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Industrial Dehumidifier Sizing

INTRODUCTION

The industrial and manufacturing industries are always looking for ways to increase production, limit spoilage and increase quality of product while minimizing overhead costs. The environment surrounding the manufacturing process and or warehousing of product before and after production has been neglected for many years. The recent climate change discussions have increased the engineering community's interest in environmental control to increase product quality and decrease manufacturing spoilage. This Application Note will highlight many areas that create a humid environment in an industrial climate.

ENVIRONMENT

One of the first items that needs to be established is: what is the best temperature and humidity for the application/ process that is being evaluated?

The Engineer of Record for the project and the client must agree what is to be used for the specific application in order to establish the project load.

The ASHRAE Application Handbook and the ACCA Manual N include published suggested design conditions for many applications that can be used for a starting point.

After the worst case load is calculated the engineer of record and the client can than agree to select equipment based on 100% of the calculated load or something less.

After the design dry bulb temperature and humidity level has been established check what the dew point is of these two conditions. This will assist in what type of equipment should be selected.

Figure 1 is a dew point table. The dew point values shown in gray indicate the operating range for most refrigeration based dehumidifiers.

Dew Point Table					
Relative Humidity	60°Fdp	65°Fdp	70°Fdp	75°Fdp	80°Fdp
30%	29°Fdp	33°Fdp	37°Fdp	42°Fdp	46°Fdp
35%	32°Fdp	37°Fdp	41°Fdp	46°Fdp	50°Fdp
40%	36°Fdp	40°Fdp	45°Fdp	49°Fdp	54°Fdp
45%	39°Fdp	43°Fdp	48°Fdp	52°Fdp	57°Fdp
50%	41°Fdp	46°Fdp	50°Fdp	55°Fdp	60°Fdp
55%	43°Fdp	49°Fdp	53°Fdp	58°Fdp	62°Fdp
60%	46°Fdp	51°Fdp	55°Fdp	60°Fdp	66°Fdp

Figure 1 - Dew Point Table

Items to Consider:

- Can the size of the space around the process be reduced?
- Can infiltration air be reduced in the area?
- Does the application require a low temperature?
- Does the application require a dew point below 40°F? If it does a desiccant system may be required
- Can a vapor barrier or a coat of vapor proof paint be added to prevent moisture migration due to infiltration and or permeation?
- Can open liquid tanks be covered?

CALCULATING THE MOISTURE LOAD

Desert Aire has developed a sizing tool that will calculate the moisture load of many industrial applications. The method used is based on the ACCA Manual N and ASHRAE formulas. The remaining pages of this Tech Bulletin will explain what information is required and or needs to be considered for your application.

The tool is not intended to include every item that may be generating moisture that is affecting manufacturing spoilage. A site evaluation should be done to ensure all moisture generating issues are included in your calculation.

This Application Note includes a list of 10 most common items that may or may not be present in an industrial application. Four of these items are related to the building structure. These items can be modified fairly easily without effecting the manufacturing process and will reduce the selection size and operating cost of the equipment specified. The building load consists of building infiltration, building permeance, door infiltration and code ventilation.

Figure 2 shows the percentage load of these four items during the winter and summers months of operation for five cities in the United States.

EXAMPLE APPLICATION INFORMATION

The example used different dry bulb and RH conditions to conserve on energy cost and adjust for seasonal requirements. The values selected for each season relate to a single dew point temperature for both Summer and Winter seasons.

Example application information:

- Winter 70Fdb/50% RH, 51°F dew point
- Summer 75Fdb/43% RH, 51°F dew point
- 5000 sq ft building, 3 to 4 exposed walls
- Semi-tight construction vapor proof paint
- 2 exterior doors and 1 overhead door
- 35 people, 1,250 cfm ventilation air
- 5lb/hr process, 4lb/hr product
- 1 therms of non-vented gas combustion equipment
- 100 sq ft of open water/wetted surfaces

Building & Code Ventilation % of Load		
Philadelphia, PA	Winter Months Average	53%
	Summer Months Average	70%
Milwaukee, WI	Winter Months Average	19%
	Summer Months Average	68%
Atlanta, GA	Winter Months Average	63%
	Summer Months Average	69%
Dallas, TX	Winter Months Average	66%
	Summer Months Average	71%
Kansas City, KS	Winter Months Average	46%
	Summer Months Average	69%

Figure 2 - Building & Code Ventilation % of Load

METHODS OF CONTROLLING THE ENVIRONMENT

It must be understood that in order to control the moisture content in the environment that is creating the issue, both the humidity and the temperature must be maintained at a constant condition in order for the equipment used to function properly during all seasons of operation.

