BEVERAGE INDUSTRY

The importance of humidity control
in production and storage

Humidification, Dehumidification
and Evaporative Cooling.

condair

The need for dehumidification in the beverage industry

Humidity control plays a prominent role in numerous applications in the beverage industry. Excessively high air humidity levels during the run-up to the actual production process, i.e. during the storage and transport of hygroscopic and moisture-sensitive raw and basic materials, can cause clumping or rotting. This can lead to severe damage to the product and impair its quality. Similarly, production and filling processes present an increased risk of condensation on plant equipment, pipework, tank surfaces and structural elements due to the often large temperature differences between ambient and process air. In addition, the regularly required cleaning work usually leaves a thin film of water on the surfaces of the equipment as well as on the floors and walls. Condensation and moisture have a detrimental effect on production, operational safety and product quality. They also provide an ideal base for the uncontrolled growth of mold, germs and bacteria. The same applies to the subsequent storage of filled bottles, drums and other containers. The proliferation of germs and mold on the containers due to condensation and the damage or peeling off of labels must be avoided at all costs.

The tasks of air dehumidification systems are therefore diverse, but can generally be summarized as follows:

- **Protection against moisture during storage of hygroscopic raw materials**
This applies to both raw materials for beverage production, such as hops, sugar, powdered additives, etc., and chemical raw materials for the production of PET bottles.

- **Ensuring hygienic standards** during the production process and storage and maintaining the operational readiness of the plants. To this end, temperature-related condensation must be avoided on pipes, containers and equipment used in the production process, as well as when water is introduced during cleaning work.

- **Ensuring optimal production conditions,** e.g. when producing PET bottles in stretch blow molding machines.

- **Prevention of condensing air humidity** on **bottles,** drums and containers during storage. Controlling the humidity remains necessary even after completion of the manufacturing process. This is especially true for the cleaning, filling and labeling processes of bottles and containers. Optimal room humidity ensures complete adherence of the labels to the bottles.

The continuous humidity control and management is therefore an absolute necessity in the various application areas of the beverage industry.

The use of efficient dehumidification systems contributes effectively to the control and precise regulation of room humidity.

Protection of hygroscopic raw materials ensures high product quality

Controlled development of certain bacterial cultures is desirable only for very specific production processes, such as beer fermentation processes. Apart from that, the formation and growth of microorganisms due to moisture must be avoided at all costs. Moisture absorption during storage of hygroscopic raw materials, such as different varieties of cereals, promotes the development of rot and fungal spores and thus impair the quality of the finished product. In addition, moisture-sensitive basic materials such as sugar and powdered additives may clump together and then become unavailable for further processing.

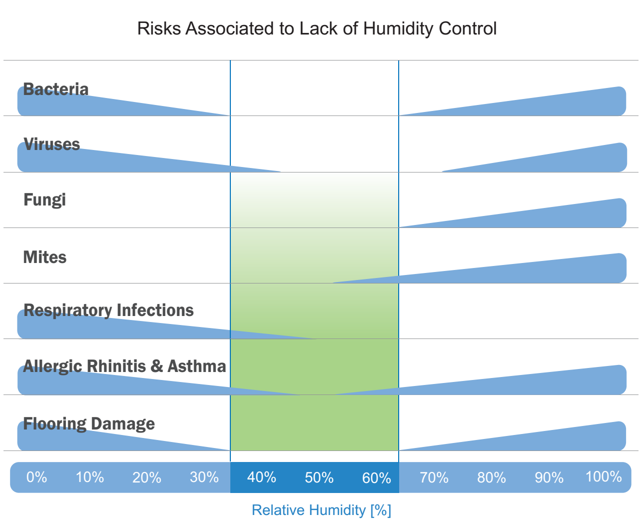
Effective control of air humidity during the storage of raw materials and moisture-sensitive basic materials is an essential requirement for maintaining a trouble-free process.

Dry surfaces for labels that adhere well — hygienic packaging

During the labelling of beverages, which are typically cold-bottled, excessive moisture near the labeling machine or during subsequent storage may prevent labels from adhering properly, or cause them to slip, wrinkle, or come off the bottle completely.

