DEHUMIDIFICATION

Planning guidelines for technical building services and specialist planners

Humidification, Dehumidification,
Evaporative cooling

condair

Planning Guidelines for Dehumidification Systems

Introduction

These guidelines are designed to assist you in the basic planning and selection of a suitable Condair dehumidification / Desiccant Drying system for professional applications. They explain the basic principles of the two most common dehumidification technologies — dehumidification through condensation and dehumidification drying through sorption. Knowledge of the operating and application limitations enables the optimal technology for the respective dehumidification task to be determined early in the planning phase. In addition, notes are provided as to which framework conditions must be clarified on-site in advance and what data is required to ensure proper design. Finally some sample calculation approaches are presented. For accurate Condair dehumidification selections, a specialist should always be called in, since there is a vast range of data inputs required to confirm a system performance. Correct selection of dehumidification systems can offer enormous potential energy savings once the correct configuration is used, best guess selection can very easily lead to disappointing end results.

1. Terms and Definitions

1.1 The gas mixture of air in nature, air is always humid. Humid air is comprised of dry air and water vapor. The dry air is a gas mixture made up of approx. 78% vol nitrogen, 21% vol oxygen and 1% vol argon.

1.2 Humidity
The term "humidity" describes the proportion of water vapor in the gas mixture of air. The water vapor content's value may be stated in different ways. Only the values that are relevant for calculating and designing dehumidification systems are presented here.

In simple terms, is a ratio of the amount of water the air holds compared to the maximum amount the air can hold at saturation, with both values being at the same temperature T1 . Thus, stating the moisture content as a percentage % relative humidity is only significant if the is qualified by a temperature.

$$\varphi = \frac{\text{The amount of water in the air in grains at T1}}{\text{The maximum amount of water the air can hold in grains at T1}} \times 100$$

1.3 Absolute humidity: The absolute humidity X, also referred to as moisture content, is defined as a relationship of humidity M_W to the mass of dry air M_{air}.

X= lbs Water / lb of Dry Air

Absolute humidity is independent of temperature.

1.4 Dry Bulb Temperature: there are a number of temperature values that can be derived from the Psychrometric chart. However the first and most critical is the direct measurement of the dry bulb temperature of the Air T as this is the value to which the relative humidity F is referenced.

1.5 Dew point temperature: The dew point temperature Td is the temperature at which condensation is first produced from a gas mixture (unsaturated, humid air) in the presence of sensible cooling. In the Psychrometric Chart (see page 7), the dew point lies at the intersection of line X = const. with the saturation line.

Water vapor condenses on surfaces and expanses whose temperatures are below the dew point temperature. To dehumidify unsaturated air, the temperature of the cooler surface (=evaporator) of a condensing dehumidifier must always be below the dew point temperature.

1.6 Wet Bulb temperature: Wb is a temperature that is lower than the dry bulb temperature. The depression of the temperature is caused by evaporation of water from a wet wick surrounding a second thermometer. The adiabatic cooling taking place is in direct relation to the Relative humidity of the air surrounding the thermometer.

1.7 Density: The density **D** states the mass **M** of a substance which is contained in a certain volume. The air density can be calculated, however it is a complex calculation involving many different parameters.

For applications at sea level and in a temperature range of 32–95 °F , a value of 0.075 lbs/ft^3 can be used to calculate to sufficient accuracy for estimation purposes.


2. The Psychrometric Chart

The Psychrometric Chart can be used to determine all the necessary dimensions for designing dehumidification systems. However, most charts show the relationships at Sea Level and are valid up to approximate altitudes of around 2400Ft. Altitude considerations need to be taken above this level and corresponding charts should be used for proper calculations.

Not all charts show Air Density, many show Specific Volume in ft^3/lb. Density is a Reciprocal value of
1 / Specific Volume
Example
Specific Volume = $14ft^3/lb$ so
Density is 1/14 = $0.0714lbs/ft^3$

Chart Parameters
A) Specific Volume: the related Specific Volume of humid air is provided in ft^3 / lb for the respectively valid total pressure of the diagram and is shown by steep angled lines on the diagram.

B) Air temperature T: The air temperature in Fahrenheit °F is outlined on the base axis. For clarity, only one limited area, approx. from 20 to + 120°F , is presented. Based on the temperature value outlined on the base axis, the reference lines run vertically with T = constant.

C) Absolute humidity (moisture content): Absolute Humidity can be expressed in several different units, commonly as Grains/lb or Lbs of water /lb of dry air. Absolute humidity in Grains/lb of dry air, dry air is shown in Figure 1 on the right hand vertical axis. From there, the lines with X = constant run horizontally across the chart right to left.

D) Relative humidity: The curves that are constructed based on the relationship between absolute water vapor content and temperature-dependent saturation water vapor quantity, running from the bottom left to the top right, describe the lines of constant relative humidity. The line φ = 100% is described as a saturation line.

E) Dew point temperature (Saturation temperature): The intersection of a line X = constant with the saturation line is designated as dew point. The associated temperature, shown on the horizontal base axis, is the dew point temperature below which condensation appears.

Water vapor partial pressure Pp: The water vapor partial pressure Pp in psia cannot be determined on the Standard Psychrometric Chart, the Values must be established from published data tables

Saturation pressure Ps: Saturation pressure Ps in psia cannot be determined on the Standard Psychrometric Chart, the Values must be established from published data tables.

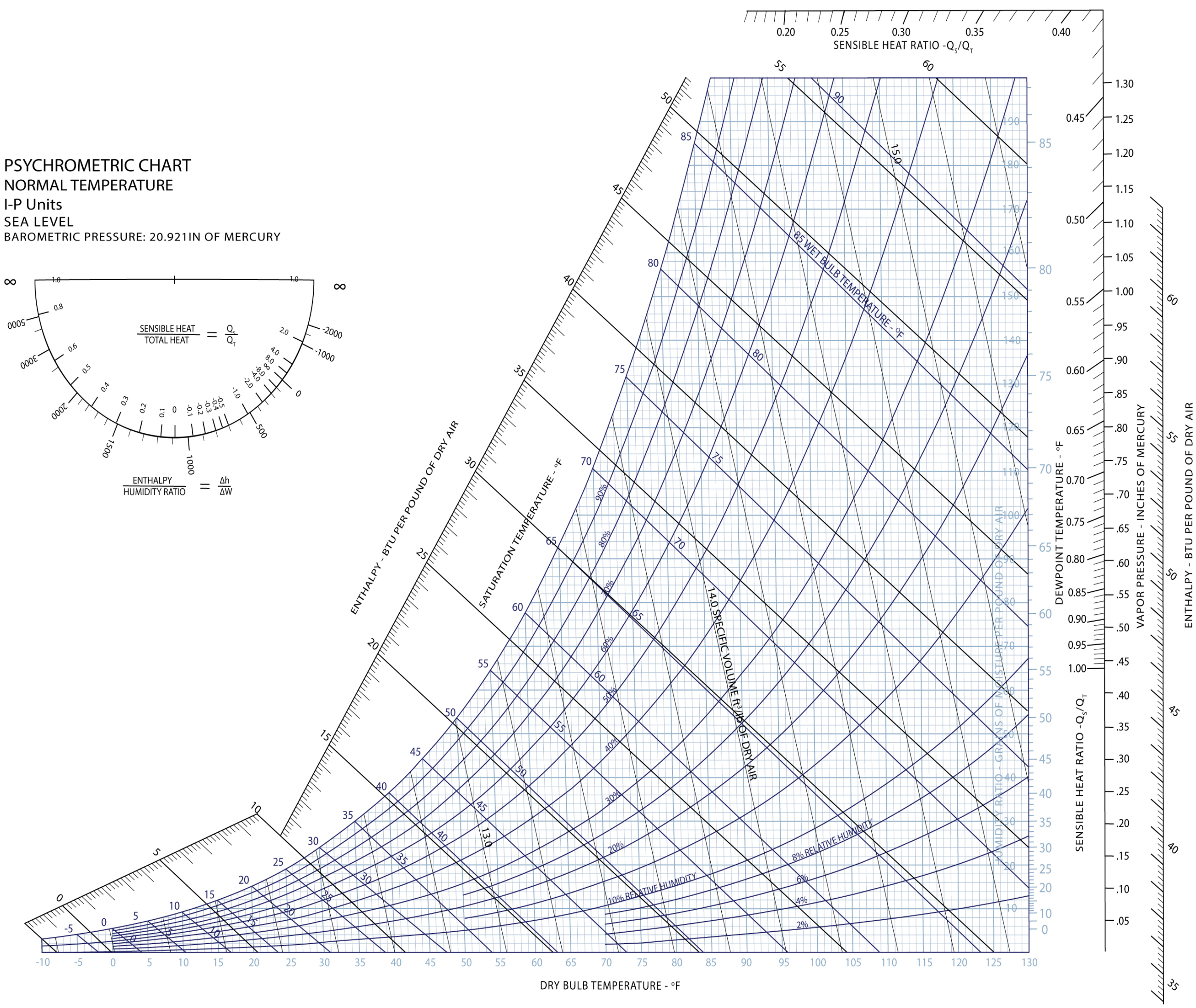


Figure 1: Psychrometric Chart

3. Dehumidification and Drying methods

There are two methods primarily used for dehumidification:

Drying through sorption Adsorption of water vapor contained in humid air by hygroscopic surfaces (silica gel rotor) desiccant. This brochure refers only to the dehumidification and drying solutions of standalone desiccant systems. Therefore, dehumidification by means of surface coolers supplied with cold water or refrigerant, as used in ventilation systems, are not discussed further.

Dehumidification through condensation: This process involves cooling the humid air below the dew point by passing the airstream across the cold surface of a heat exchanger/cooling coil (evaporator of a cooling circuit).

