PREVENT ICE FORMATION

Air dehumidification to prevent condensate and ice formation in cold storage facilities.

Humidification, Dehumidification
and Evaporative Cooling

condair

The problem with excessively humid air in cold storage

When storing food, such as meat and sausage meat and sausage products, dairy products, pasta and frozen foods, an optimal ratio between the appropriate room temperature and air humidity is top priority in ensuring lasting high product quality. Room conditions that deviate from the ideal conditions even just for a short period of time can often cause considerable damage.

Regulating the air humidity poses a particular challenge here. It is unavoidable that warm and humid air flows into the warehouse, for example when goods are being brought in or taken out, or that products newly deposited in the warehouse release moisture into the air. For many operators, removing this moisture permanently and safely is a permanent problem, especially at storage temperatures of often far below freezing. When water condenses out of the air, it precipitates as liquid or, in frozen storage, as ice on floors, walls and goods. This causes damage to the products and endangers operational safety, as people may slip and injure themselves or forklifts may slip on slippery ice.

Recirculating air coolers which draw air from the warehouse and cool it in a heat exchanger before blowing it back into the storage area dehumidify the air only slightly.

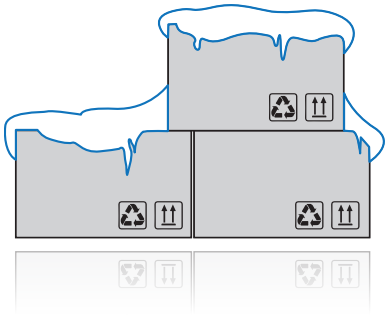
With this dehumidification method, temperatures below freezing point quickly lead to icing of the cooler and to the necessity of a de-icing phase, during which neither cooling nor dehumidification are possible. In addition, the cooler must be set to very low operating temperatures (about 5 to 7 K below room temperature) to ensure any dehumidification at all at the very cold room temperatures. This is very energy-intensive and cost-intensive.

This brochure describes and recommends the use of an adsorption dryer in addition to conventional air cooling. An adsorption dryer dries the air permanently in a very efficient and economical manner.

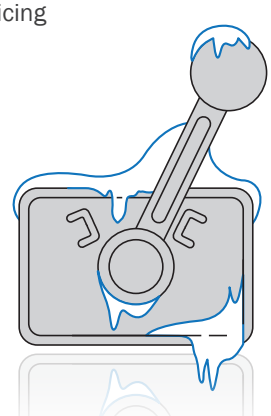
It helps avoid the aforementioned problems from the outset.

The DA Series dehumidifier is ideal for cold storage applications and thanks to its 4” (100 mm) thick, thermal bridge-free housing insulation, can also be installed outside and therefore does not take up valuable storage space.

Icing of the stored goods



System icing



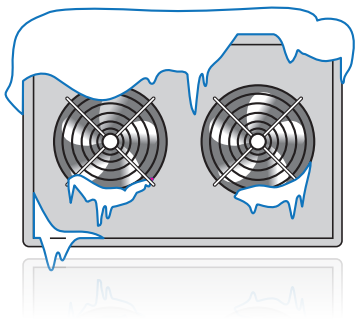
Condition of the outside air
90 °F (32 °C) / 48% RH

Icing

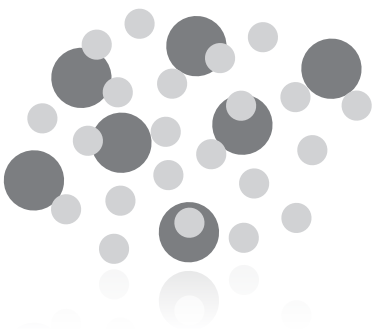
Air condition in the cold store
23 °F (-5 °C) / 100% RH

Formation of condensate
and icing

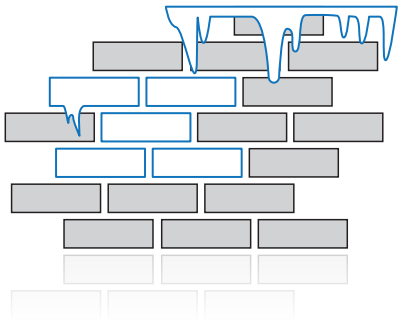
Evaporator icing



Misting



Icing of wall and
ceiling surfaces



Thermodynamics: How Dehumidification Works

In thermodynamics, the values enthalpy (h), temperature (t) and humidity (x) are inseparably related. The representation of these values is displayed in a psychrometric chart. Here the enthalpy **h** represents the total heat content of the air, consisting of the air temperature and the water vapor present in the air. With the humidity one differentiates still the absolute humidity **x** (g water vapor in the air per lb air) and the relative humidity. The relative humidity (φ) indicates to what percentage of saturation is present in the air. When it comes to dehumidifying air for a process or to ensure that the target room air conditions are met, the following is an example.