During extended storage, there is also a risk of mold growth, especially on the edges of the labels. If this were to happen, it would be a disaster for the manufacturer in many ways. On the one hand, there is the risk that a product of inherently impeccable quality will not be sold at all. On the other hand, a flawless appearance of the product's packaging is of crucial importance for the end-user's perception of the brand: an unsightly visual appearance of the product's packaging has a direct and extremely negative impact on the brand's perception.

In addition to the visual aspect, the same critical aspects previously described on condensation-related hygiene issues apply to sales containers. Modern and efficient dehumidification technologies can be used to avoid mold formation problems on sales containers and prevent labels from being rendered unsightly or unusable.



Air dehumidification ensures hygienic production conditions

Water ingress due to sterilization and disinfection, as well as general cleaning
A high degree of purity and cleanliness is regarded in all areas of the beverage industry as a guarantee for the highest authenticity of taste and sensation. As a result, cleaning work is often required, which results in a large amount of water entering the production facilities. Even with the most efficient and well-planned drainage systems, an extremely thin film of water remains on aisles, walls, equipment and containers after every cleaning. This provides a breeding ground for mold and other microorganisms. The presence or penetration of mold and microorganisms in the production area can have dramatic consequences, such as reduced product quality, costly production interruptions and mandatory plant shutdowns. Wet aisles also pose an increased risk of slips and falls for personnel, significantly compromising operational safety. Efficient dehumidification systems contribute effectively to the removal of residual moisture from cleaning operations and to ensuring perfect hygiene conditions and operational safety in the production area.

Contamination due to condensation
Manufacturing and filling processes as well as product storage are usually carried out at low room temperatures. When warmer, humid outside enters the facility, either through building openings or ventilation systems, the moisture in the incoming air condenses on cold ceilings and walls as well as on the surfaces of containers, pipes and equipment. Areas where condensation can form over an extended period of time set the stage for contamination by microorganisms such as mold and bacteria. Although the physical cause is different here, the negative consequences are exactly the same as those previously described in the case of water ingress due to cleaning operations.

Corrosion damage
Condensation quickly forms on the surfaces of objects through which cold fluids flow: pipes, fittings, tanks, structural components, ... It also forms on manufacturing components such as cooled molds of stretch blow molding machines used for the production of PET bottles.

As a result, equipment can corrode, which inevitably leads to increased downtime for maintenance and repairs. Condensation on the PET bottles can render them unusable in the worst case. Corrosion damage to the installations can also occur and will require repair, which can also lead to production downtime. Air dehumidification systems can be used to lower the dew point, the surface temperature below which water in the air condenses to liquid. This contributes to the prevention of production interruptions and associated losses.

The use of suitable dehumidifiers can help in preventing condensation-related damage.


KAUGKÜTE

Selecting the right dehumidification technology

Condensation air dehumidification and Desiccant or Sorption air drying are established and proven technologies in the beverage industry.

Due to the multitude of possible applications and tasks, the question arises of the selection of the appropriate dehumidification system.

Condensing dehumidifiers and desiccant dryers have specific physical operating characteristics and are therefore not always suitable for all applications. Thus, it is important to have a precise knowledge of the operating characteristics and the resulting application limits of both systems.

