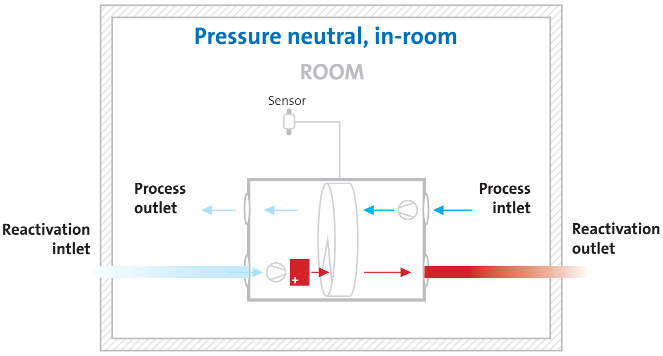
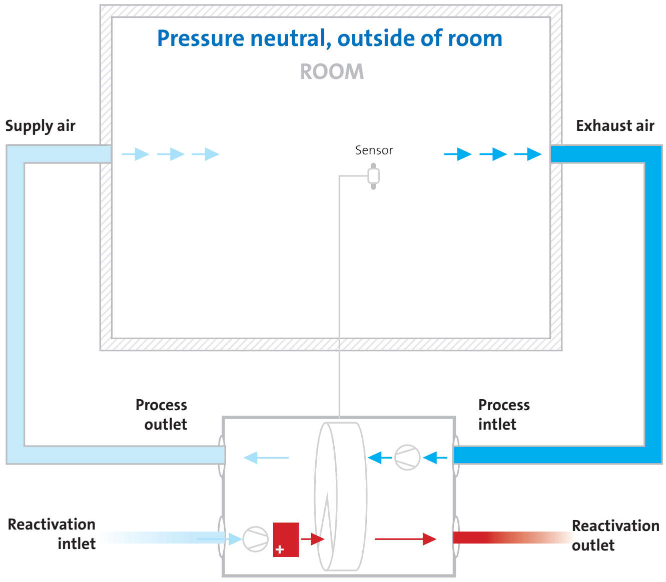
WHAT SHOULD BE CONSIDERED WHEN INSTALLING A DESICCANT DEHUMIDIFIER?





Location

The installed location of a desiccant dehumidifier largely depends on the overall system design strategy. The dehumidifier itself can be located inside the area being treated or externally, depending on available space or the environmental conditions of the room. If the area is very cold, such as a freezer store, it is beneficial to locate the dehumidifier externally to improve access and allow more advanced features to be used, such as PLC controllers.

A clearance of 1,000mm must be left in front of the unit for inspection and servicing.

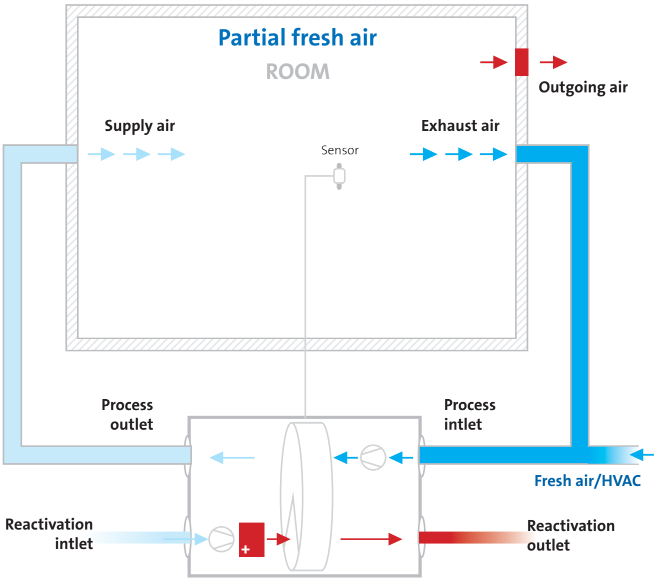
> "ducting is always required for the regeneration air outlet"

