Load Calculator Guide

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

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Section I Preface

Preface

TRION/HERRMIDIFIER welcomes you to the world of engineered humidification systems. We are your "Total Capability Humidification Resource." This Guide will familiarize you with both the need and the benefits of controlled humidification. It will also acquaint you with the technical facets of accurately calculating humidification demand loads and the selection of the best and most appropriate system for your application.

Our recognized leadership position within the industry is borne from many reasons.

Quality is No. 1

Broadest Range of Humidification Systems

- Electronic Steam
- Central Steam
  - Steam to Steam
  - Electric Steam
- Air/Water Atomizing
  - In-Duct
  - In-Space
- Water Pretreatment Systems

Factory Trained Sales Force

- A nationwide network of factory-trained technical sales representatives.

Technical Support

- Our Engineering staff will custom design a system to fill your specific needs.

Technical Leadership

- State-of-the-art, engineered and patented energy efficient system development.

Market Diversification

- Telecommunications
- Computer Rooms
- Electronic Manufacturing
- Textile
- Woodworking
- Printing
- Paper Storage
- Food Storage
- Hospitals
- Office Buildings

Service

We trust this Guide answers your questions. We have more engineering data for your use and we are ready to help you solve your dry air problems. Give us a call!

Section II Basic Information

Relative Humidity and Its Place in Environmental Control

Since the beginning of modern day engineering, environmental control in factories, offices and homes has become increasingly more important as its benefits to personnel and product alike were realized. There are three basic parts to environmental control:

1) Air Quality - Its Cleanliness and Purity
2) Temperature
3) Relative Humidity

Of the three, the most ignored is the level of relative humidity-probably because the effects of temperature and air quality are more easily seen and felt than the effects of relative humidity. Relative humidity is important as it can affect human health and comfort, operation of production machinery, quality and workability of production material. Proper control of relative humidity can also be an important factor in the total energy use and operating efficiency of a factory. To develop an understanding of relative humidity and its effect, it is first necessary to define some terms.

Definition of “Relative Humidity”

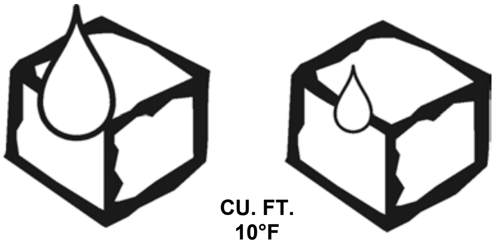
HUMIDITY is defined as “the amount of moisture in the air.” This moisture must be in the form of water vapor. Visible water droplets that have not evaporated to the vapor state do not affect humidity. The term RELATIVE HUMIDITY is used to describe “the amount of moisture in a given volume of air as compared with the greatest amount of moisture that that volume of air could contain at the same temperature, expressed as a percentage,” so that:

$$RH = \frac{Ma / t}{Mg}$$

Ma = Amount of Moisture in Air
Mg = Greatest Amount of Moisture in Air
t = Temperature

The greatest amount of moisture that a given volume of air can contain changes as the temperature of that air changes. The higher the temperature of that air, the greater the amount of moisture it can hold when saturated. The key word here is “temperature.” For example: a cubic foot of air at 69°F can hold ten (10) times as much moisture as the same cubic foot of air at 10°F.

FIGURE 1



“Dry Air” from Heating

If that cubic foot of air is saturated at 10°F (100% R.H.) and raised to 69°F, without adding or subtracting any moisture, it will now contain only 1/10 the amount of moisture it could hold at saturation; thus it now has a relative humidity of 10%2-1/2 times drier than the Sahara Desert!

This is essentially why, during the heating season, air is drier. The cold, moist outdoor air, brought in by forced air makeup, exhaust, or natural infiltration is heated and becomes warm dry air. To bring this air to an acceptable level of relative humidity, moisture must be added.