Condensing dehumidifiers

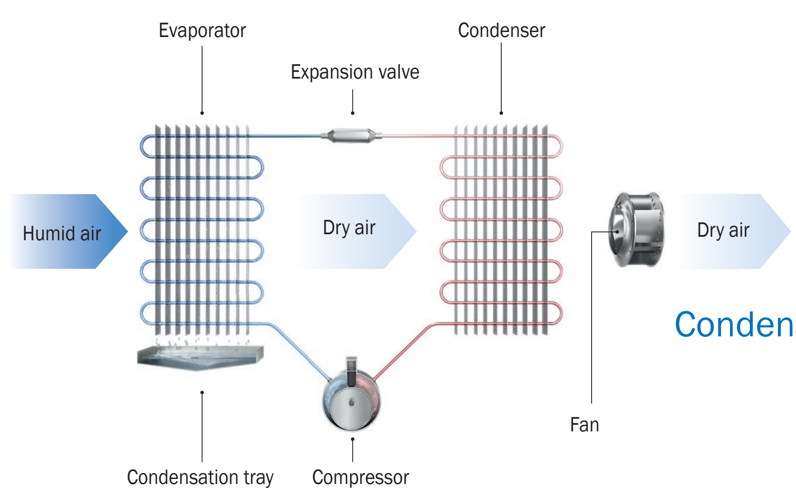
Condensing dehumidifiers are ready-to-use units typically used in standard dehumidification processes where a relative humidity of 45%RH and above must be maintained at a room temperature of about 50 to 95°F. Condensing dehumidifiers operate as a closed cooling circuit that works on the heat pump principle. As shown in the figure below, a fan draws in the humid room air, which is first filtered before flowing through the evaporator heat exchanger of the cooling circuit. At the cold surface of the evaporator, it is cooled below its dew point, with 14-21 grains/lb of water vapor condensing out on the first pass of the airflow through the heat exchanger. The condensate is collected in the dehumidifier in an appropriate tray and either discharged directly to the drain or collected in a tank that is emptied regularly. The now dehumidified but cool air then passes through the condenser heat exchanger, where it is heated by the heat of condensation from the cooling circuit. The air finally flows back into the room as dry supply air. The residual heat from the fan and the compressor is also partly absorbed by the air flowing through the dehumidifier.

Desiccant dryers

Adsorption dryers operate on the principle of sorption which refers to the ability of hygroscopic materials to bind water vapor to their surface. These hygroscopic substances usually have a large internal surface area in the range of 183,091 to 244,121 sqft/ounce. Due to the presence of extremely low water vapor partial pressure in the immediate vicinity of these substances, water vapor diffuses from areas of higher partial pressure (in this case from ambient air) to areas of lower partial pressure (sorbent). The key component of desiccant dryers is the desiccant rotor. It usually consists of a corrugated and finely laminated storage mass with an extremely large inner surface, which is coated with the highly hygroscopic silica gel. The entire cross section of the rotor is divided into a drying sector, which occupies 3/4 of the total surface area, and a regeneration sector of 1/4 of the rotor area. The sectors are isolated from each other.

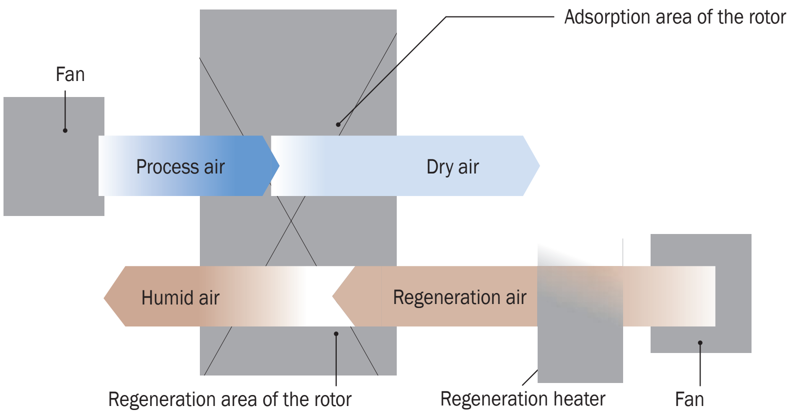
The humid airflow to be dehumidified (process air) is drawn in by a fan and passed through the desiccant rotor, which is set in steady, slow rotation by a motor. The air stream to be dried is continuously pushed through the drying sector of the rotor. In the process, most of the water vapor contains is adsorbed.

The water vapor now contained in the drying sector of the rotor must of course be removed in order to restore