Example 1
Ensuring a humidity of 50% at a room temperature of 68'F.

During the processing of a food product constantly releasing 14 grains of water per pound of air into the ambient air (68 °F, x = 14 g/lb).

This water is absorbed by the air as water vapor.

As a result, however, the humidity of the room air rises to a value of about 85% and at the same time the room temperature drops to about 59 °F. by running an air dehumidifier installed in the room (for example a condensing air dryer), which continuously draws in room air and dehumidifies it, the required room conditions are maintained.

Example 2
Dehumidification of an air volume flow to 54 °F and a humidity of 21 g/lb (shown in the h,x diagram on the opposite page). Many production processes and the storage of food require low temperatures and very low humidity. It is assumed that an outdoor air volume flow with a temperature of 90 °F and a humidity of 98 g/lb (47%) is limited to a supply air condition of 54 °F and a humidity of 21 g/lb (35%) should be dehumidified. For this purpose, an adsorption dryer is best applied. The change of state of the outside air to the supply air follows the course of the red straight line in the psychrometric chart. Step 1 is a pre-cooling and pre-dehumidification of the air to 59 °F and a humidity of 70 g/lb. In step 2, the air is dried in the adsorption dryer to a humidity of about 21 g/lb, which raises the temperature to about 104 °F. In the third step now dry air is post-cooled to the supply air temperature of 54 °F.

Following these brief theoretical principles, the subsequent pages contain further examples of air drying of various foods.

More detailed information on typical areas of application, technical working methods and properties of condensation and adsorption dryers can be found on pages 14 to thru 17.

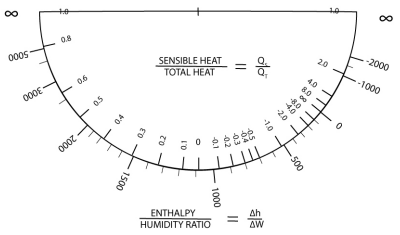
PSYCHROMETRIC CHART

NORMAL TEMPERATURE

I-P Units

SEA LEVEL

BAROMETRIC PRESSURE: 20.921IN OF MERCURY



Fully insulated adsorption dryer enables outdoor installation

Adsorption dryers are used if low air humidity below about 10% RH is desired, as well as at very low temperatures. Under these conditions, the technical and energetic outlay required to dehumidify air because of the dew point being undercut, i.e. the operating principle of a condensation dehumidifier, is enormous and accordingly difficult or impossible to realize. In contrast, adsorption dryers harness the properties of silica gels, which enable effective drying of the air even at low temperatures.

The air to be dried is conveyed into the unit by the process air fan. After passing through an air filter, the air reaches the slowly rotating sorption rotor. This consists of over 82% silica gel on an air-permeable glass fiber honeycomb structure. The silica gel is very hygroscopic due to its extremely large inner surface area. Therefore, it can absorb large amounts of water from the process air on the surface and store it in its inner structure. As the air flows through the sorption rotor, two processes take place simultaneously: The process air can be thoroughly dehumidified. However, depending on the dehumidification intensity, the air temperature may rise sharply in the process. Therefore, in many cases, the air which is now dehumidified but warm has to be cooled before it is returned 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 the rotor. This is done using regeneration air, which comes from the other side and flows through the sorption rotor in countercurrent. The regeneration air is heated and the relative humidity is thus reduced to such an extent that water can be expelled from the silica gel and bound in the air as vapor (desorption).
The regeneration air, which is now moist, leaves the adsorption dryer and is discharged to the outside after supplementary heat recovery as necessary. The media used to heat the regeneration air are hot water, steam, gas burners or electrical energy.

Condair's DA Series adsorption dryers are used wherever very low humidity levels are required at very low temperatures. The sorption rotor retains its capacity almost permanently under optimum operating conditions, enabling safe operation down to temperatures of -22°F (-30°C) and the achievement of the lowest humidity levels.

