



## Dehumidification for Archival Storage

An indepth look at the role dehumidification control plays in preserving historical materials.



Proper humidity control can help to increase the lifespan of archival materials. By preventing damage and deterioration, materials can be preserved for longer periods of time.

Storage facilities that have high levels of absolute or relative humidity encourage insect pest activities and the growth of mold.

## Introduction

Archival storage facilities house documents, manuscripts, pictures, and metal artifacts. However, the storage conditions significantly affect the longevity and quality of these items. Temperature, relative humidity, light, and airborne pollutants are the four primary factors that require management to create optimal long-term storage environments. The control of light levels and airborne contaminants are relatively simple, temperature and humidity are complex.

The term “humidity” is a broad term which encompasses three different humidities that need to be clearly understood. Absolute humidity which is a gravimetric measure of the mass of water contained in the air. Relative Humidity is a function of temperature and the air’s ability to hold moisture. Equilibrium Relative Humidity is the level of relative humidity that needs to be maintained so there is a balanced environment where there is no transfer of moisture to or from the air to the archived material.

Temperature and humidity are two critical factors that must be carefully monitored and controlled to ensure preservation of archives facilities. The absolute humidity can generate a whole range of different relative humidity levels with changes in temperature.

## Humidity for Archival Storage

As shown in Figure 1, air with a temperature of 70°F and a relative humidity of 50% can hold around 54 grains/lb of moisture. A shift in temperature of 20°F can cause the relative humidity to reach 100% if the air is cooled. Conversely, if the air is heated, the relative humidity will drop to approximately 25%. However, even a slight temperature alteration of 2-5°F can result in a 10% change in relative humidity, provided the absolute humidity remains constant during the temperature fluctuation.

Storage facilities that have high levels of absolute or relative humidity encourage insect pest activities and the growth of mold. Conversely, conditions being excessively dry can cause archival material to become brittle. Therefore, not only the level of humidity but the stability of the desired condition is crucial.

Abrupt changes in temperatures that result in shift in relative humidity can cause harm to the object. Additionally, temperature can affect the rate of deterioration since chemical reactions occur more quickly in warmer conditions.



Low air humidity below 40% RH acts as a conduit for viruses and airborne bacteria to disperse and travel around indoor environments.



Archival materials are often valuable because of their historical significance and authenticity. By preserving the integrity of materials through proper humidity control, their authenticity can be maintained.