“Dry Air” from Cooling

Under certain conditions, cooling by air conditioning and refrigeration can remove moisture from the air and reduce its relative humidity to unsatisfactory low levels. This occurs when the air is cooled below its DEW POINT-the temperature at which the air becomes saturated and if cooled further the excess moisture will condense out of the air. For example: Air at 70°F and 75% R.H. will have about 6.08 grains of moisture per cubic foot.

Air at 55°F can hold only 4.89 grains of moisture per cubic foot at saturation. Therefore, if the 70°F 75% R.H. air is cooled to 55°F it will now be at 100% R.H. and will contain a maximum of 4.89 grains of moisture per cubic foot having lost the excess of 1.19 grains (6.08-4.89 = 1.19) by condensation. When this 55°F 100% R.H. air is discharged back into the room and again warms to 70°F it will now have a relative humidity of 60% since it now contains only 4.89 grains of moisture per cubic foot instead of the original 6.08 grains. 1.19 grains of moisture per cubic foot must now be added to return the air to its original level of 75% R.H.

The Psychrometric Chart

To further illustrate the moisture holding ability of air at various temperatures, following is a chart showing the grains of water per cubic foot of saturated air, at various temperatures. This chart was abstracted from the ASHRAE Handbook.

TABLE 1A

GRAINS OF WATER PER CUBIC FOOT
Saturated Air, Various Temperatures

F.	Grains	F.	Grains
0	.475	60	5.795
5	.609	65	6.845
10	.776	70	8.055
15	.984	75	9.448
20	1.242	80	11.04
25	1.558	85	12.87
30	1.946	90	14.94
35	2.376	95	17.28
40	2.863	100	19.95
45	3.436	105	22.95
50	4.106	110	26.34
55	4.889	115	30.13

As you can see, from the above Table 1-A, as the temperature of the air increases, so does its ability to hold moisture. Determinations of MAXIMUM HUMIDIFICATION DEMAND LOAD are made from this chart. To determine a heating humidification load, simply take the maximum indoor and minimum outdoor temperatures, refer to the chart above, and write down the corresponding grains of moisture. Then multiply these times the percent of relative humidity desired. Use the lowest design R. H. for the outdoor figure. Now subtract the lower temperature figure from higher temperature figure and insert the result into the following formula for Grains/Cu. Ft., also inserting the cubic foot of air to be humidified per hour:

$$\underset{\text{(Lbs. Water/Hr.)}}{\text{LOAD}} = \frac{\text{Grains/Cu. Ft. X Cu. Ft./Hr.}}{\text{7000/Grains/lb.}}$$

Other factors influencing the maximum humidification demand load are:

- Natural Air Infiltration
- Exhaust Equipment
- Make-up Air
- Construction of Building
- Air Conditioning or Refrigeration
- Vacuum Equipment
- Vapor Barriers
- Window Area
- Hygroscopic Material

Because of all the factors involved, humidification can be simple or rather complicated. It is best to consult a humidification expert such as TRION and allow them to conduct a humidification survey.

Equilibrium Moisture Content

Dry air pulls moisture from everything it contacts-HYGROSCOPIC materials (able to absorb or emit moisture), living tissues, etc. Conversely, moist air gives up moisture to dry hygroscopic materials. An equilibrium will eventually be reached when the moisture gain of a material equal its moisture loss. This is the EQUILIBRIUM MOISTURE CONTENT OR “EMC.” This “EMC” changes with temperature, R.H. and from material to material. The reaching of this “EMC” can sometimes be detrimental as we shall see.

“Regain” Of Hygroscopic Materials

All hygroscopic materials-and a long list is so classified take on or give off moisture when the EMC is disturbed. At a given level of R.H. a given hygroscopic material will hold a certain amount of moisture. The weight of this moisture so help compared with the dry weight of the material is called “Regain” and is expressed as a percentage. Regain varies with R.H. for a given material. For example: EMC values for average wood are 5.9% Regain with 30% R.H. air; 9.3% Regain with 50% R.H. air; 14% Regain with 70% R,.H. air; etc. A standard Regain is often specified for hygroscopic items sold by weight. If the standard Regain is not attained, economic loss to the seller results.