The diagram below shows the operating characteristics of both systems:

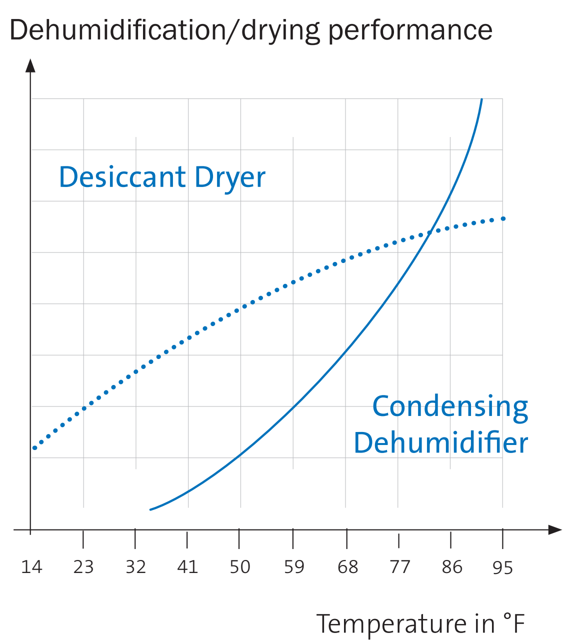


Figure 2: Operating Characteristics

Functional description of a condensing dehumidifier

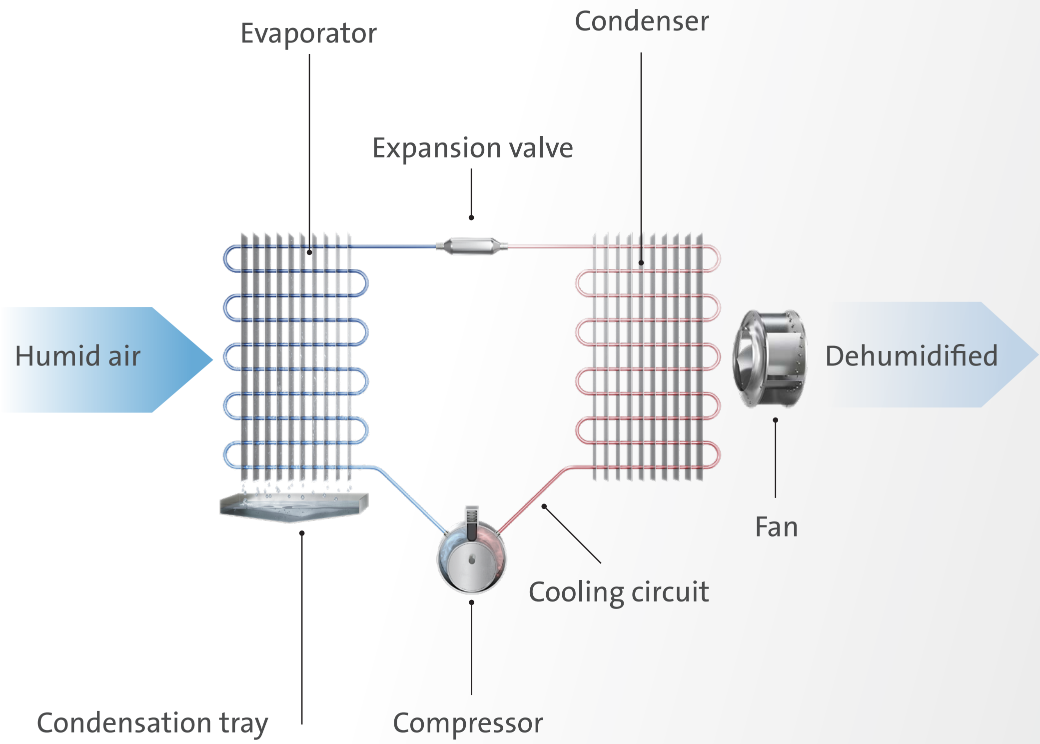


Figure 3: Overview of a condensing dehumidifier

4. Condensing Dehumidifiers:

Condensing dehumidifiers as ready-to-use systems are often used in industrial and commercial applications, and for dehumidifying swimming pools. Everywhere that air humidity levels must be kept between 45 and 60%RH, condensing dehumidifiers present an energy-efficient and cost-effective solution. Swimming pool dehumidifiers are special types of condensing dehumidifiers. They are protected against air containing chloramine through special measures (e.g. special anti-corrosive coatings of the heat exchangers) and can be equipped with additional heat exchangers for indoor heating, pool water heating condensers etc. Limiting factors regarding the achievable final moisture content are mainly the characteristics of the coolant used (pressure, temperature) and the constructive layout of the evaporator-heat exchanger (bypass factor). In general, the following principle applies: Condensing dehumidifiers can be usefully applied in temperature ranges between approx. 40 and +97 °F at an achievable relative humidity of 45%RH and above . Due to the operation of the refrigeration circuit control, final humidity is typically held within a range of +/-10%RH.

Typical Condensing Dehumidifier control performance with a set point at 50%RH

	Conditions		2008/3/25	Page 1/1
Starting time: 22.03.2007 14:30:00		Min:	Max:	Mean
Finishing time: 27.03.2007 09:10:00	C:1 [%RH] Humidity	35:20	66:80	48:65
Channels: 2 (2)	C:2 [°F] Temperature	16:70	21:90	19:34
Values: 689				
C1: SN 00958379 / 403				
Accuracy	C1: Acc:+/- 2.0 [0..100] %RH C2: Acc: =/- 0.8 [-40..-25] =/-0.5[-25..70] °F			

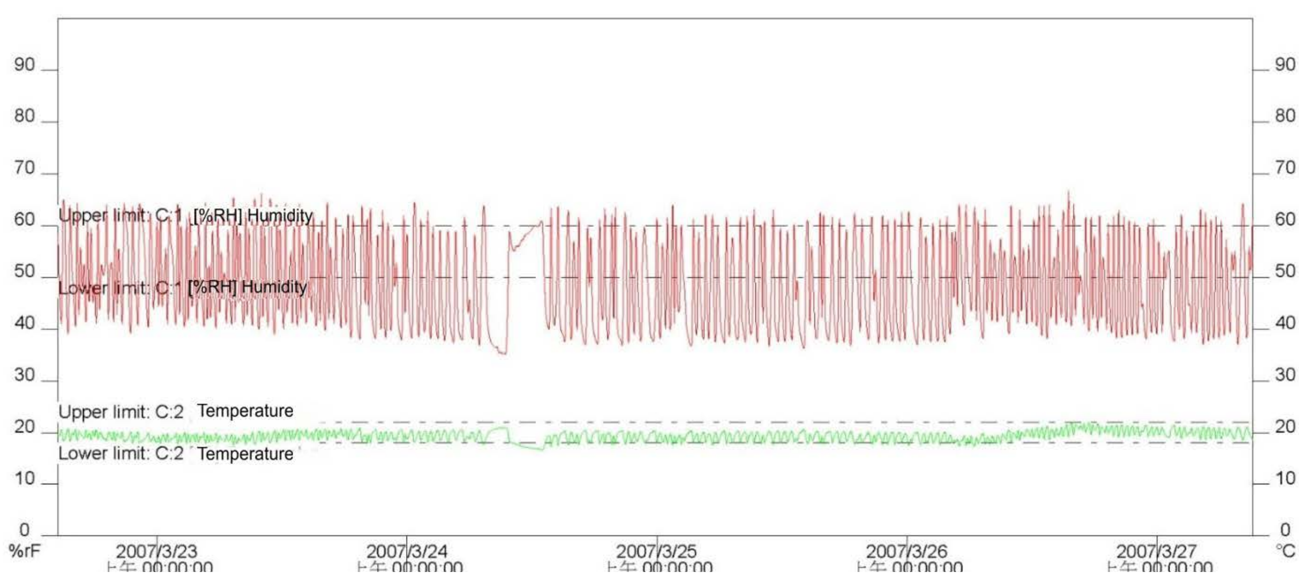


Figure 4: Condensing dehumidifier control performance iwth a set point of 50%RH

4.1 Operation of a condensing dehumidifier:

The basis of any condensing dehumidifier is a closed cooling circuit, which works in accordance with the heat pump principle. A fan draws in the humid ambient air. The air first passes through a particulate filter installed to protect the heat exchangers before the air is carried over the evaporator. As air is drawn over the cold surface of the coil, it is cooled below its dew point. A large proportion of the water vapor contained within the air is condensed and converted to condensate. The water that has become condensate is contained in a condensation tray installed under the evaporator and then transferred directly into the drain outflow or collected in a corresponding container. Next, the air stream which has now been dehumidified passes through the condenser, where it is heated through the condensation heat of the cooling circuit. The waste heat from the fan and the compressor is also partly absorbed by the airstream transferred via the dehumidifier. As a result, the dehumidified air introduced into the area is always warmer than it was when it entered the dehumidifier. The rise in temperature can be in the order of 18 to 25 °F

4.2 Sizing a Dehumidifier

After the required dehumidification procedure for the specific application has been determined on the basis of calculations (see chapter 6),

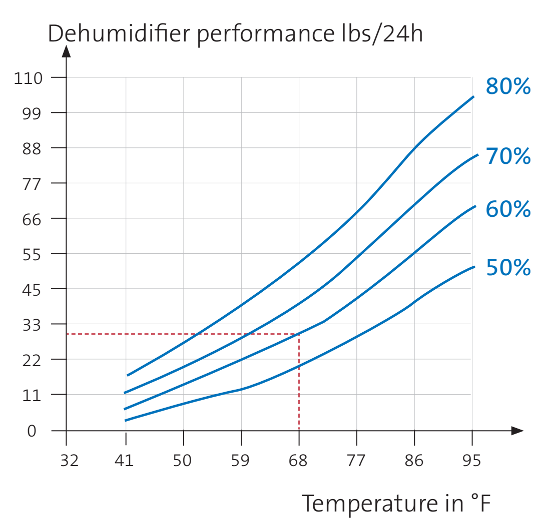


Figure 5: Dehumidifier Performance

the appropriate dehumidifier can be selected through its corresponding performance diagram. The performance and degree of effectiveness of condensing dehumidifiers increase as the temperature goes up, and decrease as temperatures go down. In the technical documentation, with respect to performance, generally only standard values at 86 °F and 80%RH, sometimes also at 80 °F and 60%RH are provided as a performance guide.