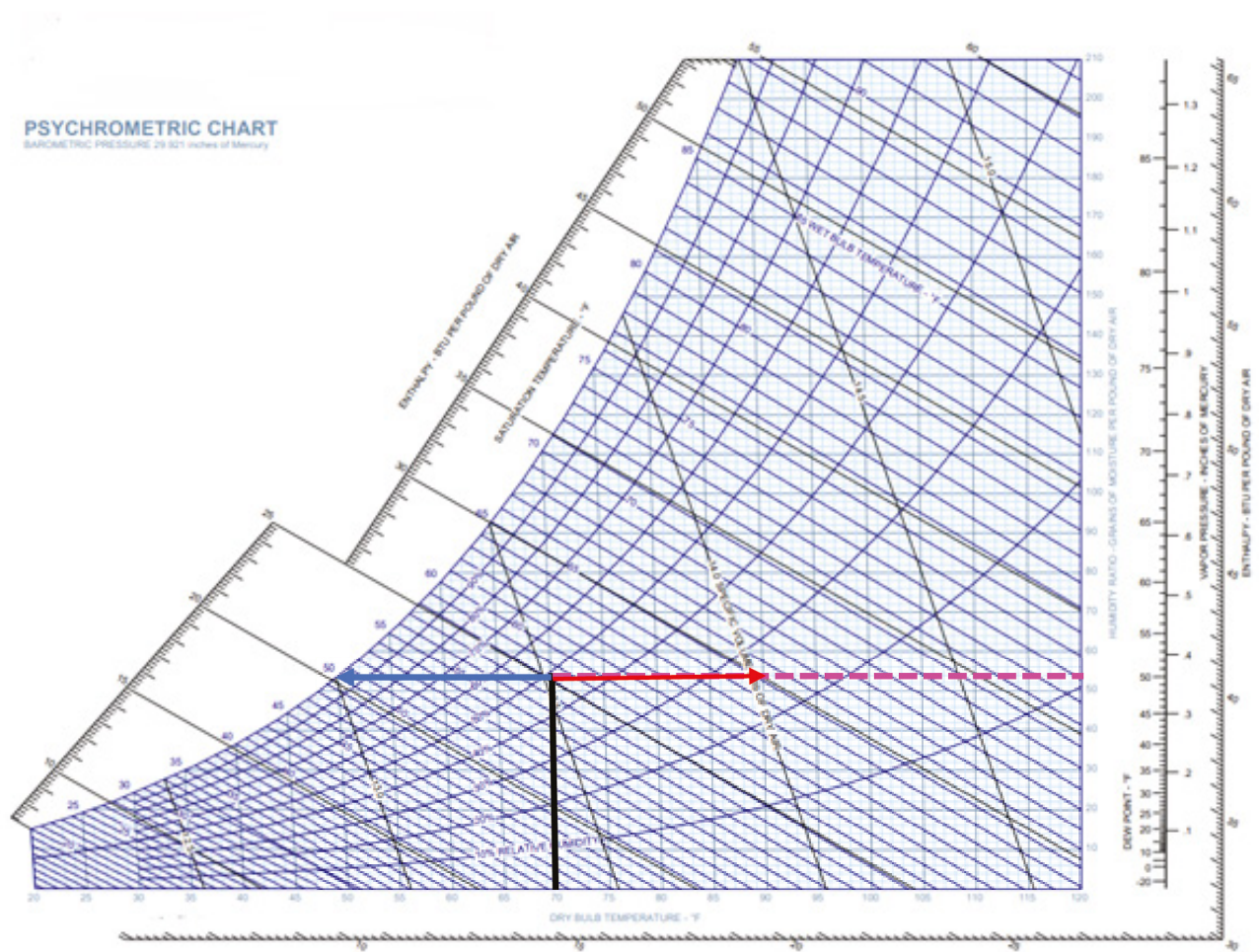


Figure 1: Psychrometric Chart. Air with a temperature of 70°F (21°C) and a relative humidity of 50% can hold around 54 grains/lb of moisture.

Organic materials typically require humidity levels of 35-60% RH to prevent damage caused by excessive moisture.



Humidity can affect the structural integrity of materials, particularly paper-based materials. If the humidity is too high or too low, it can cause paper to become brittle or warp. This can lead to tearing, cracking, or other types of damage. Maintaining the appropriate humidity level can help to preserve the integrity of archival materials.

The required level of temperature and humidity depends on the type of materials being stored. Typically, organic materials such as paper, leather, wood, or natural fibers require a temperature range of 13-68°F with a relative humidity between 35% and 60%, and stability better than +/-5%. However, this is very product dependent. The Isotherms of sorption can be a helpful guide in determining the correct relative humidity levels.

As illustrated in figure 2, Isotherms show the correlation between the absolute moisture content of the air and the equilibrium relative humidity needed for the material at the required moisture content level. Inorganic materials require humidity levels of below 35% RH to prevent corrosion and rust caused by excessive moisture. An example of steel corrosion, as shown in Figure 3, illustrates that the rate of corrosion in ounces/square foot/year decreases as the relative humidity is reduced. In fact, there is almost no corrosion when the humidity is less than 40% RH.

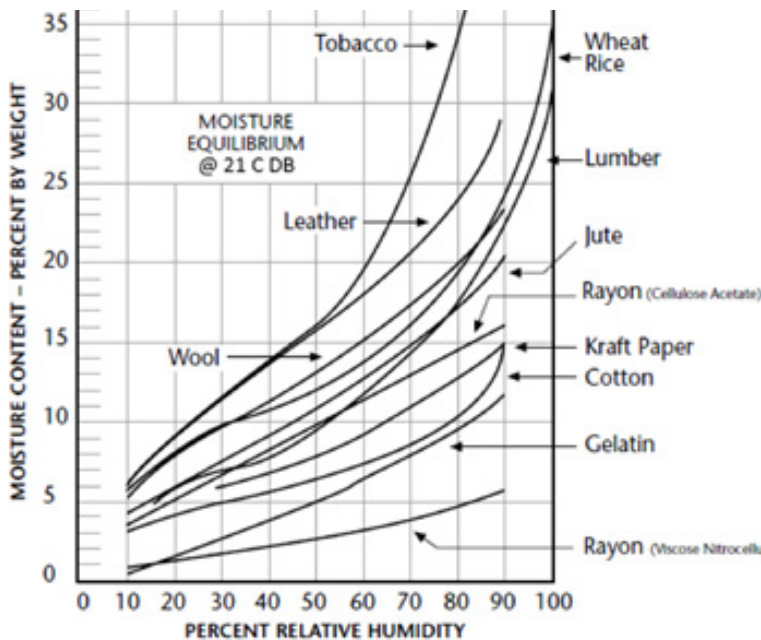


Figure 2: Moisture Sorption Isotherm: Relationship between Relative Humidity and Moisture Content between different materials