Variations in Regain cause hygroscopic materials to change in dimensions, weight, quality, workability, etc.; therefore, it is best to stabilize the Regain at the most desirable level for manufacturing, processing, testing, storage, use, consumption, etc. To do this, the R.H. of the air in contact with the material must be stabilized at the proper level, as we shall see.

“Dry Air” And Comfort

Dry air pulls moisture from anything it contacts, including the human body. Dry air will cause moisture to evaporate more readily from the surface of the skin, causing a feeling of chilliness-even at temperatures as high as 75°F! Dry air also pulls moisture from living membranes, such as the nasal passages, throat, eyes and ears, leading to the uncomfortable parched throat and sore eyes of winter. Proper control of relative humidity can help to eliminate these problems.

When moisture evaporates from the surface of the skin it causes a degree of evaporative cooling. During the winter, when heated air is dry, this evaporation occurs more readily, causing a higher degree of evaporative cooling and a feeling of chilliness. Raising the temperature will help alleviate the feeling of chilliness, but will actually aggravate the other problems of dry, parched throat and eyes, because the air at this higher temperature can now hold still more moisture (refer to Table 1 -A), which causes the R. H. to drop and the pull for moisture from body to air becomes even greater.

More comfort can readily be obtained by raising the level of relative humidity. Often, by raising the R.H. the temperature can then be lowered while maintaining the same comfort level. The following Table 1 -B illustrates various comfort levels possible. As you can see from the chart, raising the R.H. could result in your being able to lower the temperature, thereby saving energy. In this age of expensive energy, this could be a big boost for any industry, office or home. In addition the annoying parched throat, sore eyes and dry nose may be eliminated. Generally, R.H. levels of 35% to 50% are considered to be in the comfort range.

TABLE 1B

Comfort At Various Levels of Relative Humidity And Temperature

Factory		Office	
°F	% R.H.	°F	% R.H.
65	40	68	45
68	30	70	40
72	20	76	25
78	10	79	20

Humidity And Dust

Dust is not only a cleaning and maintenance nuisance but a common vehicle for microorganisms. It is well known that the R.H. of the air will significantly affect the amount of dust in the air. A higher level of R.H. (50%) will cause the particles to settle out of the air.

Also, dry air will pull moisture from the fibers of carpets and rugs causing them to become brittle, break off and float in the air. By raising the level of R.H. in the air this problem can be significantly reduced. For example, in one study a carpet cleaned weekly, under low levels of relative humidity, produced 3 to 4 bags of broken fibers or “fuzz.” After the R.H. in the office was raised to 50% the weekly cleaning produced only a half bag of “fuzz.” Needless to say, the carpet life was probably extended, as well as a reduction of dust from the fibers of the carpet achieved. Humidity And Its

Effect On Bacteria And Virus Life

Several studies on various bacterial strains and viruses have shown that at R.H. levels close to 50% these microorganisms fail to survive for long periods of time. Possible explanations of this are that at low levels of R.H. these microorganisms can enter a “dormant” state and simply float around in the air until such time as they contact a moist surface where they can become “active” again. At high levels of R.H. there is enough moisture in the air that these microorganisms may be able to thrive “actively.” In the middle levels of R.H., near 50%, there is enough moisture in the air that these microorganisms cannot remain “dormant,” but not enough that they can thrive “actively” either.

“Dry Air” And Static Electricity

Dry air permits the buildup of static electricity charges on machinery, materials and people. These electrostatic charges may cause production problems because of the electrostatic attraction built up between materials, unpleasant shocks to personnel, and in some cases, explosion hazards.