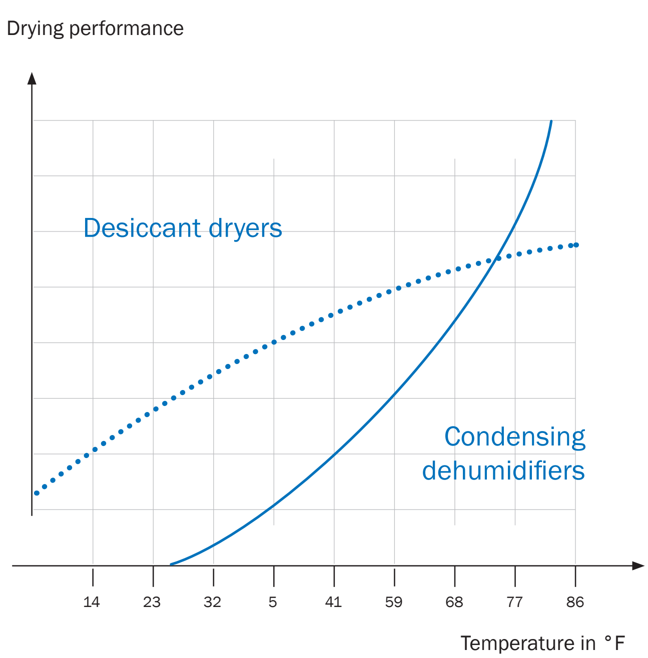


Condensation dehumidification — operating principle the sorption capacity of the silica gel and thus maintain a continuous and uninterrupted drying process. This takes place in the regeneration sector, where regeneration air, a separate air flow previously heated to approx. 248 °F via a PTC regeneration heater, flows in the opposite direction to the process air.

Due to heating, the relative humidity of the regeneration air drops to below 1% RH and as a result, adsorbed water vapor bound in the rotor is exhausted, meaning desorption takes place. The expelled water vapor is discharged to the outside with the humid air stream. The volume of the separate airflow used for regeneration is approx. 25% of the process airflow.



Desiccant drying — operating principle



Performance characteristics of desiccant dryers compared to condensing dehumidifiers
The application range of condensing dehumidifiers is restricted by the operational limits of the refrigerant used in terms of the application temperature and the achievable humidity levels. In addition, the regular activation of the defrost function to protect against icing leads to more or less frequent interruptions of the dehumidification operation, which can result in fluctuations of the indoor air humidity during the defrost phase. However, for many applications, in particular static storage under normal indoor air conditions, condensing dehumidifiers are an effective and energy-efficient solution. Desiccant dryers are much less affected by temperature and humidity restrictions and ensure continuous, uninterrupted precision drying even at very low temperatures. The low dew point that desiccant dryers can achieve allows to reach the lowest residual humidity levels. For this reason, and for the possible integration of pre- and post-cooling coils, desiccant dryers are used in many applications in the beverage industry. The diagram above shows the drying performance of condensing dehumidifiers and desiccant dryers as a function of temperature. According to this diagram, condensing dehumidifiers work are particularly efficient at high temperatures and high moisture loads. In applications where the ambient temperature is below 50 °F and target humidity levels of less than 50% RH are desired, desiccant dryers can safely and effectively meet the dehumidification requirements. In the beverage industry, this applies to all production and storage applications with low ambient temperatures. For these applications, air dehumidification by condensation would be too costly and energy intensive.

However, the use of adsorption dryers is not limited to humidity levels below 50% or to low temperature applications. Any form of condensing dehumidifier will generally provide control within ±10% of the set point. Desiccant adsorption dryers, on the other hand, provide ±2% control of relative humidity.

Dehumidification concepts in the beverage industry

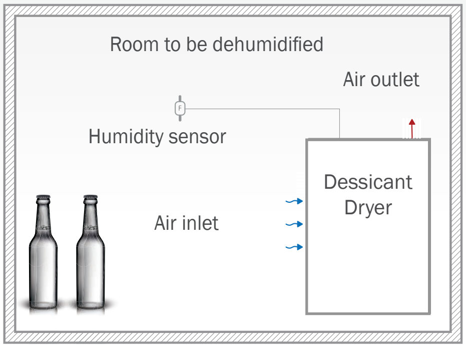
Due to the wide range of tasks for which dehumidification systems are used in the beverage industry, there are different concepts that must be adapted to each application.
These concepts differ considerably in terms of technical complexity. In the field of beverage production with upstream and downstream areas, we regularly encounter the following four system concepts:

Concept for humidity control in static storage areas

1 Desiccant dryer in recirculation mode

Closed storage areas are characterized by the fact that there is no significant supply of outside air through building openings, regularly opening doors and gates or ventilation systems. The objective is to ensure a favorable indoor climate for the stored goods.

Typical examples are the protection of wine barrels against mold or the prevention of bottle labels peeling of. Dehumidification is usually carried out by the recirculation method.
Condensation dehumidifiers or desiccant dryers are used depending on the desired temperature and humidity level, room volume, etc.



