



## 10-POINT GUIDE TO IMPROVING PRODUCTIVITY IN PRINT AND PACKAGING WITH HUMIDITY CONTROL

Humidification, Dehumidification  
and Evaporative Cooling



# MANAGE HUMIDITY IMPROVE PROFITABILITY



Controlling humidity to optimum levels in printing and packaging production is a deciding factor in the success of many processes. When paper or card substrate is produced, it is designed to have a specific moisture content. Any deviation away from this ideal internal moisture content will cause dimensional changes and impact the quality of the material and its behaviour whilst processing.

Moisture evaporation from a printing or packaging material, or absorption by it, can occur very rapidly once it is exposed to an atmosphere.

Alongside the direct result of humidity on the materials being processed, humidity plays a vital role in the

management of electrostatic. Print and packaging production involves a significant amount of friction between materials, which inevitably results in the build-up of electrostatic. This results in attraction or repulsion between materials and subsequent poor processing behaviour, and electrostatic discharge (sparks).

As a global leader in humidity control, Condair has delivered successful strategies to manage humidity in print and packaging facilities around the world. This document presents an introductory guide for production managers looking to enhance their factory's profitability by improving humidity control.



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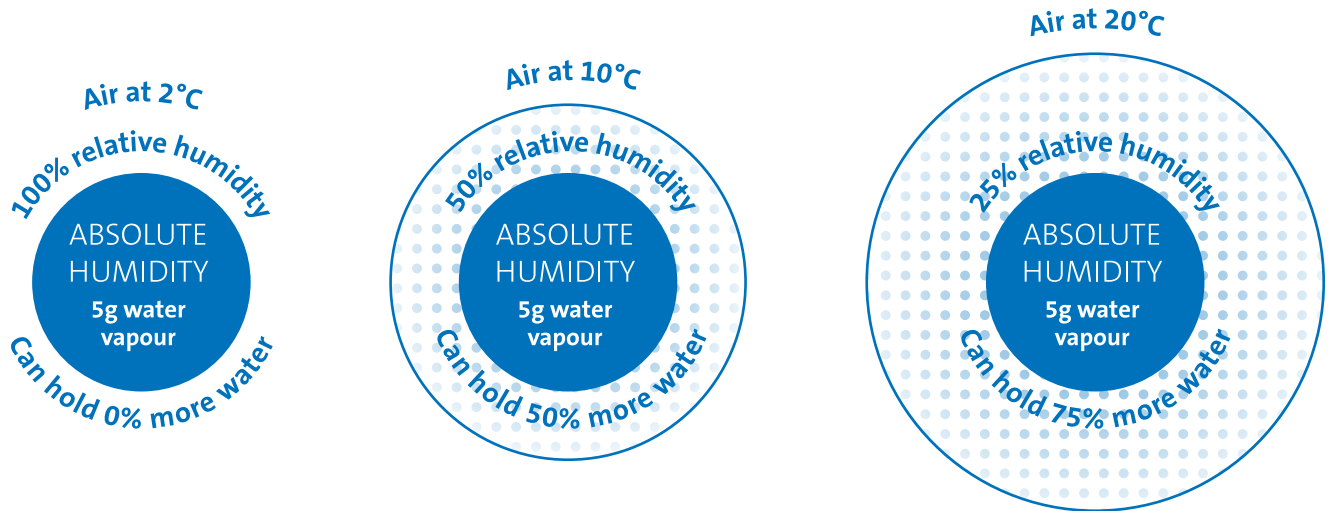
# WHAT IS RELATIVE HUMIDITY?

## Absolute humidity

The amount of water air contains, e.g. 5g

## Relative humidity

The amount of water air contains, expressed as a percentage of the maximum amount it could contain at the same temperature, e.g. 50%RH



The amount of water air can hold depends on its temperature. A volume of cold air can physically hold less water than the same volume of hot air. So heating air increases the amount of water it can hold and, vice versa, cooling air reduces its ability to hold water.

Heating air does not remove water from it. As the air temperature rises, its capacity for absorbing water increases and, unless more moisture is added, its relative humidity drops.