Static electricity charges are built up by movement of machinery and materials, such as in a printing press or a spinning machine, by people walking across carpeted floors, etc. These charges are constantly being generated and their buildup and discharge are affected by the level of R.H. Relative humidity levels above 45% will serve to eliminate electrostatic charge buildup and discharge. What happens when R.H. is higher is that an invisible moisture film will form on the surface of materials and equipment. This film contains impurities, from the air, which allow it to be a conductor. As electrostatic charges are generated, this film conducts the charges to ground before they can build up sufficiently high to cause a spark to jump.

Control of static electricity is important in many industries. Printing plants need to eliminate the static electricity caused problems of erratic feeding, sticking sheets, tacky ink and misregistration of color. Textile mills can ill afford to have huge electrostatic charges build up on spindles and cards.

Data Processing is especially sensitive to static electricity as it can cause malfunction by improper feeding of cards and paper, brittle tape and electrostatic discharges. Explosive production areas must be humidified. To chance a static discharge in an explosive atmosphere is extremely dangerous.

"Dry Air" And Hygroscopic Materials

HYGROSCOPIC materials (those able to take on or give up moisture) are particularly sensitive to humidity changes in their environment. Materials so classified would include wood and wood products, paper and paper products, textiles, leather, ceramics, food and a long list of others.

These materials respond to their environment by taking on or giving up moisture, thereby changing their REGAIN. When these materials finally reach a balance, where they are stable and no longer take on or give off moisture, they are said to have reached their EQUILIBRIUM MOISTURE CONTENT (EMC).

When a hygroscopic material is stabilized at is EMC for a particular temperature and R.H., there is little effect on the material. The problems begin when the R.H. begins to drop and the air pulls moisture from the material, upsetting its EMC. When the material loses moisture it will shrink, warp, crack, check, become thirsty for solvents, etc. This causes problems not only with the material, but also with the machinery, finishing processes, coatings and so on. Weight and texture are also effected.

When the EMC is upset to the point of damaging a product (cracking, splitting, warping) and rendering it unsaleable, economic loss results. This includes the loss of any and all energy required to make that product, (from the raw material refining to the finished product) if the product must be scrapped, the additional energy input and labor expense if the product is reworked, down time when machinery is jammed or damaged and higher per piece costs if machinery must be run slower than normal to prevent electrostatic buildup. For example, one woodworking plant reported savings of $900 a week after introducing controlled humidity to the plant. One investment castings company reported savings of $4,800 per week and the textile industry was even more dramatic with $6,700 per week! These savings are realized from better product workability, faster machine operation and production of less non-saleable units. Following is a charge listing the Regain for several materials, after which we shall take a look at some industries in depth.

Table 1-C

Hygroscopic materials lose moisture to dry air…pick up moisture from humidified air. This can materially affect your profit!

REGAIN OF HYGROSCOPIC MATERIALS

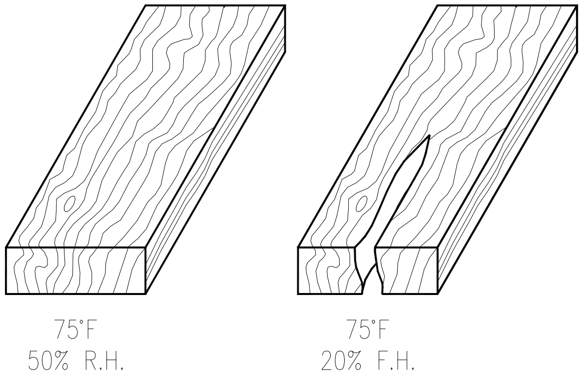
Moisture Content expressed in Per Cent of Dry Weight of the Substance at Various Relative Humidities – Temperature 75°F.