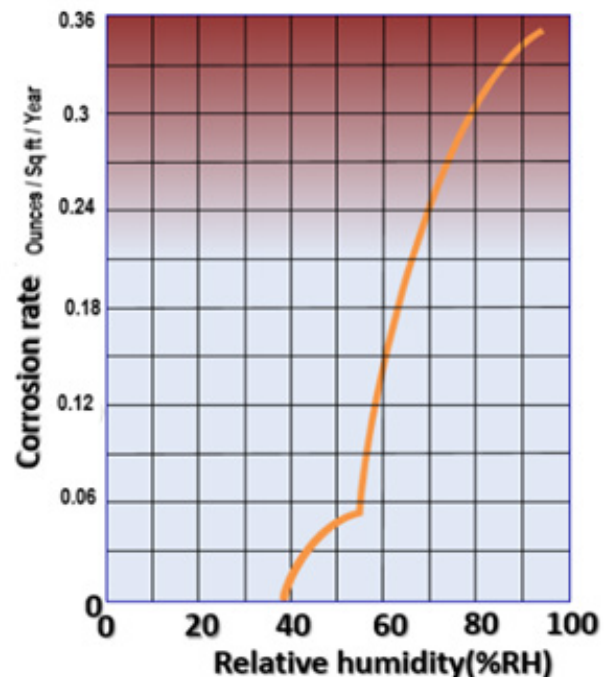


Figure 3: Corrosion rate at different relative humidity



High humidity levels can cause deterioration and damage to archival materials, including documents, photographs, and artifacts. Humidity levels that are too low can also lead to damage. Maintaining a consistent humidity level within an appropriate range can help to prevent this type of damage.

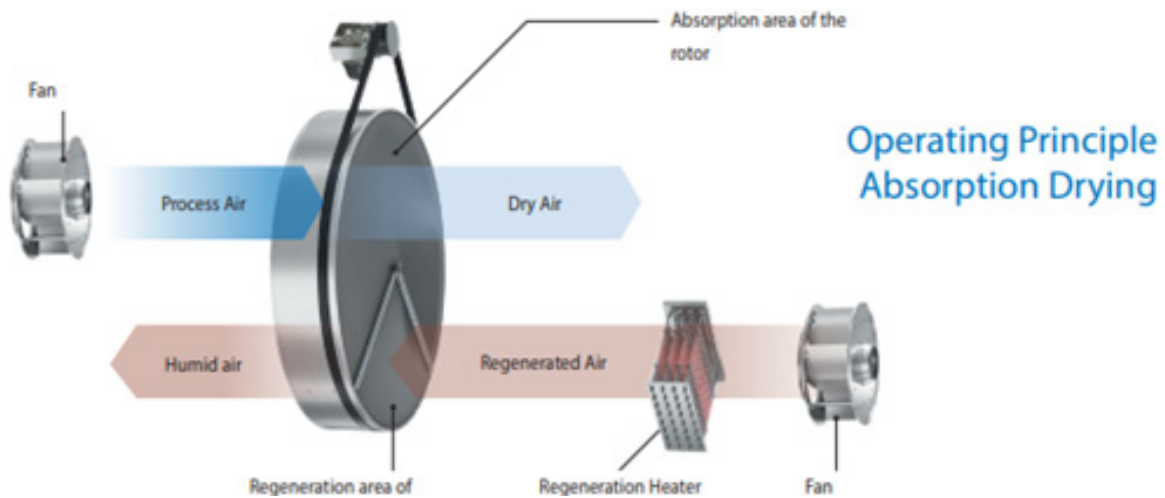


Figure 4: Adsorption dryer diagram.

## How Desiccant Dehumidifiers Work


Desiccant dehumidifiers are also called adsorption dryers. Adsorption dryers are used when the moisture content of less than about 45% RH is required, often at very low temperatures and humidity levels. They can attain much lower relative humidity levels, even less than 10% RH if required, while providing much more stable overall control, usually better than +/-2% RH.

An adsorption dryer consists of a sorption rotor, air filters, two fans for conveying the process air and the regeneration air, a heater for heating the regeneration air and the associated control system.

Figure 4 is a diagram of the adsorption dryer. The process air fan conveys air for drying into the device. After the air is filtered, the air reaches the slowly rotating sorption rotor. This consists of over 82% silica gel on a fully bonded air-permeable glass fiber honeycomb structure.

Due to its extremely large inner surface of up to 24,000 sqft/ounce, the silica gel is very hygroscopic and can therefore adsorb large amounts of water from the process air on the surface and store it in its internal structure.

Proper archival storage maintenance leads to optimum environments for perfect preservation of artifacts.



In archive storage facilities, adsorption dehumidifiers offer a flexible solution with a wide variety of operational parameters. They are capable of dehumidifying air at low temperatures and can manage ambient humidity levels ranging from 0-100%RH

**Two processes take place simultaneously as the air flows through the sorption rotor:**

The process air can be dehumidified effectively. However, depending on the intensity of dehumidification, the air temperature may rise significantly.