In many cases, only the maximum possible dehumidification performance at 95 °F and 80% RH is stated. With respect to the specific application concerned, these specifications are often insufficient to enable an estimation of the selected system's capability to actually provide the required dehumidification performance under the conditions for which it was designed. Most manufacturers typically supply performance diagrams to facilitate a sufficiently reasonable determination of the actual dehumidification capacity under the design conditions.

Example: a condensing dehumidifier is stated in the documentation as having a dehumidification performance of 88lbs/24h at 86 °F and 80% RH.

By calculation, the dehumidifier to be selected should have a dehumidifying capacity of 44lbs/24h at 68 °F and 60%RH. The actual dehumidification capacity at the required conditions is shown in the manufacturer's performance diagram.

Result: Instead of the required dehumidification performance of 44lbs/24h, the system only has a capacity of 26lbs/24h under the design conditions. Therefore, it would be significantly undersized. This example shows how important it is to always determine the necessary performance in relation to the required design conditions. Nowadays, some manufacturers choose not to Issue performance diagrams and instead supply, on request, computer-generated data sheets, which present all relevant performance data specifically related to the project.

4.3 Notes on the planning selection and operation of condensing dehumidifiers:

Check application limits: Generally speaking, condensing dehumidifiers are suitable for operation where the lowest humidity will be approx. 45% RH and within a temperature range of approx. 41– 96°F

For conditions other than these, use a desiccant dryer Condair DA .

Design: For the design, always include the required ambient set point conditions in °F and % RH.

Performance specifications are only significant when they are specifically related to the required design conditions. For this purpose, request the performance diagrams or computer-generated design from the manufacturer.

Electrical power consumption: Also, a comparison of the electrical power consumption, which changes dramatically in condensing dehumidifiers depending on temperature and humidity, is only useful and significant when related to the respective design conditions.

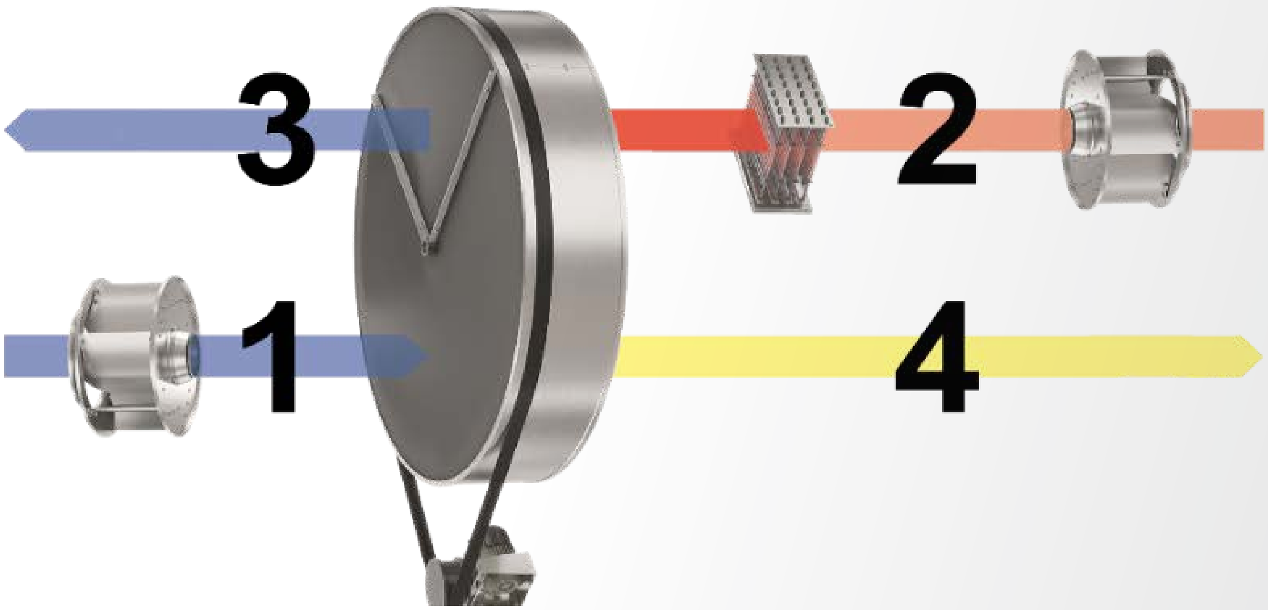
Temperature increase: All condensing dehumidifiers release the exhaust heat of the cooling circuit, fan motors and internal electricity back into the ambient air, which can lead to a minimal increase in ambient temperature, or a large additional thermal load — depending on the size of the system. In many applications, this effect may be negligible or even desired (e.g. In the area of swimming pools), but in certain applications may lead to problems. In particular, with large facilities and temperature-sensitive applications, the temperature aspect must therefore be taken into account in the planning.

Ambient air quality: Condensing dehumidifiers are generally suitable for operation under normal ambient air conditions, e.g. not for aggressive chemical latent air, explosive environments, or air which is carrying toxic substances. Substances such as chloramine and ozone can attack parts and quickly destroy the systems. Therefore, Swimming Pool Dehumidifiers are already protected from chloramines as a standard using special anti-corrosive coatings. Some manufacturers are in a position to supply industry clients with special systems that have special protective coatings, e.g. to protect against other volatile airborne chemicals.

Installation: Condensing dehumidifiers are available in either a mobile or a stationary version. Mobile systems are almost always operated with the dry air released into the ambient, while large industrial dehumidifiers can also be attached to a network of ventilation ducts. In this case, it is important to ensure sufficient static pressures.

Condensation: In most cases, the liquid condensate generated is discharged via the drain outflow. Especially when it comes to high-performance systems, it is essential to ensure connection to the wastewater system via a drain p-trap.

Functional Description of a Desiccant Dryer



1 Process air in
2 Regeneration air In
3 Humid regeneration air out
4 Dry process air out

Note: All Condair DA Dehumidifiers use 2 fans and the fans operate in a Pushing mode so they are not exposed to extremes of temperature or humidity. All units incorporate standard PTC regeneration heaters.

Figure 6: Overview of a desiccant dryer

5. Desiccant Dryers

Desiccant dryers are applied in a variety of industrial and commercial applications. Often, they are applied when condensing dehumidifiers physically reach their limits and compliance with minimum absolute humidity, low water vapor levels or tight +/- control is required.

With this technology, the water vapor level is no longer stated in % RH, but rather always in the absolute humidity X in Grains/lb of dry air or in the associated dew point temperature Td in °F. The principle of sorption refers to the capacity of certain substances to bind water vapor to its surface. The inner surface of these substances is of a scale in the order of 228864 to 244121 sqFt/ ounce

An extremely low water vapor partial pressure exists in the immediate surroundings of these chemical substances. Due to the laws of thermo-dynamics, water vapor diffuses from areas of higher partial pressure (in this case from ambient air) to areas of lower partial pressure (sorbent). Silica gel, aluminum oxide or sometimes molecular sieves are used as sorbents. The further examination focus exclusively on adsorption using silica gel, as this is by far the most widely-used sorbent on the commercial HVAC market.

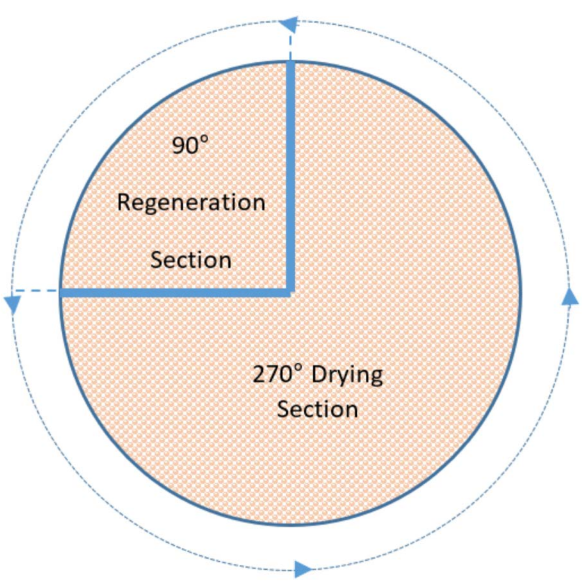


Figure 7: Overview of a condensing dehumidifier

5.1 Operation of a desiccant dryer: Humid ambient air (process air) is drawn in by a fan and pushed through an adsorption rotor. The adsorption rotor consists of a corrugated and finely laminated storage mass with an enormous inner surface, which is coated with the highly hygroscopic silica gel.

The entire cross section of the rotor is divided into a drying sector of 270° and a regeneration sector of 90°. The sectors are insulated from each other. A continual, slow turning of the adsorption rotor is carried out by the motor, the turning speed is in the range of 5–30 turns per hour.

The air stream to be dried is continuously pushed through the drying sector of the rotor. In the process, the water vapor it contains is almost fully adsorbed. The 90° regeneration sector of the rotor is conducted into the countercurrent of regeneration air, which was previously heated to approx. 248°F via a PTC heater.

As a result, adsorbed water vapor bound in the rotor is forced back out and discharged to the outside in the humid air stream. The regeneration air current amounts to approx. 1/3 of the process air stream.

This adsorption/ desorption process can be repeated as often as required without the degree of effectiveness of the sorbent being significantly influenced. The adsorption capacity of silica gel is so large that that dew points of -90°F can easily be attained.

5.2 Regeneration: In order to force out and discharge adsorbed water vapor bound in the rotor, the adhesive powers operating on the surface of the sorbent must be removed. To do this, the regeneration air stream must be heated accordingly. This is carried out by means of an upstream PTC regeneration heater.

5.3 Residual heat: The material of the rotor is heated by the application of high temperature air at around 248°F to force out the adsorbed water vapor bound in the rotor. The change of state of the drying sector is not completely carried out through an adiabatic process at constant enthalpy, there is still some heat remaining in the rotor mass. The remaining heat in the rotor is designated as residual heat and leads to additional sensible heating of the dry air flow by approx. 0.4°F per grain/lb dry air of drying performance.