Industry Materials		**Relative Humidity - %**								
		10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**
Baking:	Crackers	2.1	2.8	3.3	3.9	5.0	6.5	8.3	10.9	14.9
	Flour	2.6	4.1	5.3	6.5	8.0	9.9	12.4	15.4	19.1
	White Bread	0.5	1.7	3.1	4.5	6.2	8.5	11.1	14.5	19.0
Leather:	Sole Oak, tanned	5.0	8.5	11.2	13.6	16.0	18.3	20.6	24.0	29.2
Printing:	Paper – Comm. Ledger – 75% Rag. 1% Ash	3.2	4.2	5.0	5.6	6.2	6.9	8.1	10.3	13.9
	Paper – M.F. Newsprint – 24% Ash	2.1	3.2	4.0	4.7	5.3	6.1	7.2	8.7	10.6
	Paper – White Bond Rag – 1% Ash	2.4	3.7	4.7	5.5	6.5	7.5	8.8	10.8	13.2
	Paper – Writing – 3% Ash	3.0	4.2	5.2	6.2	7.2	8.3	9.9	11.9	14.2
Textile:	Cotton –Absorbent	4.8	9.0	12.5	15.7	18.5	20.8	22.8	24.3	25.8
	Cotton – American-cloth	2.6	3.7	4.4	5.2	5.9	6.8	8.1	10.0	14.3
	Cotton – Sea Isle-roving	2.5	3.7	4.6	5.5	6.6	7.9	9.5	11.5	14.1
	Hemp – Manila & Sisal	2.7	4.7	6.0	7.2	8.5	9.9	11.6	13.6	15.7
	Jute – Average grade	3.1	5.2	6.9	8.5	10.2	12.2	14.4	17.1	20.2
	Linen – Dry Spun – yarn	3.6	5.4	6.5	7.3	8.1	8.9	9.8	11.2	13.8
	Rayon – Cellulose – Acetate-Fibre	0.8	1.1	1.4	1.9	2.4	3.0	3.6	4.3	5.3
	Rayon – Cupramonium – Average Skein	4.0	5.7	6.8	7.9	9.2	10.8	12.4	14.2	16.0
	Rayon – Vicose Nitrocel	4.0	5.7	6.8	7.9	9.2	10.8	12.4	14.2	16.0
	Silk – Raw Cheyennes – Skein	3.2	5.5	6.9	8.0	8.9	10.2	11.9	14.3	18.8
	Wool – Australian – Marino - Skein	4.7	7.0	8.9	10.8	12.8	14.9	17.2	19.9	23.4
	Cigarette	5.4	8.6	11.0	13.3	16.0	19.5	25.0	33.5	50.0
Wood:	Timber – Average	3.0	404	5.9	7.6	9.3	11.3	14.0	17.5	22.0
	Glue – Hide	3.4	4.8	5.8	6.6	7.6	9.0	10.7	11.8	12.5
Miscellaneous:	Charcoal – Steam Activated	7.1	14.3	22.8	26.2	28.3	29.2	30.0	31.1	32.7
	Gelatin	0.7	1.6	2.8	3.8	4.9	6.1	7.6	9.3	11.4
	Silica Gel	5.7	9.8	12.7	15.2	17.2	18.8	20.2	21.5	22.6
	Soap	1.9	3.8	5.7	7.6	10.0	12.9	16.1	19.8	23.8
	Starch	2.2	3.8	5.2	6.4	7.4	8.3	9.2	10.6	12.7

Woodworking And Humidification

In the woodworking industry controlled humidification can often mean the difference between a profitable operation and bankruptcy. A company, manufacturing wood products, that must reject one (1) out of ten units due to cracking, warping, splitting or checking suffers losses due to wasted raw materials, wasted labor and wasted energy in the production of nonsaleable items. These losses can be profound-particularly the energy loss, as this goes all the way back to the cutting of the tree and transporting of the lumber. If the damaged unit can be reworked there is still the added cost of doing so. These losses and added costs must be added to the costs of producing the other nine out of ten saleable units. It is not hard to see why controlled humidification can result in substantial savings for the woodworking industry.

Figure 2



How Is Wood Affected By Humidity?