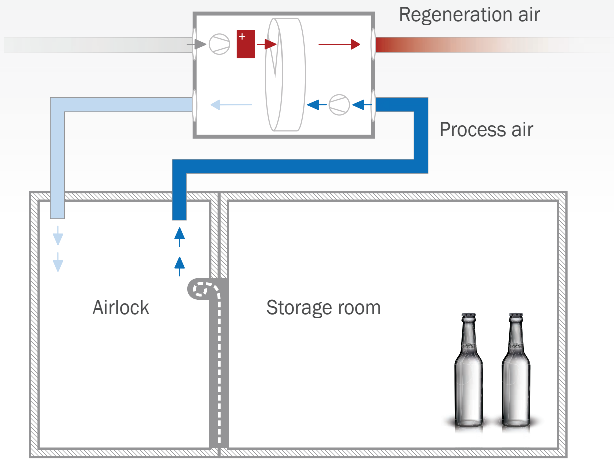
The figure shows a simple recirculation dehumidification process with a desiccant dryer. Heating modules, etc., can be configured and ensure a continuous supply of process air under the desired conditions and within the tolerances.

Concept for humidity control in dynamic storage areas

2 Dehumidification of the airlock area of a cold store

In dynamic storage areas, there is a regular and significant inflow of outside air, which is usually higher in temperature and humidity than the air inside the storage area. Uncontrolled inflow of outside air is particularly characteristic of storage areas where doors and gates are opened frequently and regularly.

This is the case, for example, in cold stores, distribution warehouses and the airlock areas of deep-freeze warehouses. Desiccant dryers are typically used here because of the low dew points to be achieved, especially in the cold storage area.

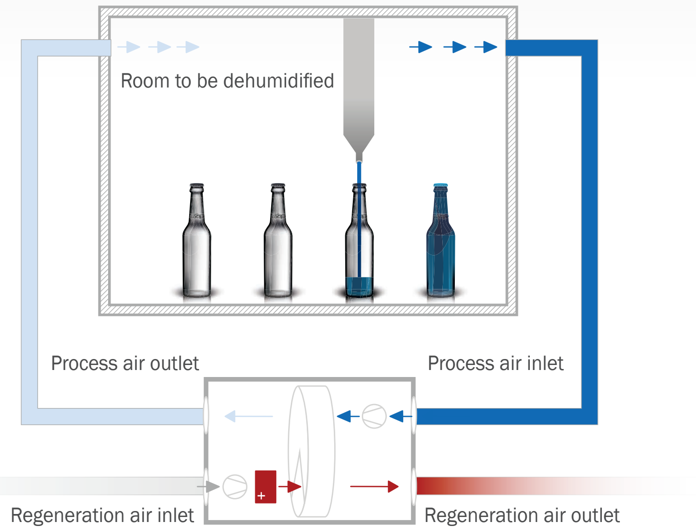


Concept for humidity control in the production environment

3 Regulation of indoor air conditions by means of desiccant dryers

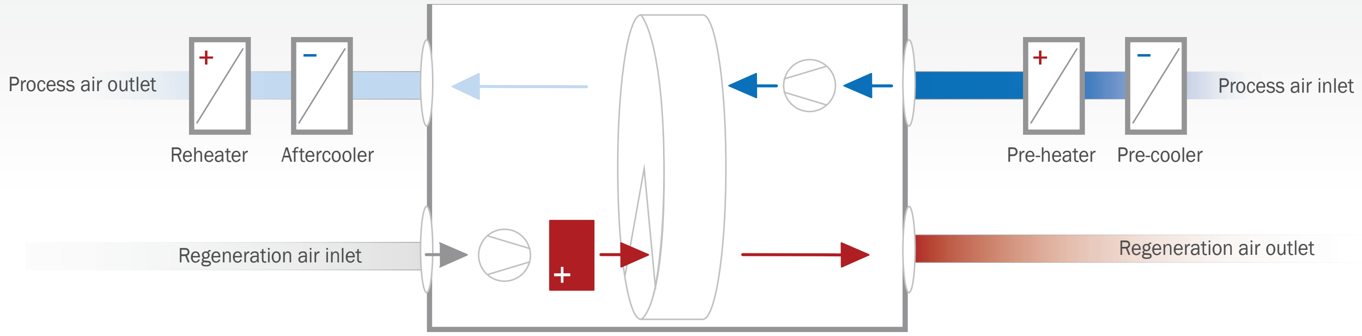
In the production environment, i.e. the manufacturing plant, the primary concern is to comply with strict hygiene requirements and maintain operational safety. Mold and microorganism growth must be prevented, and work areas must be kept dry. Residual moisture from cleaning operations should be maintained at an acceptable level.