For example with an assumed residual heat of 0.4°F/grain/lb, this additional heating amounts to, e.g. in a drying process of 80, to 50 grains/lb dry air: 0.4°F/grain/lb x (80 – 50)grains/lb = 12°F. This temperature is a sensible heat gain additional at the end of the drying process line of constant enthalpy

Knowledge of this fact is important for the assessment of the integration of a desiccant dryer into the overall air conditioning strategy of the area to be dried. In the manufacturer's technical calculations, the stored heat is already taken into consideration and the actual temperature of the dry air stream is stated.

The following diagram shows the change of state on drying through adsorption.

1: Process air IN (room air)
2: Dry air OUT
1'. Regeneration air IN
2'. Regeneration air to heater
3'. Wet air OUT (i.e. to outside)
D1 Latent Heat Energy
D2 Residual Heat from regeneration
DT Total heat gain

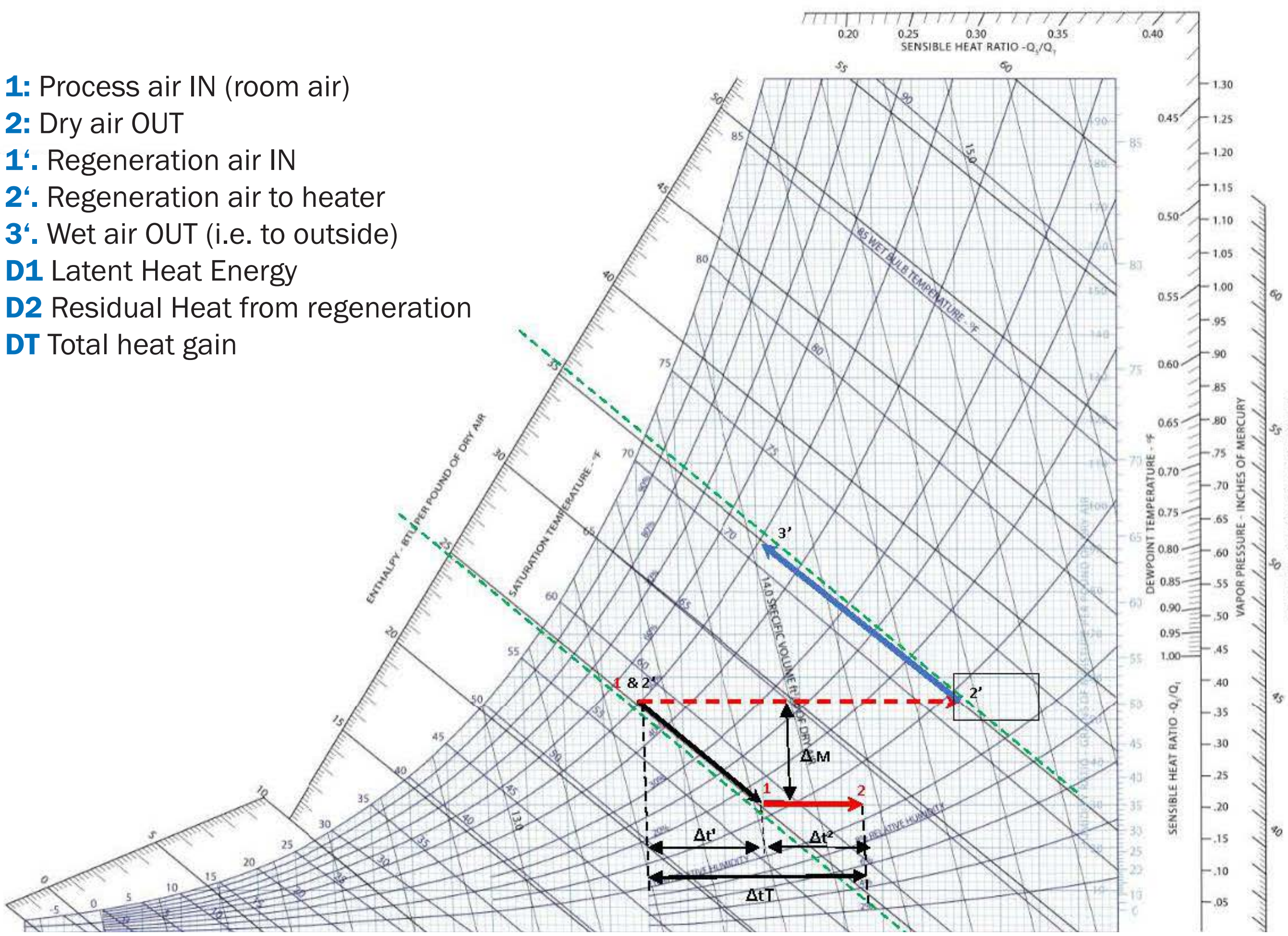


Figure 8: Change of state on drying through absorption

5.4 Sizing: Desiccant dryers are typically used in more sensitive applications than condensing dehumidifiers. For this reason, due to the high latent and sensible heat outputs this should always be calculated using a manufacturer specific sizing program.

5.4 Control accuracy
Desiccant dryers will give a much higher degree of control accuracy than that of any condensing dehumidifier. While common applications for Desiccant dryers are more typically focused where very low absolute humidity levels are required, they work equally as well at higher levels of Absolute humidity in applications where overall control and stability are a requirement.

Typical control accuracy of a Condair DA Desiccant unit against a set point of 50% rh

	Conditions		2008/4/1	Page 1/1
Starting time: 25.03.2008 09:00:00		Min:	Max:	Mean
Finishing time: 01.04.2008 09:00:00	C:1 [%RH] Humidity	40:80	54:40	49.90
Channels: 2 (2)	C:2 [°F] Temperature	14:50	16:30	15:59
Values: 1009				
C1: SN 01135973 / 510				
Accuracy	C1: Acc:+/- 2.0 [0..100] %rF C2: Acc: =/- 0.8 [-40..-25] =/-0.5[-25..70] °F			

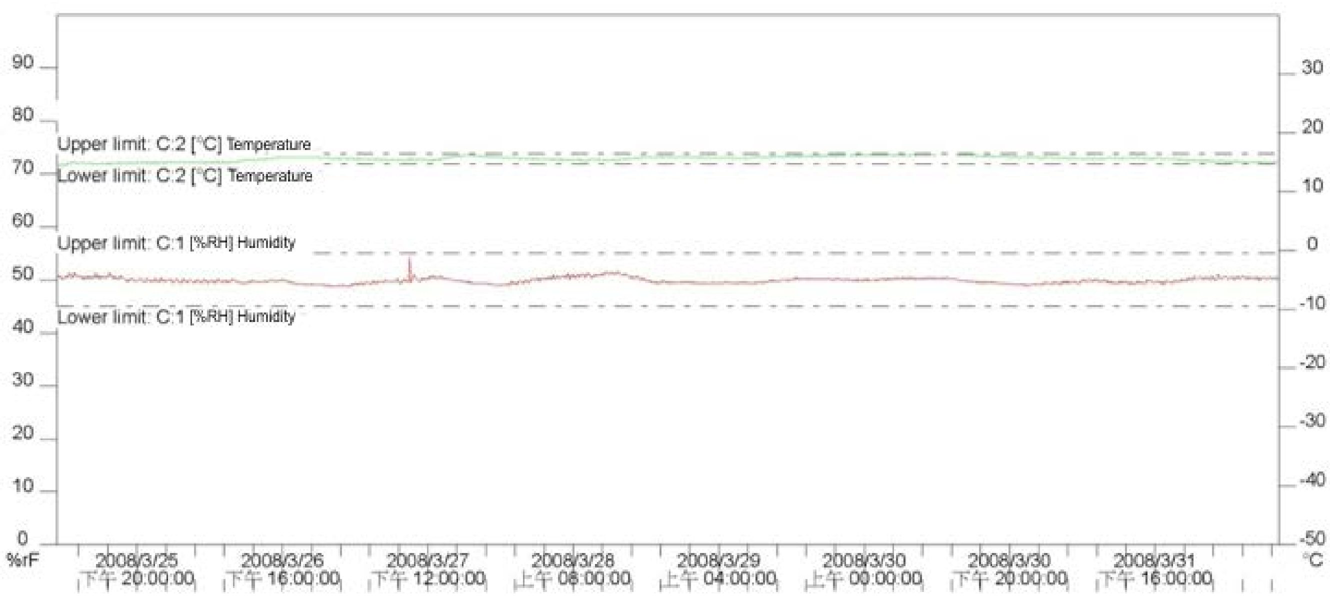


Figure 9: Control accuracy of a Condair DA Desiccant unit against a set point of 50% RH

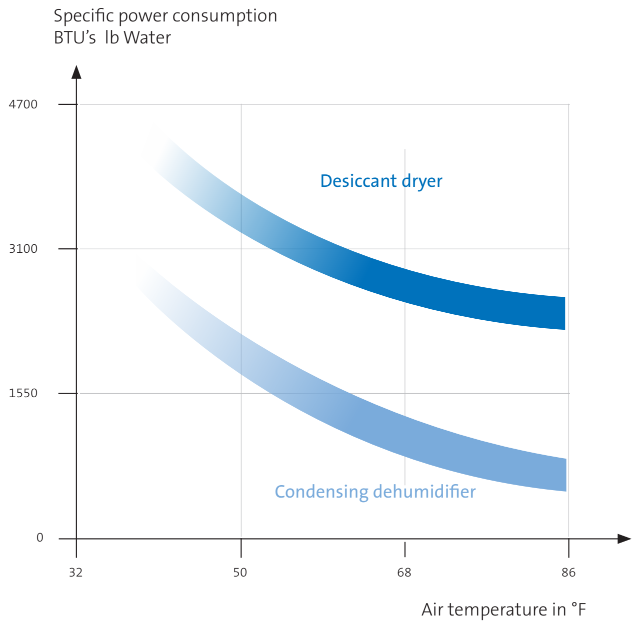


Figure 10:

Connection: The different air flows of the desiccant dryer must be transmitted through ventilation ducts. This is generally carried out using circular ducting. The regeneration discharge humid air duct must be ducted to the outside and should be insulated. If external air is used as process air, care must be taken to ensure that the hot humid discharge air outlet is sufficiently placed away from the outside air inlet. The humid air must always be conducted downwards to ensure any potential condensate drains away from the Condair dryer.