However, as this process happens, if the air comes into contact with anything that has a greater moisture content than itself, the air will absorb moisture from the product in question until an equilibrium is reached.

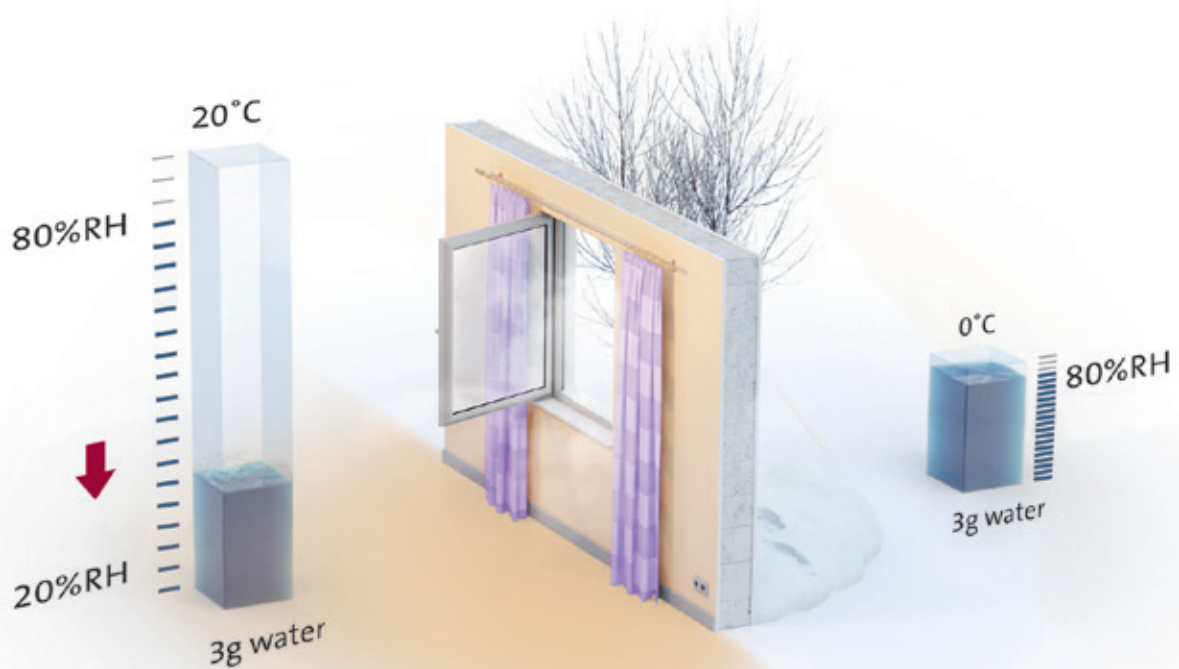
Understanding how temperature affects air humidity and moisture movement is essential when assessing humidity's impact on print or packaging operations. It also underlines the need to investigate and understand the temperature and humidity profile across the production area.

“

cold air can  
physically  
hold less water

”

## WHY IS INDOOR AIR DRIER IN THE WINTER?



As the outside air is cold in the winter, the amount of moisture it can physically hold is low (see point 1). Even though the amount of water vapour in the air is low, its cold temperature means the outdoor air will be at near saturation point with a high relative humidity.

Cold winter outdoor air has very little capacity to absorb any further moisture. This is evident when you hang wet washing outside on a cold day and it takes a very long time to dry.

However, when cold winter air enters a building and is heated, its relative humidity drops because its capacity to hold moisture increases.

For instance, when a cubic metre of cold outside air at 0°C and 80%RH

enters a building and is heated to 20°C, its relative humidity could drop to around 20%RH. It could potentially hold 80% more moisture.

In these dry conditions, air draws moisture from any available source it touches. In print or packaging production, this includes exposed paper, card, or other hygroscopic substrates being processed.

Opening doors and windows to ventilate a heated production area in winter will not increase indoor relative humidity or resolve the dry-air problem. The more cold outside air enters and is heated, the more moisture the airflow will absorb from the materials being processed.