Common types of systems:

- Make-up air system
- Refrigeration based dehumidifiers
- Standard HVAC Systems
- Desiccant Dehumidifiers

MAKE-UP AIR SYSTEMS

The first method uses the principle of dilution, removing a portion of the moisture laden air from a space and replacing it with drier air. The net result is lower average moisture content. This method is relatively inexpensive to install, but relies on the fact that drier air is available. Since the most common source is outside make-up air, this method is difficult to apply in most geographic areas during summer months and expensive to operate in winter due to reheating costs.

DESSICCANT DEHUMIDIFICATION SYSTEMS

Desiccant dehumidifiers use special materials that absorb or hold moisture. The material is unique in that it does not change in size or shape when acquiring the moisture and can be regenerated by applying heat. This method is used effectively to dry air in the range of 0% to 50% RH or below a 35°F dew point.

REFRIGERATION BASED DEHUMIDIFICATION SYSTEMS

Refrigeration based dehumidifiers reduce the moisture in the air by passing the air over a cold surface, removing the moisture by condensation. According to ASHRAE definition this method is effective for desired conditions down to a 40°F to 45°F dew point. This method has moderate capital costs and can recover much of the latent energy thus offsetting operating costs. These units are typically designed to have a 60% sensible capacity and a 40% latent capacity.

STANDARD HVAC SYSTEMS

Standard HVAC Systems are basically designed to control space temperature and only remove moisture when running in the sensible cooling mode. The equipment refrigeration components are typically sized for 80% sensible capacity and 20% latent capacity. Standard HVAC Systems do not have a sequence of operation to start the refrigeration system on a call for humidity control. When these systems are modified to start on a call for humidity they will struggle or fail to operate when the space temperature drops below 70°F.

SOURCES OF MOISTURE

Building Infiltration: The amount of air (CFM) entering the space through cracks, joints and seals from exterior areas.

Building Permeation: Is the migration of water vapor through construction materials due to a vapor pressure differential.

Overhead Door Openings: The amount of air (CFM) that is entering the space from overhead doors, windows, or other openings such as conveyor openings to another no treated space.

People: People evaporate moisture from their body at a rate depending on the activity rate of the work being performed.

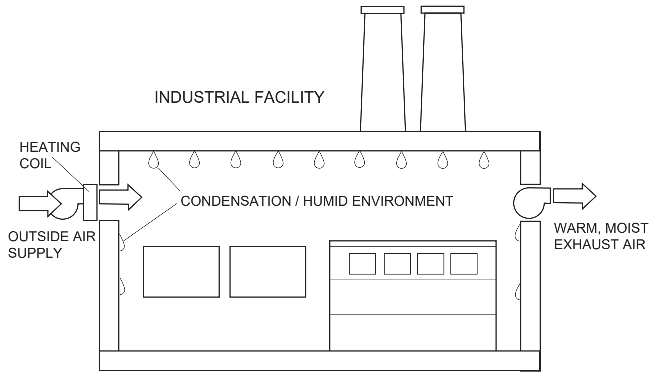
Code Ventilation: The amount of air (CFM) required by local codes that must be introduced to work area for proper indoor air quality.

Manufacturing Processes: Some manufacturing processes may use some type of liquid that is evaporating moisture into the space. This could be cooking vessels or heating of a material that is off gassing moisture.