Temperature control: To reach especially low supply air humidity levels, pre coolers must be installed upstream of the process air inlet. In temperature-sensitive areas, the supply air temperature must be regulated directly after the dryer by means of an after cooler, possibly in combination with a post-heating pack.

Ideally, the manufacturer of the desiccant dryer should deliver the required modules, ready to be connected, built-in to the dryer housing. In Winter operation when untreated external air is being dried, a pre-heater should be provided for protection from frost.

Heat recovery: When larger desiccant dryers are being used, in view of the higher energy consumption of the regeneration heater due to the system size, the on-site installation of a heat recovery unit is recommended. In this process, prior to discharge to the outside, the heated humid air is conducted through a crossflow heat exchanger, where it releases the majority of the heat energy it contains to the air flow which is needed for regeneration. As a result, the energy consumption of the regeneration heater can be significantly reduced.

Air-cooled condensers: Under suitable ambient conditions, an air-cooled condenser can be used on the regeneration humid air discharge. As a result, the humid air discharge via ventilation ducts can be omitted. This is effective at low to medium ambient temperatures.

5.6 Summary: In the preceding chapters, the physical bases underlying the two most common dehumidification technologies were explained, and notes on planning and applications provided.

Ultimately, the decision as to which of the two systems is most suitable must be made on a case-by-case basis.

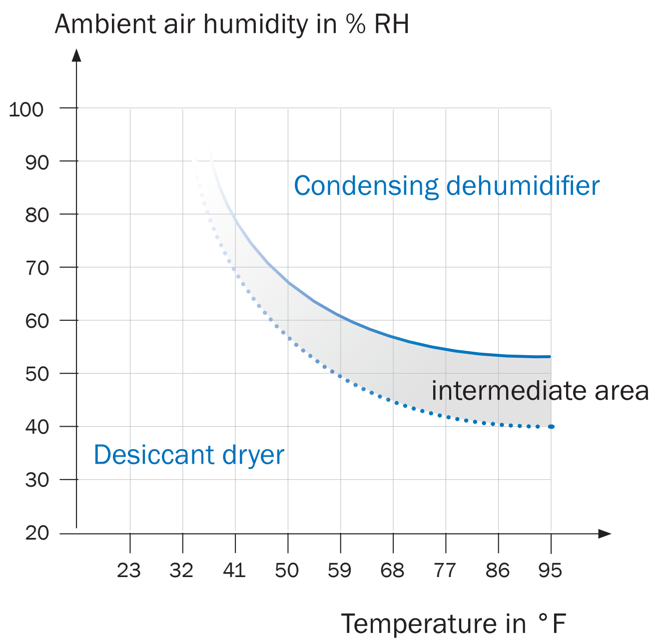


Figure 11:

The diagram above provides a rough overview of the areas in which the use of desiccant dryers makes sense. In particular with respect to dehumidification tasks that are at the limits regarding the parameters of temperature and final humidity, a specialist should always be called in for further assessment and for the selection of the appropriate system.

6. Calculation Basis

The primary goal of any dehumidifier is always to control the moisture content of the air. A few formulas and calculation methods are sufficient for calculation. Which calculation approach must be chosen depends to a large extent, on the planned application of the dehumidification system. Possible applications may include: Simple control/reduction of ambient air humidity, e.g. in warehousing, to protect against corrosion, in archives, etc. Protection from the formation of condensation on cold surfaces, e.g. pipes and installations in the water supply area, food industry, etc. Product drying Ensuring optimal conditions in production processes. Drying of external air including Direct temperature control via the dryer. Use in low temperature range, e.g. ice skating rinks and cold-storage rooms.

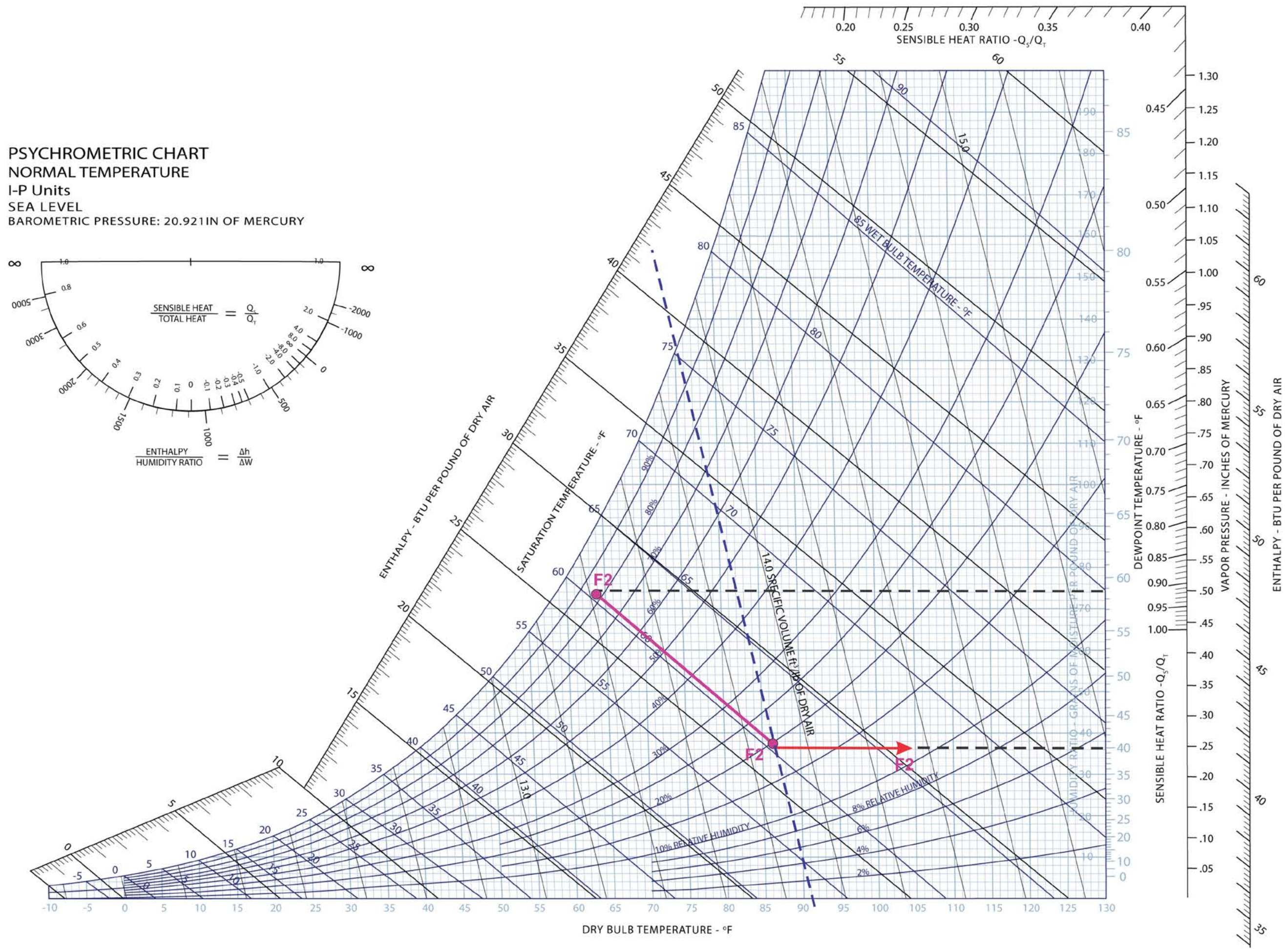
6.1 Specifications required for the planning and design of dehumidification systems in the industrial and commercial sectors:

Application/description of dehumidification task: When an exact specification of the planned application is provided, the appropriate dehumidification technology can often be determined in the first step.

- Area volume in ft^3
- Target conditions following dehumidification in °F and % RH
- Required absolute final humidity in grains/lb dry air
- Most unfavorable temperature and humidity values in °F and % RH before dehumidification
- Initial humidity in grains/lb dry air
- Mechanical ventilation: If available, specifications on volume stream and supply air conditions (summer).
- External air conditions in summertime: Is necessary for calculating the moisture load introduced by the external air, be it through mechanical extraction / input or infiltration.
- System location: Is required by the manufacturer to determine the extreme values of the external air conditions, if these values are not provided by the customer.
- Height above sea level: The thermodynamic framework conditions change as the geodetic height increases, i.e. with decreasing air pressure. Mainly relevant for very sensitive applications and very elevated installation locations.
- Specification on internal moisture loads: Humidity emitted by products, through production, cleaning processes, etc.?
- Number of people in the area?
- Open expanses of water: If available, specification of water temperature and water surface for calculation of evaporation.
- Air conditioning: Is a temperature control system available on-site?
- How temperature-sensitive is the application? Is post-cooling necessary?
- Drying of external air: If external air must be dried all year round, alongside the extreme values for the summertime, the conditions for the case of winter must also be provided, as a pre-heater may need to be installed for protection from frost.

The list of required data is huge for a correct selection of a suitable Desiccant dryer.
The final page of this manual shows the complete list of data required, please complete this in full and submit to your local Condair representative so a fully detailed selection submittal can be provided.