Wood is a hygroscopic material, able to take on or give up moisture to the surrounding air. As wood takes on moisture it swells. As it gives up moisture it shrinks. It does so in response to the changing atmospheric conditions of temperature and humidity, humidity having the greater effect. The amount of moisture in the wood, expressed as a percentage of its dry weight, is referred to as its REGAIN. This Regain varies with temperature, relative humidity and type of material. When the Regain of a piece of wood reaches a balance, where it is no longer taking on or giving up moisture, it is said to have reached its EQUILIBRIUM MOISTURE CONTENT (EMC) for that particular temperature and R.H. At this state the wood is stable and will not change dimensionally. The EMC changes with temperature and R.H. For example, a piece of wood with an EMC regain of 9.3% at 75F 50% R.H. will have an EMC regain of only 4.4% at 75°F 20% R.H. (See Table 1-C.)

Why Does Wood Crack Or Warp?

As wood loses moisture it shrinks. However, the tangential shrinkage is much greater than the radial shrinkage. This causes dimensional changes and instability in the wood and the wood pulls apart, along the grain causing cracks. If the wood is strong enough not to crack it will warp as the uneven shrinkage occurs. This is why it is important to condition wood to the proper Regain for best workability and then stabilize it at the corresponding EMC by maintaining proper humidity control.

What Is The Best R.H. For Wood?

The Regain should be between 5%-9% depending on the species of wood and its use. This regain corresponds to the EMC with 35%--45% R.H. air at 75°F. If you are able to maintain the proper EMC Regain in the wood by maintaining the proper R.H. in the air surrounding it, rejects will be sharply reduced, production efficiency increased and profits increased!

What About Gluing And Finishing?

When dry thirsty air pulls moisture from it, the wood also becomes thirsty, so that when a varnish or other coating is applied the dry wood will act like a sponge and quickly absorb the liquid. This leads to a dull finish or excessive use of coating to produce a bright finish. Glue will not cure properly or quickly if the air and wood that it is in contact with are too dry.

What R.H. Do I Need For Gluing And Finishing?

Generally, 40%-50% R.H. is recommended for gluing and a minimum of 60% R.H. recommended for finishing areas. You must remember that if wood has not been conditioned previously and enters the humidified gluing and finishing areas dry and thirsty, it will still produce the problems experienced before. It is important to maintain the stability of your wood, from start to finish, by proper humidity control. The economic gains from proper humidity control, can often pay for the equipment in less than one year.

Paper Products And Humidification

The common problems experienced in every paper industry, whether it involves manufacture of cardboard boxes, sheet paper, etc. are: curling of stock, cracking on folds of paper or boxes, failure to feed properly into machines and glue that won't hold. Generally these problems are experienced in the winter heating season when the R.H. indoors is low. Once again, the cause of these problems is moisture loss from materials.

Paper and paper products are made up of fibrils. When these fibrils lose moisture they shrink and become brittle. This brittleness contributes to cracking when the paper or cardboard is folded, stretched or deformed. Weight and strength are also reduced by this loss of moisture. Glues sometimes will not hold, (for the same reasons as discussed in woodworking) and printing of cardboard boxes dulls or misregisters.

The recommended Regain of cardboard is 5% to 7%. This corresponds to the EMC with air in the range of 40%-50% R.H., depending on the composition of the paper. (Refer to Table I -C.) Maintaining a proper level of R.H. will result in less scrap, less rejects and increased production efficiency

Printing And Humidification

The problems suffered in the printing industry are basically the same as those found in the paper products industries. The specific problems of the printing industry would include: brittle paper, curling edges, smeared ink and electrostatic attraction between papers and rolls. These problems are, once again, caused by dry air pulling moisture from the fibers in the paper.

Paper curling is caused because, as in paper products, moisture loss causes uneven shrinkage of the paper and causes it to curl with the grain. This leads to difficult handling and web breakage as paper is fed through the press.