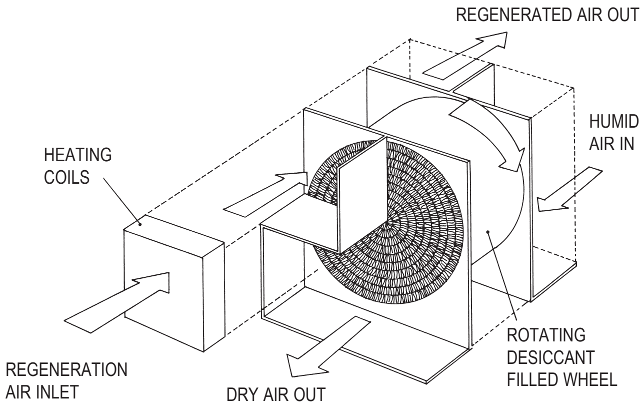
Product: Some products/material used in the manufacturing processes may contain moisture that is evaporating to the space creating high humidity. Tables are available in the ASHRAE Handbooks to evaluate the latent content.

Open Liquid Tanks/Sprayed Liquids: Any surface area of a liquid that is exposed to an open atmosphere will evaporate moisture. The surface area, liquid temperature, the temperature and the relative humidity of the air directly above the liquid is required to calculate the evaporation rate.

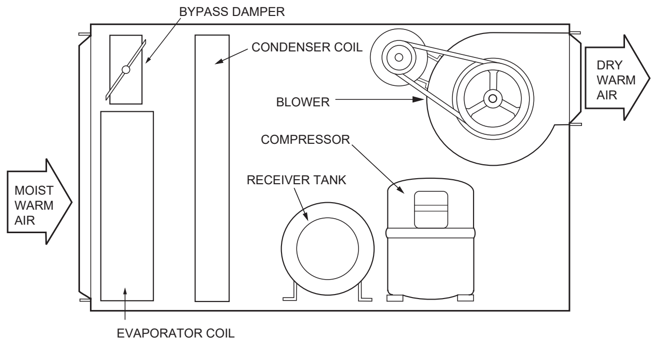
Make-up Air: The amount of outside air introduced to the space in excess of the ventilation air required by code. This could be added to control space humidity or building pressure.



Make-up Air Method



Desiccant Dehumidifier Schematic



Refrigeration Dehumidifier Schematic

Figure 3 - Make-up Air Method, Desiccant/Refrigeration Dehumidifier Schematic

Non Vented Gas Combustion: Gas combustion generates a large amount of water vapor. If it is not vented to the outside this amount of latent must be included in the overall total latent load.

1 cu.ft. of natural gas = 650 grains = 0.093 lbs of moisture

1 therm of natural gas = 100 cu.ft = 9.31 lbs = 1.1 gallons

Items That Have Limited Control:
Out of the 10 items listed that contribute moisture to the space we have limited control over building permeance, people, effects related to the manufacturing process, effects related to products and non-vented gas combustion equipment that are used for production. These items usually are not affected by seasonal changes and remain the same during the entire year.

Building permeance in most applications contributes a small amount of moisture to the total load and can usually be limited by a coat of vapor proof paint or in the case of new construction a poly vapor barrier can be included in the construction process.

All of these items will require a review of the Industrial process if a reduction of the moisture load produced is desired.

ITEMS THAT CAN BE CONTROLLED

Investigate if open water tanks can be covered to reduce the evaporation created. Investigate if wetted areas can be reduced. Determine if the liquid temperature can be lowered to reduce the evaporation.

Building infiltration, door openings, make-up air and code ventilation usually are the greatest contributors to the moisture load. These items also vary greatly depending on the geographical location of the application. Seasonal changes in weather conditions will also vary month to month during the entire year.

Minimizing the leakage in the building, Limit the number of openings of exterior doors, upgrade overhead doors and windows, and seal cracks.

Use a dedicated outside air system (DOAS) unit to pre-treat the ventilation air before it is introduced to the space.

CALCULATION OF LOAD

Desert Aire can assist in organizing and analyzing the load calculation. Contact your local Desert Aire representative for evaluation and suggested equipment selection. Desert Aire will provide a recommendation of the design load and dehumidification solution.