Simple Calculation Based on Psychrometrics



Simple Calculation

- Determine the total air volume you need to dry in CFM
- Determine your start Condition Absolute Humidity F1
- Determine your finish Condition Absolute Humidity F2
- Draw in the process line F1 to F2
- Determine the grains/lb difference
- Determine the Specific Volume or density of F2

Calculation

Using Specific Volume	Using Density
$\dfrac{\text{CFM} \times 60 \times (\text{F1} - \text{F2})}{\text{Specific Volume}}$	CFM x 60 x Density x (F1- F2)

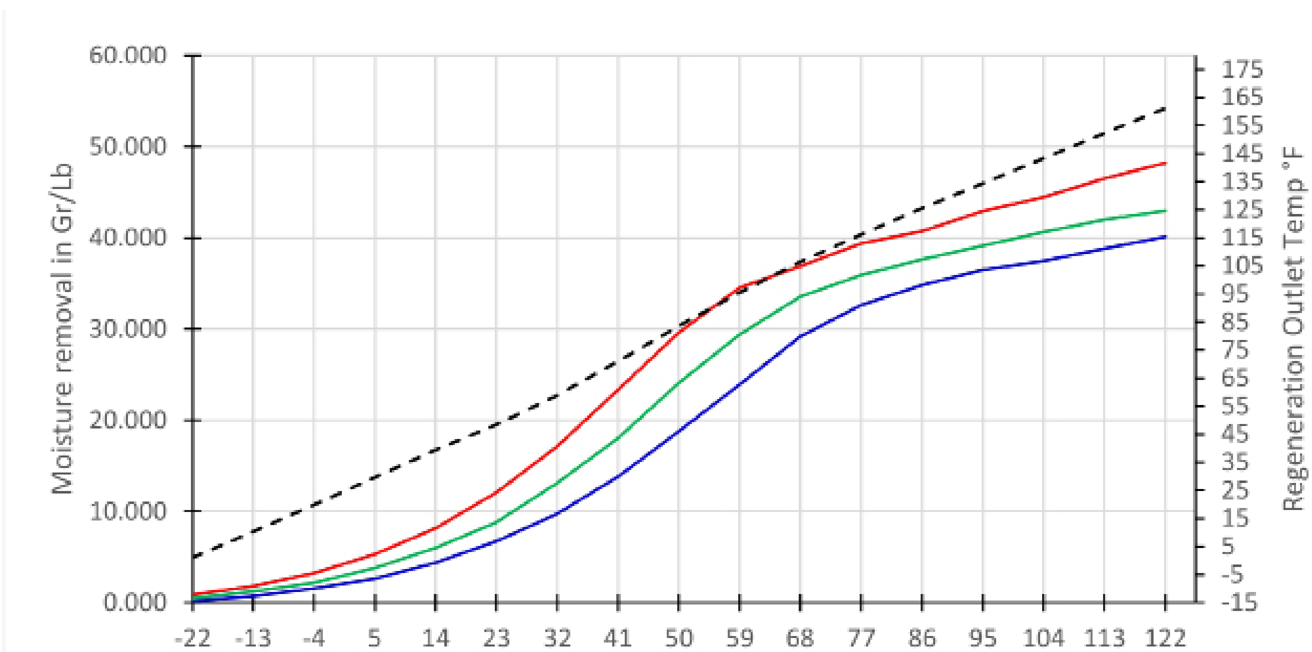
- This will then give you a nominal total duty in grains/hr required.
- Divide by 7000 to convert to lbs/hr

From your Total air volume refer this to the airflow capacity of the Condair DA Range

Model	Minimum CFM	Recommended CFM	Maximum CFM
DA 300N	118	290	471
DA 400N	206	410	471
DA 600N	294	580	647
DA 800N	294	815	941
DA 1400N	588	1390	1589
DA 2000N*	588	1970	2236

208V only

- Determine the Model required
- Look up the model against the nominal performance chart for that model



NOTE: Data is indicative of unit performance.

• At your air-on temperature draw in a vertical line that intersects the DA unit performance lines
• From the intersection on Humidity lines closest to your air on condition, draw a line horizontally to the left Axis and this gives an indicative drying capacity in Grains/lb
• From the intersection of your vertical temperature line with the process air outlet temperature draw a line horizontally to the right Axis and this gives an indicative process air outlet temperature.

Example
Total air volume to be dried   325CFM
Air on F1: 65°F and 80%RH Absolute humidity 76grains/lb
Air offF2: 87°F and 20%RH Absolute humidity 40grains/lb

Difference 76 – 40 =36 grains/lb

Specific Volume 13.9 ft^3/lb
Density = 1/ 13.9 = 0.072 lbs / ft^3

Duty Estimation

By Specific Volume	By Density
325 x 60 x (76 - 40) 13.89 = 50539 7000 = 7.2lbs/hr	325 x 60 x 0.072 x (76 – 40) = 50544 7000 = 7.2lbs/hr

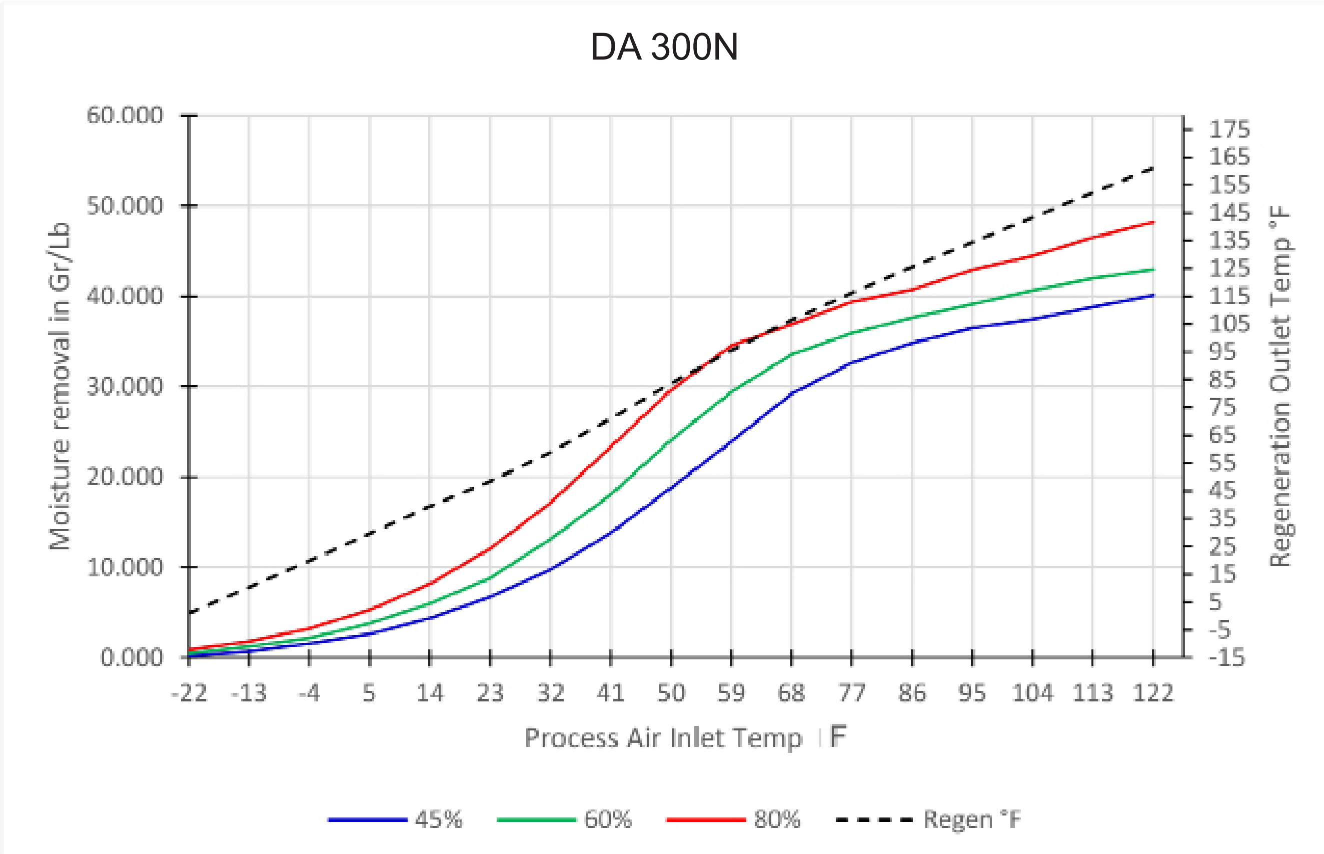
From the Air volume table 325CFM is easily handled by the DA 300N model.
At air on condition of 65°F 80%RH the drying capacity is around 37 - 38 grains /lb so within you required drying capacity

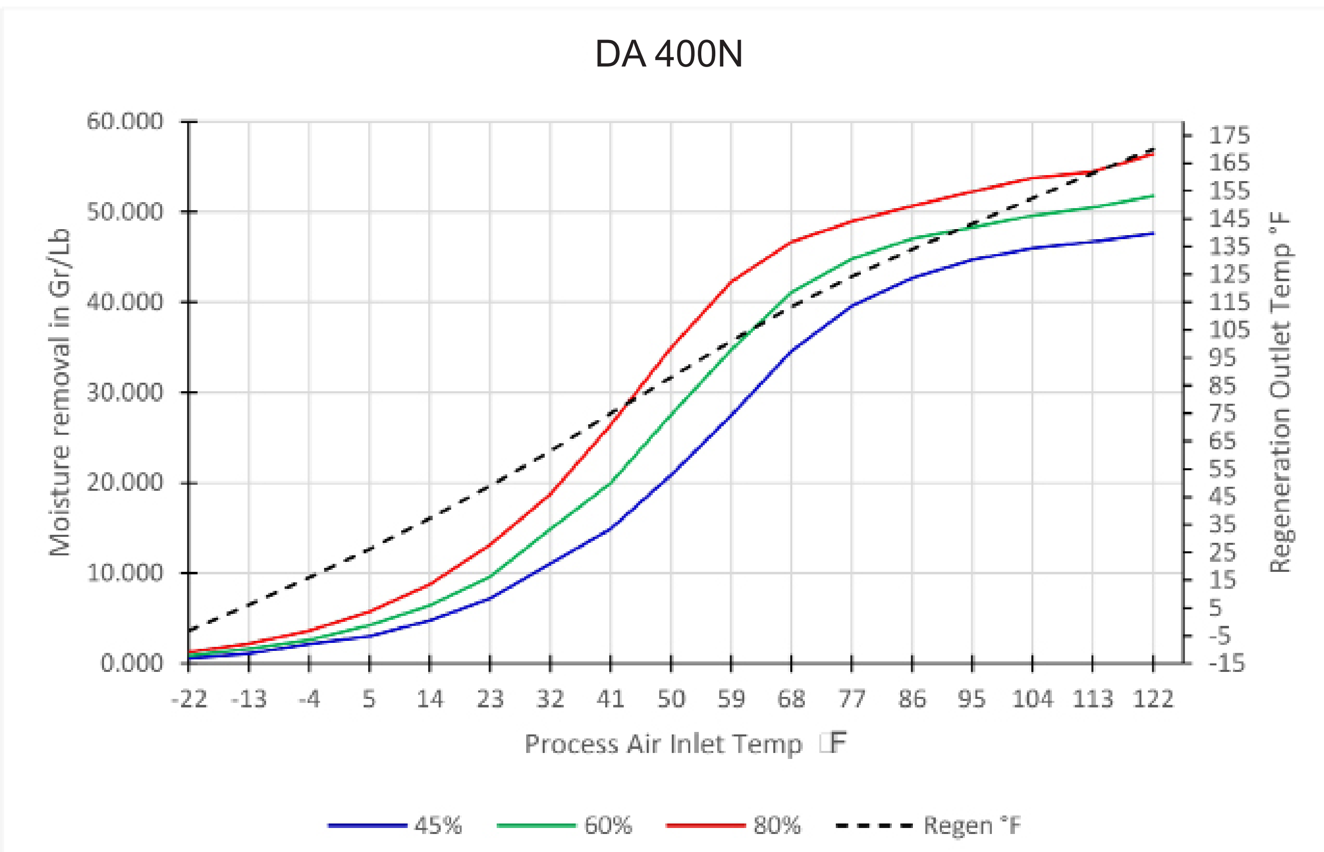
However do be aware that you process air out temperature will be in the region of 105°F