An additional problem encountered in the printing industry is that of electrostatic charge accumulation. As paper is unwound off a roll, or papers are shuffled against each other, they build up electrostatic charges which cause attraction between sheets and rolls. The result is to cause the paper unwinding off a roll to pull taut. This also occurs as the charged paper is attracted to the rollers in the press. These attractions put undue stress on the paper and, since paper under these conditions would be dry and brittle, web breakage, misregistration of colors, smeared ink and foldingjogging problems result. These problems are best eliminated by maintaining a R.H. above 45%.

The recommended level of R.H. needed in the printing industry is roughly the same as that needed for paper products, again depending on the composition of the paper. Newsprint, which is generally about 24% Ash, would require 50%-65% R.H. Writing paper, generally about 3% Ash, requires 40%-50% R.H. (Refer to Table 1-C.)

Textiles And Humidification

Humidification is vital to the textile industry, both for material value and operation efficiency. When the R.H. is too low, the fibers become brittle and will break causing shutdown of machinery and excessive “fly” in the air. Huge electrostatic charges can be built up as textiles are spun and wound. These charges also slow down equipment. Losses from production problems caused, by dry air can amount to more than $7,000 per week!

There are also economic reasons to humidify in the textile industry. The fibers used in textiles are hygroscopic and as such can increase or decrease in weight as they take on or give up moisture. For example, a cotton yarn shipment of 1,000 pounds that is a 2% Regain will contain 20 pounds of water. Another shipment at 8% Regain contains 80 pounds of water. Both shipments weigh 1,000 pounds, including the water, but the one with 2% Regain has 60 more pounds of cotton. If the selling price of this cotton is $.40 per pound it costs the manufacturer of the 2% Regain yarn 60 x $.40 = $24.00 to provide cotton in place of water to match the weight of his competitor’s shipment. You can see where selling a hygroscopic material by weight at less than the proper Regain not only is detrimental to the material but also economically unsound.

The Regain of textile fibers should be between 6%-15% depending on the type of fiber and its use. This Regain corresponds to an EMC Regain with 50%-70% air. Care should be taken in choosing the proper humidification system for a textile plant, because of the dirty atmosphere in these areas. Since humidification must be used all year round in textile plants, steam is not always the best answer. It is best to consult a humidification expert.

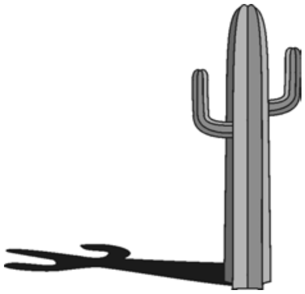
Food Storage, Processing And Humidification

Almost all foods are hygroscopic and will be affected by humidity, or lack of it, with regards to quality, texture, freshness and taste. Potatoes stored in special humidified and cooled areas stay meatier and resist sprouting and spoiling for longer periods of time. Apples stored in a proper humidity controlled environment will last longer in a fresh saleable state. Meats processed in controlled humidity retain their quality and bright moist color.

Many ripening fruits and vegetables can be enhanced by proper humidity control. The level of R.H. in food storage and processing areas is often high-as high as 95% R.H. while temperature must be kept low. Because of this low temperature and high humidity the best humidification equipment for this application is usually atomizing equipment, since it will add some evaporative cooling. (As we shall see later on.) For the proper humidification level of R.H. needed for a particular food, consult Table 1-D.

Leather Processing And Humidification

Proper levels of controlled humidity (40%-60% R.H.) will keep leather soft and pliable, helping it to resist cracking when handled and worked. Leather should be stored in a humidity controlled environment before working it to ensure that it is soft, pliable and at the proper regain. Different tanning processes will require different levels of R.H. (See Table 1 -D.)