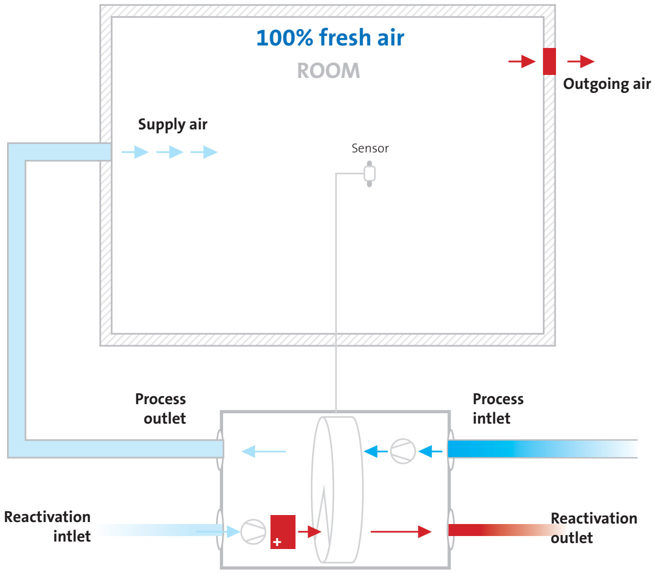
Ducting & airflow

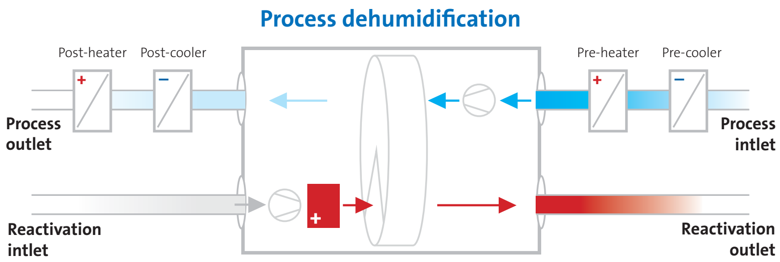
Wherever the dehumidifier is located, ducting is always required for the regeneration air outlet, to exhaust the hot, wet air (typically outside). Unlike a condensing system, there is no drain connection normally required. The out-going regeneration duct needs to have a downward incline of at least 2° from the dehumidifier, so that any condensation forming in the duct does not flow back into the unit. It is also beneficial to keep this duct as short as possible to minimise the risk of condensation, and insulate should there be a potential risk of the dewpoint being reached.

To prevent crossflow of air through the desiccant rotor, from the process airflow to the regeneration airflow, it is beneficial to maintain a slight positive pressure on both incoming airflows. To do this a damper can be fitted, which requires at least a short duct section.

Balancing pressure through the system is vital to performance, and airflows should not exceed the nominal airflow rates for the dehumidifier's fan. If duct lengths or number of bends adversely affect the pressure, higher rated fans can be incorporated into the dehumidifier or inline fans incorporated into the ducting.







Additional components

Heating and cooling modules can be connected, either before or after the dehumidifier, to ensure conditioned air is introduced to a room at a specific temperature as well as humidity, or to provide more extreme drying performance (see Process dehumidification diagram).

Condair offers free, expert advice on dehumidifier installation and commissioning

10 WHAT ARE THE MAINTENANCE REQUIREMENTS OF DEHUMIDIFIERS?

A quality dehumidifier is a robust system and if installed and operated correctly, should provide many years of drying performance with very little maintenance needed. The below gives a general overview of the activities that should be routinely undertaken but does not constitute a comprehensive list of service actions, as that will vary on a model-by-model basis.

Condensing dehumidifier

As condensing dehumidifiers incorporate refrigerant gases, any maintenance work needed to the refrigerant circuit must be carried out by a trained individual, with the appropriate regional accreditations. However, unless there is a malfunction, the refrigerant circuit should not need any routine maintenance.

Electrical system

- Clean electronics and components of any dust
- Ensure cables are tight in clamps
- Check integrity of insulating coating on cables
- Check current draw of fans, compressor and pumps

Condensing coil & fan

- Clean finned coils
- Check for freon leaks
- Check noise and vibration level of fans
- Clean drain line and drain pan

Compressor

- Check noise and vibration levels
- Check oil level using oil fill level indicator
- Check crankcase heater is powered and working

Desiccant dehumidifier

Fans & vents

- Clean or replace the filters
- Clean air intake and outlet grille
- Remove and clean fans
- Clean coils and heating elements
- Check fans can rotate freely

Electrical system

- Check electrical connections
- Inspect wiring
- Test supply voltage
- Test controls and safety circuit

Other

- Clean dust from inside of unit
- For pre-cooling option, check inlet and outlet temperature
- Check and adjust rotor belt tension

> “many years of drying performance with very little maintenance needed”

Condair offers advice and servicing for any Condair dehumidifier

WORLD LEADING HUMIDITY CONTROL SPECIALIST

Condair is a world leader in humidity control and evaporative cooling. It has manufacturing facilities in Asia, Europe and North America, sales operations in 22 countries and distributors in over 50 more.

As well as benefiting from the most advanced humidity control technology available, clients are supported by local specialist engineering teams, which can offer installation, commissioning, maintenance and spares support.

Condair offers free expert advice and guidance to HVAC consultants and building designers who are specifying dehumidification systems.

Many factors influence correct dehumidifier design. Having Condair support you on your dehumidification project will ensure all elements have been fully considered by experts who specialise in this niche field.

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