This calculation must only be used for rough estimations it must be calculated fully in software to give accurate values

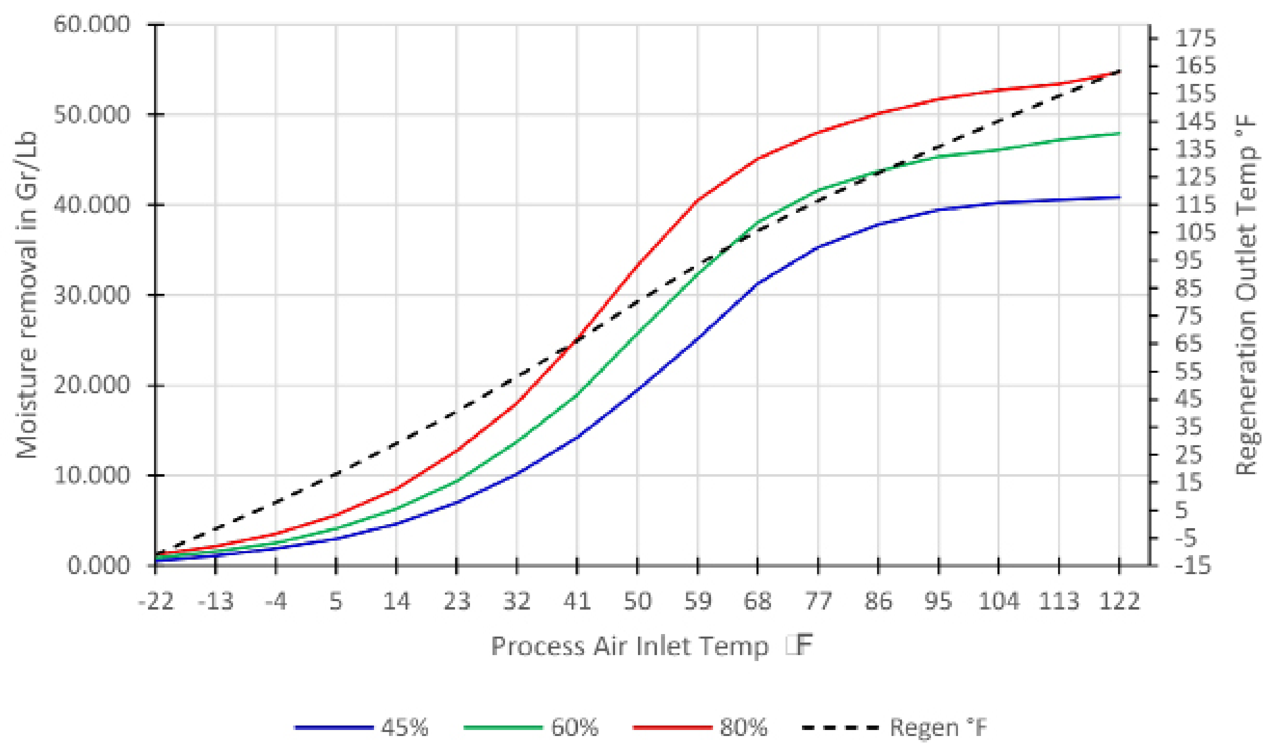
7.0 Provisional Performance Charts

NOTE: Data is indicative of unit performance.