All processes operating in the adsorption dryer in line with the supply air target conditions are controlled depending on the current operating conditions via either the on-site ICE or optionally the PLC integrated in the unit.

Application example:
Frozen storage

If humidity problems occur in cold stores with internal temperatures often well below freezing, they quickly become apparent. When warmer, more humid air flows into the cold room, water condenses out of the air and then precipitates as ice on floors, ceilings and walls. Large ice formations are quickly formed, especially on the evaporators of the refrigeration system and in the dock area, which then require time-consuming manual removal.

And when evaporators ice over, this increases the pressure loss compared to the air, which must be constantly cooled using the recirculation method. This results in lower air and cooling capacities, frequent defrost cycles and higher operating costs. At the same time, especially with ice forming on the floor, there is an increased risk of people slipping and injuring themselves or that forklifts cannot be driven safely.

These problems are prevented by consistently dehumidifying the air in the frozen storage using an adsorption dryer. Such an adsorption dryer constantly draws in room air from the cold storage and dehumidifies it below the dew point, then blows the dehumidified, dry air back into the room or, ideally, directly back to the recirculating air coolers.
This reliably and permanently prevents the unwanted condensation of water from the air and the formation of ice in the cold storage area.

As the temperature difference between the outside air and the cold storage is usually very high, in most cases, it makes sense to install the adsorption dryer directly in the cold store. This helps avoid power losses due to the transfer of heat from the cold inside of the dryer to the warm outside air.

Application example: Test bench

Test benches frequently have to maintain temperatures from 95 °F (35 °C) down to -4 °F (-20 °C) for specified measurements. Irrespective of the temperature, however, the humidity must also be adapted to these extreme conditions.

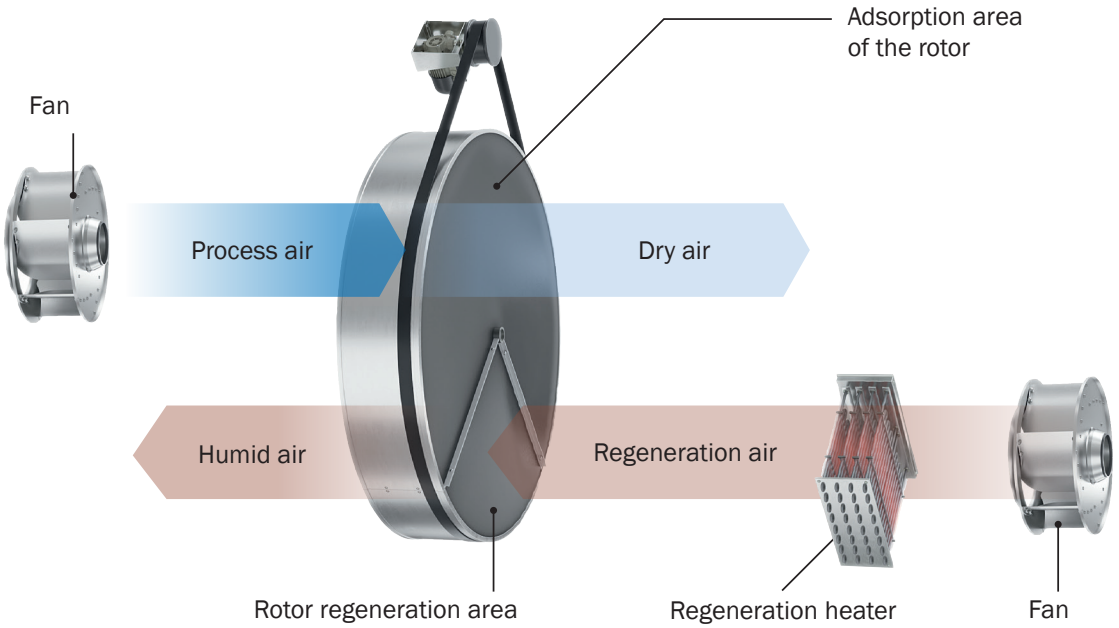
Adsorption dryers are particularly suitable for this purpose, because they can dehumidify the air reliably and efficiently over the entire temperature range by means of the sorption principle.