“  
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”

Condair offer free expert advice on humidity levels and system design

**Seasonal effects**

Cold winter air contains very little moisture because low temperatures limit how much water vapour it can hold. Although outdoor winter air may have a high relative humidity, its absolute moisture content is low. When this air enters a building and is heated, its capacity to hold moisture increases, causing the relative humidity to fall. For example, air at 0°C and 80%RH may drop to around 20%RH when heated to 20°C.

**Building condition**

Poor insulation or building defects can allow moisture to enter or create thermal bridges, increasing the risk of internal condensation and mould growth.

**Ventilation**

Ventilation affects indoor humidity, whether it comes from open doors and windows or mechanical HVAC systems. Its impact depends on the condition of the incoming air and any heating, cooling or humidity control applied to it. Ventilation rates are set by building regulations and are typically based on occupancy levels or the need to control indoor pollutants such as dust and VOCs.

**Machinery**

Production machinery can be a significant source of heat in a room. Any increase in temperature will reduce relative humidity. Heat from machinery can cause localised hot spots with subsequent localised low humidity. Because of this varying room humidity profile, it is important to monitor humidity at the point of need, rather than a measurement taken remotely from the moisture sensitive process or material.



**Wet weather**

Regardless of the season, rain can increase indoor moisture through open doors and windows, wet clothing and logistics activity.

**Wet processes**

Evaporation from water-based inks or any wet production process can lead to an increase in indoor humidity.

**Heating and cooling systems**

Systems that manage temperature will influence humidity levels. Air conditioning can cause a localised increase in relative humidity, as it chills the air. However, condensation sent to drain from the AC system lowers the absolute humidity level. So, as the cooled air is warmed in the room, the overall relative humidity can be low. Radiators and in-room heaters will also lower humidity levels.

**Solar heat gain**

Sunlight from windows and glazing will increase the thermal energy of a space, and therefore impact humidity levels.

**People**

Staff will directly add to the indoor humidity through respiration. Moisture introduced from people is calculated on their level of activity, with sitting at a desk resulting in 35g per person per hour, up to intense exercise being 185g per person per hour.

**Material temperature**

If a substrate is stored at a cooler temperature than the production hall, when it is introduced to the hall and unwrapped, the cool surface can encourage high local humidity (condensation). This can lead to moisture absorption by the material causing dimensional change. Production materials should always be acclimatised to the production environment prior to unwrapping.

Condair offers free consultations on improving productivity by managing humidity

## WHAT ARE THE BENEFITS OF MANAGING HUMIDITY?

Humidity control offers many benefits in print and packaging production. Its primary objective is to improve productivity while maximising product quality. Some benefits are specific to particular production processes, while others apply more broadly.

The following are some of the most common reasons for humidity control in print and packaging facilities, covering both humidification and dehumidification.



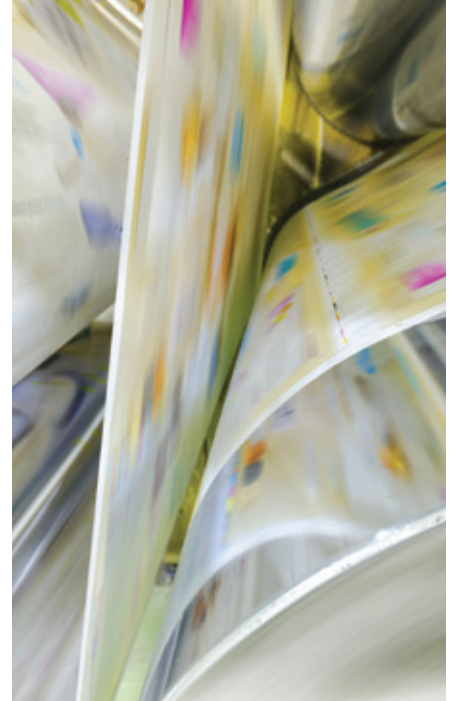
### **Prevent dimensional change**

Any hygroscopic production material can suffer from evaporation or adsorption of moisture, with resultant dimensional change. Even slight dimensional changes to paper and card will cause significant issues, including mis-feeds, machine downtime and stacking problems due to curling and wavy edges.