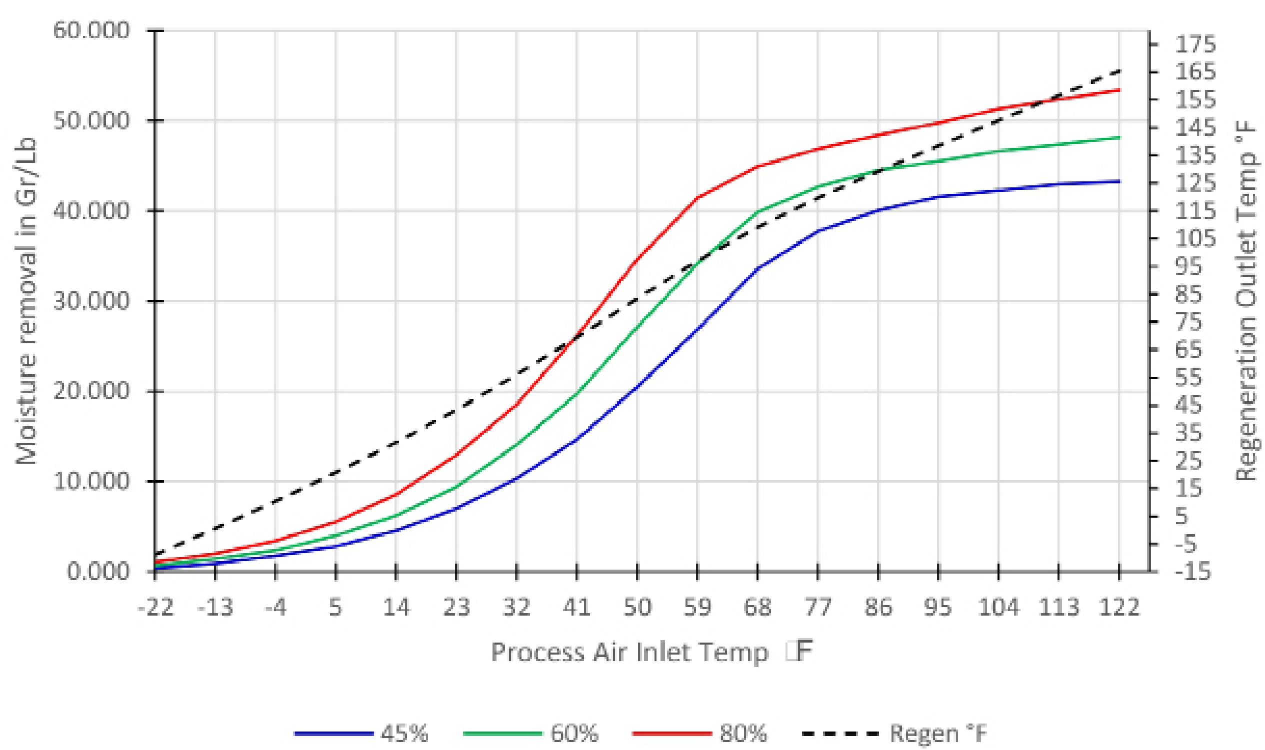




DA 600N

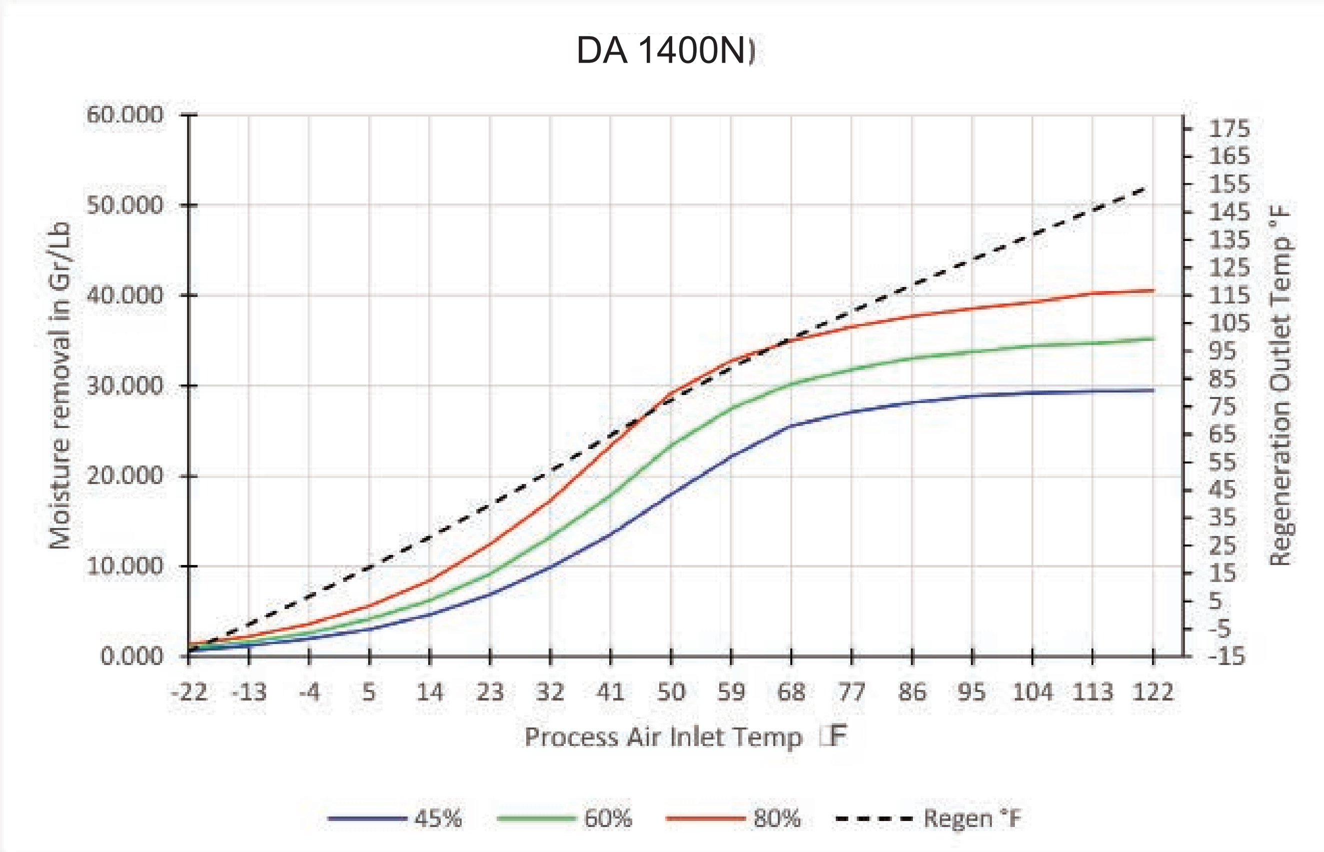


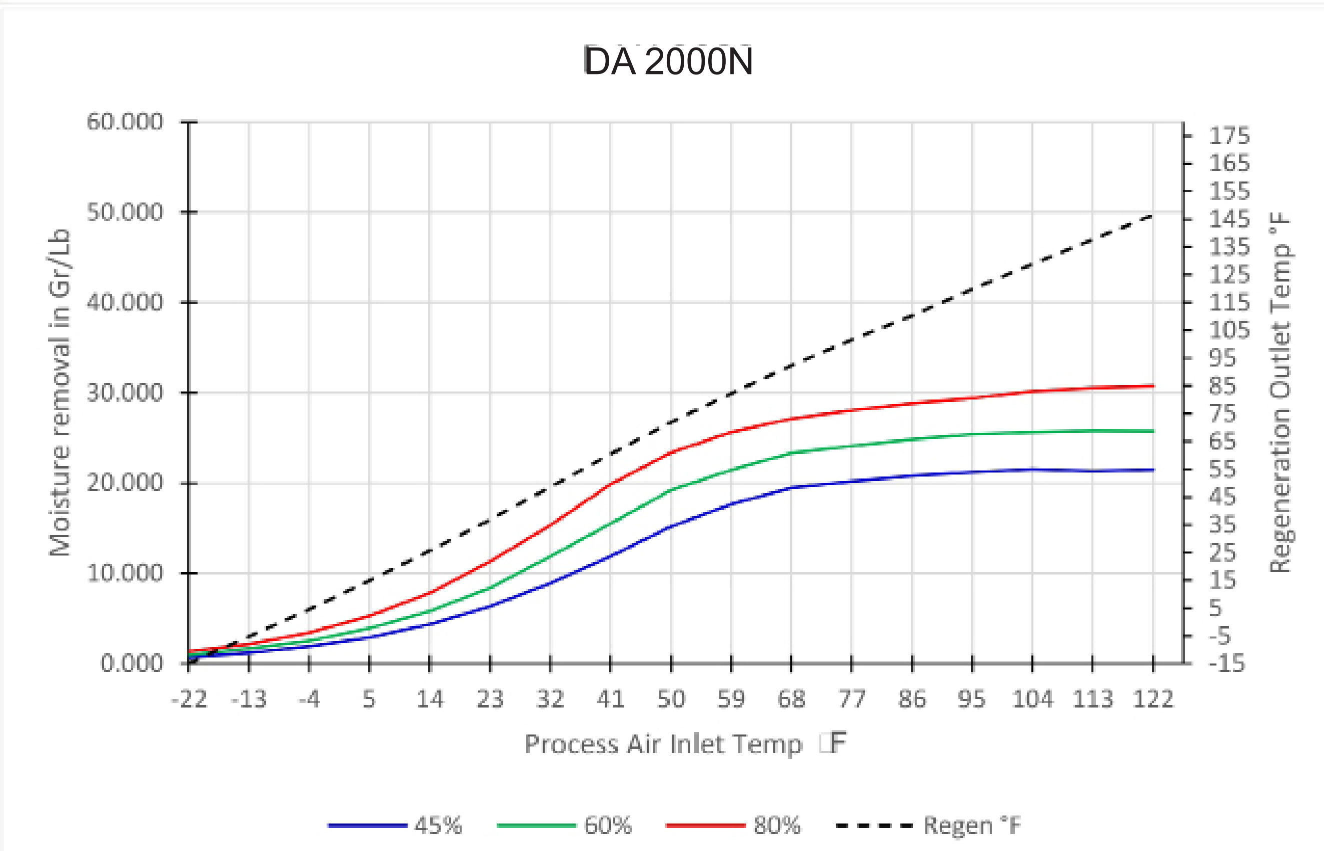
DA 800N



Provisional Performance Charts - continued

NOTE: Data is indicative of unit performance.





8.0 Recommended Conditions in Accordance with Areas of Application

Sector	Area of application	Relative humidity	Temperature
Antiquities	Storage and repair	45–50%	68–75 °F (20–24 °C)
Automotive industry	Manufacturing	45–55%	72–77 °F (22–25 °C)
	Car spraying plant	50–55%	72–77 °F (22–25 °C)
Library	Book warehouse	40–50%	70- 77 °F (21–25 °C)
	Reading rooms	35–55%	70- 77 °F (21–25 °C)
Hospital	Operating room	50–60%	72–78 °F (22–26 °C)
	Patients' rooms	40–50%	68–72 °F (20–22 °C)
	Nursery	50%	75 °F (24 °C)
Furniture industry	Veneer storage	50–60%	59–64 °F (15–18 °C)
	Furniture production	40–50%	64–72 °F (18–22 °C)
	Manufacture clamping plates	50–55%	54–68 °F (12–20 °C)
	Wooden furniture storage	50–55%	54–64 °F (12–18 °C)
Fashion	Tannery	65–70%	50–68 °F (10–20 °C)
	Storage of furs	50–60%	40-50 °F (5–10 °C)
	Spinning mill / Silk	50–65%	68–77 °F (20–25 °C)
Museums	Paintings	40–55%	64–75 °F (18–24 °C)
Paper industry	Storage	50–60%	59–68 °F (15–20 °C)
	Rotary printing	60%	68–77 °F (20–25 °C)
	Screen printing	50–60%	72–75 °F (22–24 °C)
	Processing (binding/cutting)	50–60%	72–86 °C (22–30 °C)
Pharmaceutical industry	Raw material storage	30–40%	70–80 °F (21–27 °C)
	Penicillin production	60%	77 °F (25 °C)
	Tablet press	35–50%	70–81 °F (21–27 °C)
Clean rooms	Electronic equipment for microscopy	40–45%	72 °F (22 °C)
Confectionery industry	Wafer production	40–45%	72 °F (22 °C)
	Storage of yeast	60–75%	32–40 °F (0–5 °C)
	Flour storage	50–60%	59–77 °F (15–25 °C)
	Chocolate storage	60–65%	64–70 °F (18–21 °C)
	Dried fruit storage	50%	50–55 °F (10–13 °C)
	Sugar storage	35%	77 °F (25 °C)
Tobacco industry	Raw tobacco storage	60–65%	70–73 °F (21–23 °C)

9.0 Questionaire for Air Dehumidification

Please complete all questions on both pages before submitting as we cannot select a suitable unit without all the data.

SITE DATA

Company Name: ____________________ Name: ____________________

Address: ____

City: ____________________ State: ____________________

Zip code: ____________________ Country: ____________________

Phone: ____________________ Email: ____________________

Altitude above sea level? ____________________ft

Design base outdoor conditions ____________________°F(°C) ____________________%RH

Application

Detailed description of the intended use: ____

____

Detailed description of the process, resp. the moisture problem: ______________________________

____

Room Dimensions

Length ____________________ft Width ____________________ft

Height ____________________ft Volume ____________________ft^3

Current conditions inside the room (temperature and humidity)? __________°F(°C) __________%RH

Target conditions for the room (temperature and humidity)? __________°F(°C) __________%RH

Specific Design Data

Process Air Supply Source: ____________________

Process air on Conditions ____________________°F(°C) ____________________%RH

Regeneration air supply source ____________________

Regeneration air on conditions ____________________°F(°C) ____________________%RH

Continue to page 2 of the questionnaire...

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Internal moisture load:

Number of people inside the room? ____________________

Intensity of the working condition (low, middle, heavy)? ____________________

Work process associated with these staff? ____________________

Any other moisture loads within the area? _____ Yes _____ No If YES what? ________________

Other important details:

Are there any aggressive chemicals inside the room air? ____________________

If YES, what? ____

If present, concentration (chlorine, detergents, ozone, acids, etc.)? ____________________ppm

Are there any alternative heat sources available? _____ Yes _____ No
(warm water, steam, gas for regeneration of absorption driers)

If YES what? _____________________________________

Supply voltage and frequency ____________________volts ____________________phase

Special filtration requirements - G4 standard for absorption dryers ____

General information:

Mechancial ventilation system supply to the room? ________________ Supply Air Volume ________________

Cooling Capacity ____________________ Cooling Medium ____________________

If chilled water flow and return temperatures __________°F(°C) Flow __________°F(°C) Return

Ventilation supply air conditions (temperature and humidity)? ________°F(°C) __________%RH

Air tightness of the room/facility ____________________

Number of doors and/or windows which get opened frequently? ________doors ________windows

Dimensions (width x height) ________ft ________ft

Completed questionnaires can be submitted to ____________________

22-552

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