When available, the cooling systems of the air handling units are usually not capable of achieving the required humidity level. Due to the low temperatures prevailing in the beverage industry, this task is usually addressed with desiccant dryers, which are equipped with pre- and post-cooling modules depending on the required conditions.



Concept for process air drying

4 Typical process air drying with additional cooling and heating modules



Constant control of the humidity and temperature of the process air supplied is required in the various production plants, whether in the manufacture of the product itself or upstream in the production of PET bottles and other sales containers, during the cleaning of recyclable bottles or in the filling process.

The focus is on perfect product quality and the guarantee of uninterrupted and efficient production.

Efficient sorption-based drying systems, which can be adapted to the application with pre- and post-cooling modules, heat exchangers for different energy sources, heating modules, etc., ensure a continuous supply of process air under the required conditions and within the tolerances.

Practical example: Dehumidification in a brewery plant

As part of its expansion, a brewery builds a new modern hall in which the beer produced is matured in 50 stainless steel tanks of 2200 to 6599 gal each. The total volume of beer stored there is 241,966 gal. The tanks are cooled to approx. 32 °F and have no additional insulation. The storage hall itself, on the other hand, was built with maximum airtightness and solid insulation. In winter, the indoor temperature of the hall is 37.4 to 39.2 °F, in summer it's between 46.4 and 50 °F. Despite a process technology that minimizes water from the outset, additional water is introduced, e.g. through cleaning work.

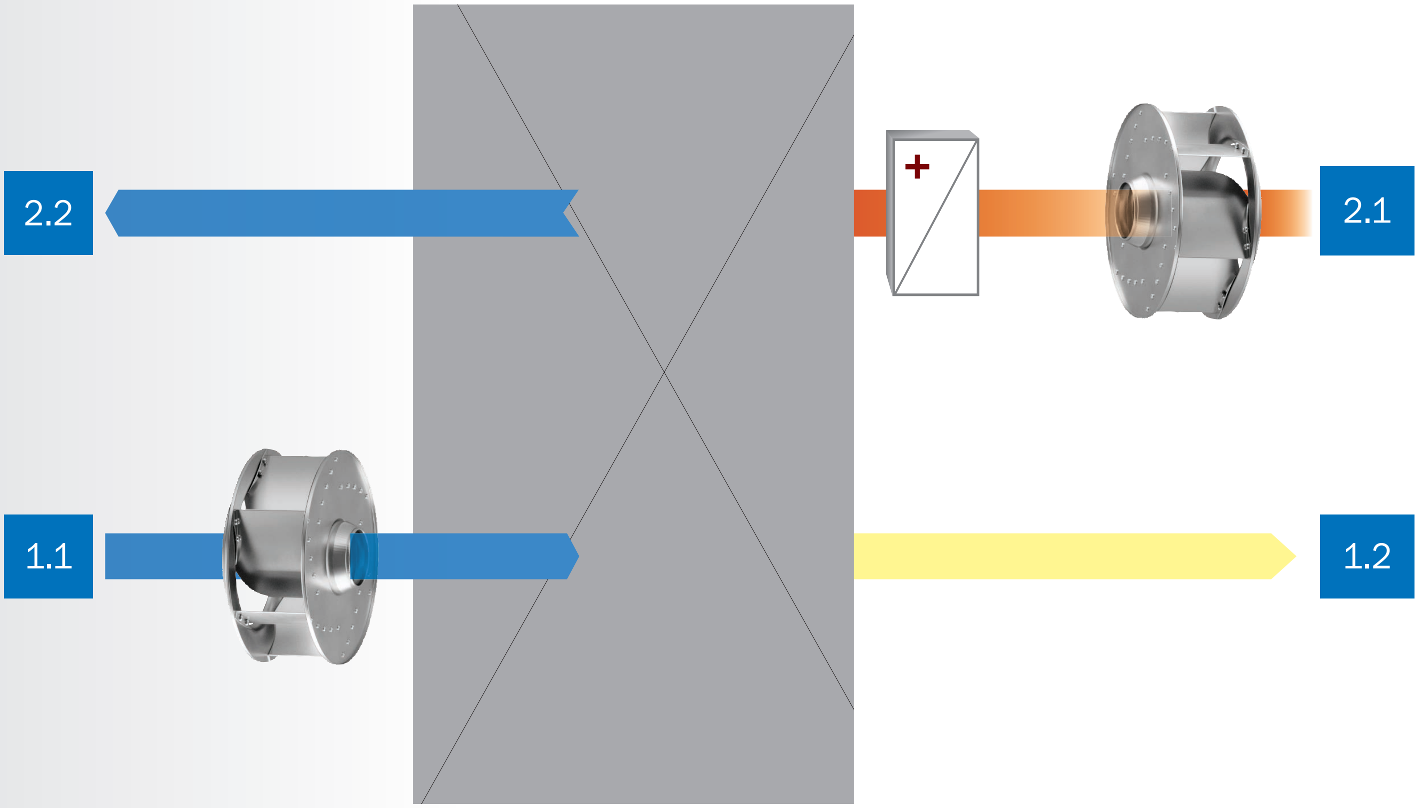
To prevent the formation of condensation and ice on the surfaces of the stainless steel tanks, the indoor air must be dried considerably. The highest demands for drying naturally occur during summer months. Despite the extremely tight construction of the building, the ingress of warm and very humid outside air cannot be completely avoided. This would inevitably lead to condensation of the moisture contained in the ambient air and formation of ice on the cooled plant equipment if the room air were not dried.