### **Prevent fold cracking**

Stock fibres that become dry are less flexible and more likely to crack when folded. They split to reveal a white, unprinted core, particularly on heavier stock weights. Maintaining proper air humidity levels prevents this, resulting in a better finish.



### **Prevent web breaks**

Roll edges are exposed to air more than the centre, so they can dry and shrink unevenly in low humidity. When tension is applied, this uneven shrinkage can cause the web to tear.



#### Prevent static

Air with a humidity above 45%RH will act as a natural conductor for electrical charge. This is a very effective way of preventing static in manufacturing environments (see point 6). Static can cause behavioural issues for materials, leading to machine downtime, as well as contamination on films and plates.



#### Evaporative cooling

Cold-water humidifiers increase humidity while also providing evaporative cooling. For example, a spray system delivering 100kg/h of moisture provides approximately 68kW of cooling. This energy-efficient cooling can be particularly beneficial in production halls, where machinery generates significant heat.



#### Reduce staff absenteeism

At a humidity of 40-60%RH, the respiratory immune system functions optimally, and the quantity and infectious nature of airborne viruses is significantly reduced. This will reduce staff sickness from illnesses such as colds and flu.



#### Prevent condensation and mould

Excess humidity can often occur in cooler storage areas and will damage materials through condensation and mould. The building fabric itself can also suffer if left exposed to high humidity. Dehumidification and proper air ventilation will avoid these issues.

“ improve productivity  
whilst maximising  
product quality ”

Condair offers free expert advice and  
return on investment projections

## WHAT IS THE IDEAL HUMIDITY LEVEL?



The “ideal” humidity will depend on the objective of the process in question. Humidity is often managed to prevent any moisture loss or gain from a material. An equilibrium is created between the moisture content of the material and the air. This is often referred to as the Equilibrium Relative Humidity (ERH). An ERH is dependent on the materials being processed and their moisture content.

A supplier should be able to advise on the ideal humidity for their stock, but typically, in print and packaging production facilities the most common target humidity is 45-60%RH. At this level, most papers will be in balance with their environment, with minimal moisture movement. This level of humidity will also help dissipate static (see point 6).

| Application                               | Typical humidity level    | Humidity control objective                                           |
|-------------------------------------------|---------------------------|----------------------------------------------------------------------|
| Paper storage & warehousing               | 50-60% RH                 | Prevents paper shrinking, curling, edge wave and dimensional changes |
| Sheet-fed offset printing                 | 45-55% RH (typically 50%) | Maintains sheet flatness, registration accuracy and reduces static.  |
| Web offset printing                       | 50-55% RH                 | Prevents web breaks, tension variations and paper movement.          |
| Digital printing                          | 45-55% RH                 | Reduces paper feeding problems and static electricity.               |
| Flexographic printing                     | 45-60% RH                 | Controls substrate stability, ink behaviour and static.              |
| Gravure printing                          | 50-60% RH                 | Helps maintain substrate dimensions and consistent ink transfer.     |
| Corrugated board production               | 50-60% RH                 | Prevents warp, bowing and moisture imbalance between liners.         |
| Carton converting & die cutting           | 50-60% RH                 | Improves board stability and cutting accuracy.                       |
| Label printing & converting               | 45-55% RH                 | Minimises static and improves web handling.                          |
| Film packaging production (BOPP, PET, PE) | 50-60% RH                 | Reduces static attraction of dust and improves web control.          |
| Finishing: folding, stitching, binding    | 50-60% RH                 | Prevents cracking, curl and misalignment.                            |
| Gluing and carton erection                | 50-60% RH                 | Promotes consistent adhesive performance and board stability.        |

“ the most common target humidity is 45-60%RH ”

## HOW DOES HUMIDITY CONTROL STATIC?



Electrostatic occurs when electric charges become imbalanced on or within a material, often through friction that transfers charge between surfaces. Static can make materials attract, repel or spark, all of which can disrupt sensitive production environments.