Therefore, it is often necessary to cool the now dehumidified but warm air before returning it to the room. For this dehumidification process to work, the sorption rotor must be continuously regenerated: This means that the moisture stored in the silica gel must be constantly removed from it. This is done with regeneration air, which flows through the sorption rotor from the other side in countercurrent. The regeneration air is heated, and consequently the relative humidity drops so much that it is sufficient to expel the water from the silica gel and bind it as steam in the air (desorption.) The now humid corrosion rate at different relative humidity.

## Benefits of Dehumidification:

Proper humidification and indoor humidity levels in storage facilities has proven beneficial in studies for several reasons. These benefits include:

- Preserving documents, paintings, and films etc.
- Preventing mold growth and insect infestation.
- Preventing corrosion on metal items.
- Low energy and low maintenance solutions.
- Optimum environment for perfect preservation.



Figure 5: Condair DA Dryer



According to ASHRAE, the recommended relative humidity levels for archive storage facilities are between 30% to 50%, with a temperature range of 60-68°F (15.5-20°C)

## Condair DA Series

According to ASHRAE, the recommended relative humidity levels for archive storage facilities are between 30% to 50%, with a temperature range of 60-68°F. Depending on the specific product the relative humidity level may vary on the material being stored. Example – Materials such as photographs and films may require a lower relative humidity level as compared to paper and paintings to prevent damage.

Areas where low humidity levels are required, Condair adsorption dryers of DA Series are used. The silica-gel impregnated rotor operates practically wear-free under optimal operating conditions and enables safe operation down to temperatures of -8°F and the achievement of even the lowest possible humidity.

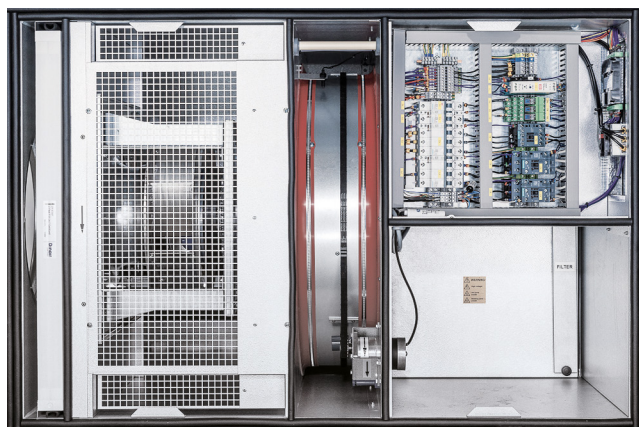


Figure 6: Inside of the Condair DA Series Dryer

The silica gel used as drying medium is not respirable and not flammable. Alongside standard versions with dehumidification capacities from 7 to 44 lbs/hr for process air flows from 300 to 2400 CFM, the DA dryers can be available with pre-cooling and/or post-cooling chilled water modules.

### Product Features:

- High-performance desiccant rotor
- Robust AluZinc® housing with RAL9006 powder coating
- Insulated casing with double skin layout.
- Electric reactivation with self-regulating PTC heater
- EC fans for process and reactivation air
- PLC control with touchscreen
- Comprehensive control options – Modbus TCP/IP board or Modbus RS485 for PLC
- Service-friendly design

Wherever low humidity levels are required Condair adsorption dryers of DA Series are used.



## Conclusion

In archive storage facilities, adsorption dehumidifiers offer a flexible solution with a wide variety of operational parameters. They are capable of dehumidifying air at low temperatures and can manage ambient humidity levels ranging from 0-100% RH, making them perfect for unheated storage spaces. If necessary, these dehumidifiers can reduce humidity levels to below 10% RH with a control precision of +/-2% RH. Maintaining low humidity environments helps to inhibit microbial growth, decay, and minimize corrosion when accurately controlled.

### Other Dehumidification Applications:

These are just a few industries and buildings that benefit from Condair dehumidification solutions:

- Cold Storage
- Food Processing
- Electronic Manufacturing
- Beverage Industry
- Power Plants
- Military Storage
- Archival Storage
- Art Galleries and Museums
- Pharmaceutical Manufacturing

### About Condair

Condair Group, founded in 1948 and based in Switzerland, is the global leader in humidification, dehumidification and evaporative cooling. Supported by science, we engineer individual, holistic solutions that customers can trust through the entire lifecycle. With optimal humidity, we increase productivity and create healthier built environments.

Condair Group has production sites in Europe, North America and China, its own sales and service organizations in 22 countries, and representatives in 50 locations worldwide. You can rely on our comprehensive portfolio of innovative technologies for air humidification, dehumidification and evaporative cooling for the entire lifecycle of each product.