Due to the very wide temperature range on test benches, the following problem arises: At cool process air temperatures, the adsorption dryer housing also cools down considerably and condensate from the room air forms on the housing at first, eventually even leading to hoarfrost. This may also spread to the electrical compartment and the regeneration section. Accepting icing as a given and, in the best case, equipping the units with a condensate tray is certainly not a permanently acceptable solution here from a professional viewpoint.

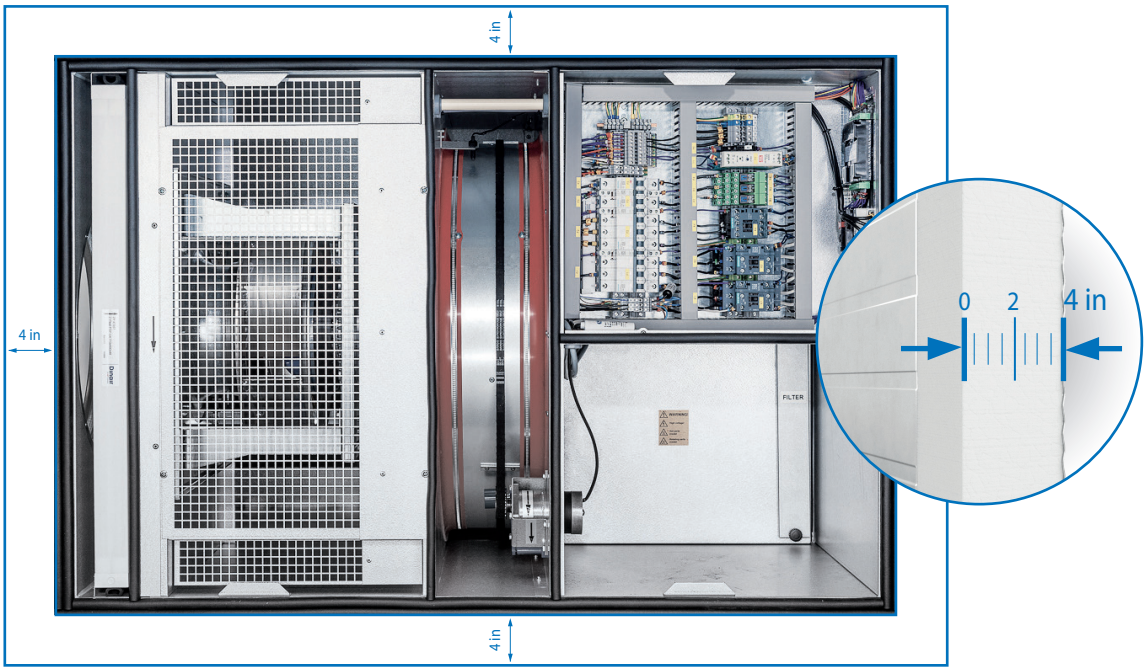
An alternative is to preheat the cold air before it enters the adsorption dryer, then to dehumidify it, and finally to cool it back down to the target temperature. This is an extremely high energy outlay, since not only does the air have to be constantly heated to an additional perceptible degree and then cooled, but heating the air also leads to a drop in the relative humidity and consequently the dehumidification process also becomes more inefficient.

This is because a lower relative humidity [% RH] with a constant absolute humidity requires a higher energy input in the regeneration process and results in very high humid air temperatures.

Functional principle of adsorption dryer



Comprehensive insulation Condair DA Freezer



Absorption Dryer
Condair DA Series

Wherever very low humidity levels are required, for example in industrial drying processes or applications with very low temperatures, Condair adsorption dryers of DA series are used.

The silica-gel coated sorption 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. 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 are also available in many special designs.

For example, the units can be equipped at the factory with pre and/or post-cooling coils, heat exchanger or condensation modules. As a results of the heat gain it is often necessary to install after-cooling of the dried, but thereby heated process air should be taken into account at an early stage in the plant design. In addition to the selection of different regeneration processes, it is also possible to use already existing media such as steam or hot water.

The combination of these media with the electrical regeneration heater integrated in the unit allows considerable savings in operating costs, especially for larger systems.

Depending on the current operating conditions, all processes in the adsorption dryer are controlled to the target conditions of the supply air either via the on-site MSR or optionally via the PLC installed in the unit.

Condair DA 300 - 2400
Diverse customer-specific configurable adsorption dryer, especially for use in production areas and large rooms.

Nominal drying capacity**
7-44 lbs/hr.

21-551

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