Maintaining humidity above 45%RH helps electric charge dissipate naturally, reducing static build-up. This will not

only improve the performance of paper and card on machinery but will prevent dust adhering to production surfaces, such as plates, which must remain uncontaminated.

Static is often controlled in printing using elimination bars, ionisers and conductive brushes. These can be effective, local solutions, but humidity control presents a holistic solution across a whole room or building.

“ maintain air humidity above 45%RH ”

| Activity (@ 21°C)                 | Static voltages |           |           |
|-----------------------------------|-----------------|-----------|-----------|
|                                   | 10-20% RH       | 65-90% RH | Reduction |
| Walking across vinyl floor        | 12,000V         | 250V      | 98%       |
| Walking across synthetic carpet   | 35,000V         | 1,500V    | 96%       |
| Arising from foam cushion         | 18,000V         | 1,500V    | 92%       |
| Picking up polythene bag          | 20,000V         | 600V      | 97%       |
| Sliding styrene box on carpet     | 18,000V         | 1,500V    | 92%       |
| Removing Mylar tape from PC board | 12,000V         | 1,500V    | 87%       |
| Shrinkable film on PC board       | 16,000V         | 3,000V    | 81%       |
| Triggering vacuum solder remover  | 8,000V          | 1,000V    | 87%       |
| Aerosol circuit freeze spray      | 15,000V         | 5,000V    | 67%       |

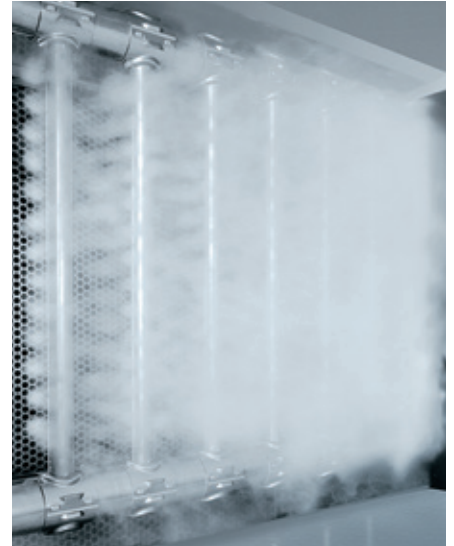
Shows the reduction in the level of electric charge produced by various activities when maintaining a high rather than low humidity. Ref: Military Handbook, 1991, USA, Department of Defence, MIL-BDBK-263B.



Condair offers free expert advice on humidity levels and system design

# WHAT HUMIDIFIER OPTIONS ARE THERE?

Humidification systems can introduce moisture directly to a room or into a central air handling unit (AHU).



## In-room steam humidifier

This humidifier boils water, typically using electricity, and releases steam through a fan unit, either mounted on the humidifier or positioned remotely up to 3m away. With outputs of up to 40kg/h, a single unit is well suited to smaller production areas, such as digital print rooms.

Steam humidifiers provide precise, hygienic humidity control. A room humidity sensor monitors conditions and automatically adjusts output to maintain the required level.

Limescale left after boiling must be periodically removed from the boiling chamber as part of routine maintenance. Using low-mineral RO water can reduce servicing requirements, although it will increase water consumption.

## Spray humidifier

Cold water spray humidifiers are ideal for medium to large production areas. They use high pressure or compressed air to create a fine aerosol that rapidly evaporates. A central pump and water treatment unit feeds water to a series of spray heads located around a facility. The spray heads are strategically located to provide the optimum air conditions for any size of area or production layout.

As well as managing humidity, spray humidifiers will provide evaporative cooling. This can be a welcome benefit given the heat gain from machinery. A 100kg/h spray humidifier will offer around 68kW/h of cooling.

The energy consumption of a spray humidifier is much less than a steam system, as the water is not boiled. Hygiene is assured through a combination of water treatment and flush and drain cycles, which ensures the water is pure and cannot remain in the system to stagnate.

## Central AHU humidifier

If a building has a central air handling unit (AHU) and ducted ventilation, adding humidification to the AHU is often the most efficient option. Depending on the building's requirements, this may use a steam, spray or evaporative humidifier.