Added to this is production-related water ingress. Without additional drying of the indoor air, hygienic and safe operating conditions could not be guaranteed.

Extensive planning and determination of the moisture loads to be removed, as well as consideration of the low room and surface temperatures, quickly led to the realization that the corresponding dehumidification task could only be solved by a high-performance desiccant dryer.

The Condair desiccant dryer used has a drying capacity of 66 lb/h and allows to reduce the dew point to 23 °F even during summer months. The increased outlet temperature inherent to desiccant dryers is fully compensated by the cold surfaces of the storage tanks.

Example of process air drying by means of desiccant dryers



Data point		Airflow volume [CFM]	Temperature [°F]	Relative humidity [% RH]	Absolute humidity [grains/lb]
1.1	Process air In	9,417	41	46	17.5
1.2	Dry air Out	9,417	50	13	6.79
2.1	Heated regeneration air	2,531	173.7	4	86.8
2.2	Humid air Out	2,531	126.3	21	130.9

Desiccant dryers
Condair DA series

Condair desiccant dryers of the DA series are used wherever very low target humidity values are required or drying must take place in a low temperature range. The silica gel-based adsorption rotor allows for safe and practically wear-free operation down to air temperatures of -22°F under optimum operating conditions, while achieving minimum residual moisture. The silica gel used as a drying medium is non-respirable and non-flammable.

To achieve the desired supply air temperature, pre and/or post cooling modules may be required. The desiccant dryers are delivered ready to be connected to cooling modules by others or can be equipped with these modules at the factory for installation in the ductwork.

Condair DA series dessicant dryers are available in standard versions, with dehumidification capacities from 7 to 44 lbs/hr for process air flows from 300 to 2400 CFM. All standard models have electrical PTC heating elements for the regeneration process. The self-regulating properties of the PTC heating elements provide protection against fusing and thermostat interruptions.

DA desiccant dryers come equipped with a PLC with touch screen which allows the control of humidity and increase operational reliability by monitoring the internal components. They can also be controlled via the on site BMS.

Condair DA 300N - 2400N
Desiccant dryers that can be configured in a variety of ways to suit our customers' individual needs, especially for use in production areas and large rooms.

Nominal drying capacity**
7-44 lb/h.

**at 68°F – 60% RH

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