However, in print and packaging production, heat from machinery often means the AHU supplies cool air to maintain a comfortable working environment. Because cold air holds little moisture, central humidification may be impractical, making in-room systems the better solution.

## WHAT DEHUMIDIFIER OPTIONS ARE THERE?

Moisture can be removed from air either by condensing it on a cold surface or by absorbing it with a desiccant material. Commercial dehumidifiers use one of these two methods to reduce humidity.

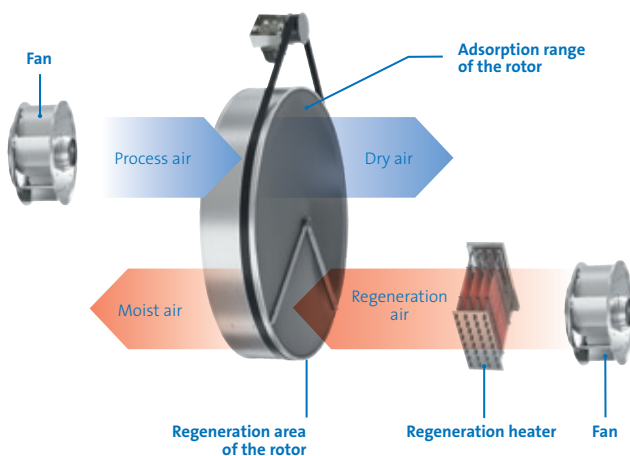
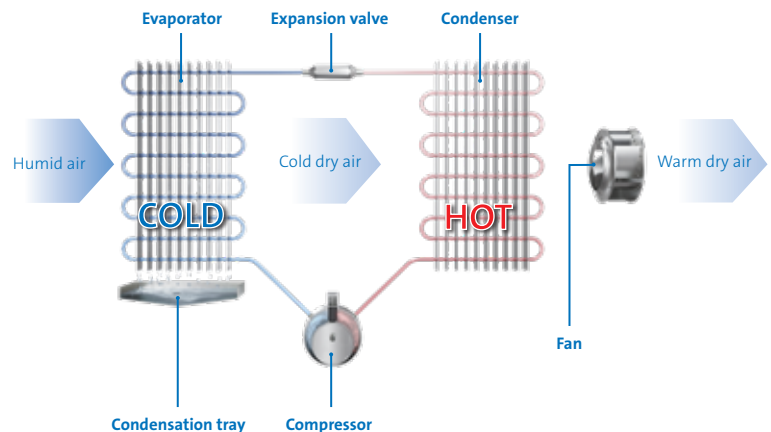
When choosing the most suitable technology for a production facility, the required humidity level and room temperature should be considered. Condensing dehumidifiers are best suited to spaces requiring humidity levels of 50%RH or above and ambient temperatures above 15°C.

Below these conditions, desiccant systems are often more effective. Both technologies can operate as standalone room dryers or be connected to a building's central air handling system.

### Condensing dehumidifier process

A condensing dehumidifier uses the same type of refrigerant circuit found in split air conditioners or refrigerators. Through the expansion of refrigerant gas, a cold coil is created over which room air is passed. Moisture condenses on the cold surface and drips into a tray, where it is either collected in a water tank or sent directly to drain.

The cold air is then heated by the compression of the refrigerant gas and reintroduced to the room at a low humidity.



### Desiccant dehumidifier process

Desiccant dehumidifiers draw in moist ambient air and pass it through an absorbent desiccant wheel. Water is absorbed by the desiccant material and the dry air is passed back into the room. In order to remove the moisture from the wheel, hot air is continually passed through a small portion of it. This hot air absorbs the moisture, dries the wheel as it slowly rotates, and is then exhausted either outside or to an appropriate area.

As this hot regenerating airflow heats the wheel, some of this heat is passed back into the room as the hot section of the wheel rotates back into the process airflow.

Desiccant dehumidifiers require the waste air to be vented somewhere. Condensing dehumidifiers simply require a drain, as the moisture is removed in a liquid state rather than in a gaseous form. Both types can add heat to a room but can be fitted with cooling or heating modules to manage the supply air temperature as well as humidity, if required.

“commercial dehumidifiers use one of these two strategies”

Condair offers free product selection and system design advice

# HOW MUCH ENERGY DOES HUMIDITY CONTROL USE?



## Humidification

The amount of energy used will depend on the type of humidifier. Steam humidifiers will use around 0.75kW of electricity to turn 1kg of water into steam. Cold water spray humidifiers use much less as they do not need to heat the water. The energy consumed by a cold-water humidifier can include the pump used to pressurise the water, compressed air supply (if needed), fans to disperse the aerosol, and any water treatment system.

To deliver 100kg of humidity, a steam humidification system would require around 75kW of electricity, whilst a cold-water system of the same size might just need between 1-2kW.

When cold-water humidifiers evaporate water, it creates a cooling effect, as the energy is drawn from the heat in the air. This is often very beneficial in print and packaging operations, as there is excess heat from machinery. However, if the cooling effect results in supplementary heating being needed, this should also be factored into the system's energy use.

## Dehumidification

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 heating the regeneration airflow. This is typically done electrically, although gas-fired heating or recovered process heat can also be used. After passing through the wet desiccant rotor, the outgoing regeneration air can be 60°C. A heat exchanger can recover energy to pre-heat the incoming regeneration airflow, cutting overall energy use of the system by around 50%.

## WHAT IS THE PAYBACK OF HUMIDITY CONTROL?



Calculating the ROI of a humidity control system requires balancing the total cost of ownership (TCO) against the financial benefits from the system. It is important to properly identify all elements on both sides of this equation, as not all costs and benefits are obvious.

As well as the capital cost of the equipment, the initial project will also involve installation costs and commissioning to correctly set up and configure the system. Alongside a humidifier or dehumidifier, associated elements could include water treatment systems, pumps and tanks, and pipework. After the initial project, ongoing overheads will be energy, water, servicing and necessary spares.

There are many benefits to humidity control (see point 4). Savings and financial benefits should be calculated against direct elements, such as savings on materials from reduced waste, as well as indirect elements, such as the machine time it takes to re-run erroneous production.

Faster production runs will have a direct benefit on energy and staff overheads, as well as potentially enabling more production if orders are outstanding, thus increasing turnover.

Better quality production will enhance client retention and repeat business. This can be difficult to quantify but should form part of the ROI calculation. Clients don't always make it clear they are placing jobs elsewhere due to quality or scheduling issues, so the loss to the business isn't always easy to identify. But it is reasonable to assume a higher quality output will result in more business.

Improved environmental control will enhance staff wellbeing and reduce

viral transmission. In turn, this will reduce absenteeism, so estimates should include this factor. This could include both a direct reduction in sick pay and improved profits from staff productivity.

Once all probable annual financial benefits have been captured and ongoing annual overheads subtracted, the capital cost can be divided by the annual net benefit to give the payback period.

### Example ROI calculation:

|                                   |       |
|-----------------------------------|-------|
| Material waste                    | £10k  |
| Machine downtime                  | £10k  |
| Production speed                  | £8.5k |
| Client retention and sales uplift | £12k  |
| Staff sickness                    | £1.5k |
| Annual system overhead            | -£6k  |
| Total productivity improvements   | £36k  |

$$\frac{\text{£45k - system total cost}}{\text{£36k - annual productivity improvements}} = \text{Payback in 1.25 years (approx. 15 months)}$$

Condair offers free consultations and ROI calculations for any production facility



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ON-SITE CONSULTATION

## 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 23 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 humidity control systems. Many factors influence correct system design.

Having Condair support you on your humidifier or dehumidifier project will ensure all elements have been fully considered by experts who specialise in this niche field.

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Condair Limited  
Artex Avenue, Rustington, Littlehampton, West Sussex, BN16 3LN, UK  
Tel: +44 (0)1903 850200 - [uk.sales@condair.com](mailto:uk.sales@condair.com) - [www.condair.co.uk](http://www.condair.co.uk)