DRY
AIR
“KILLS”
PRODUCTS

A Humidification Synopsis

There is not a single industry that cannot use humidification in some area of production, either for material or personnel benefit. Offices, hospitals, nursing homes, libraries, museums, furniture stores, bowling alleys, etc., all contain hygroscopic materials (wood, carpets, etc.) which can be damaged by dry air. Proper humification protects these materials and also safeguard the comfort of personnel in these areas. For an overview of some industries and their humidity requirements see Table I -D following. If your particular industry is not listed, contact TRION/HERRMIDIFIER, and we will supply you with a humidification fact sheet for your industry telling you why proper humidification is needed and how it can be accomplished.

Table 1-D

RECOMMENDED HUMIDITIES AND TEMPERATURES FOR VARIOUS INDUSTRIES

Industry	Degrees Fahrenheit	Relative Humidity	Industry	Degrees Fahrenheit	Relative Humidity
Baking			**Hospitals:**		
Cake mixing	70-75	65%	Nurseries	75	50-65%
Crackers & biscuits	60-65	50%	Operating room	75	55%
Fermenting	75-80	70-75%	Patients’ rooms	75	40-50%
Flour storage	65-80	50-65%	**Laboratories**	As required	
Loaf cooling	70	60-70%	**Leather**		
Make-up room	75-80	65-70%	Chrome tanned (dying)	120	45%
Mixer-bread dough	75-80	65-70%	Vegetable tanned (drying)	70	75%
Proof box	90-95	80-90%	Storage	50-60	40-60%
Yeast storage	32-45	60-75%	**Libraries & Museums**	70-80	40-50%
Bowling Centers	70	35-45%	**Paint Application:**		
Cereal: packaging	75-80	45-50%	Air drying lacquers	70-90	60%
Confectionary:			Air drying oil paint	60-90	60%
Chocolate covering	62-65	50-65%	**Paper Products:**		
Centers for coating	80-85	40-50%	Binding	70	50-65%
Hard candy	70-80	30-50%	Printing & Folding	75-80	45-55%
Storage	60-68	50-65%	Storage	75-80	40-60%
Cork Processing	80	45%	**Schools**	72	35-50%
Computers:			**Textiles:**		
Data Processing	70-75	45-55%	Cotton – carding	75-80	50-55%
Computer Mfg & Assembly	70-75	45-55%	Cotton – spinning	60-80	50-70%
Electrical:			Cotton – weaving	68-75	85%
Mfg. Cotton covered wire	60-80	60-70%	Rayon – spinning	80	50-60%
Storage – general	60-80	35-50%	Rayon – throwing	70	85%
Food:			Silk Processing	75-80	65-70%
Apple storage	30-32	75-85%	Woolens – carding	80-85	65-70%
Banana – ripening	68	90-95%	Woolens – spinning	80-85	50-60%
Banana – storage	60	85-90%	Woolens – weaving	80-85	60%
Citrus fruit – storage	60	85%	**Tobacco:**		
Egg storage	35-55	75-80%	Cigar & cigarette	70-75	55-65%
Grain storage	60	30-45%	Other processing & storage	75	70-75%
Meat – beef aging	40	80%	Casing room	90	88-95%

Section III Load Calculations

Knowing that controlled humidification is needed is the first step toward increasing productivity and cutting losses. The second, and most important step, is to accurately determine the amount of moisture required to be added to the air to reach the target R.H. level. A humidification project that starts out with good intentions can fall flat because the demand load was not calculated accurately and too little or too much humidification equipment was installed. Following is a simple, accurate guideline for determining your MAXIMUM HUMIDIFICATION DEMAND LOAD. Help with calculating this can be obtained by returning form I/C DI-5 to TRION/ HERRMIDIFIER.

The Psychrometric Chart

All humidification calculations involve knowing the maximum amount of moisture a given quantity of air can hold at saturation (100% R.H.), and being able, by calculations, to compare this with the amount of moisture present and that which is desired in that air. The amount of moisture in the air is measured in grains per cubic foot. This figure is used in calculations to eventually arrive at a demand load, in pounds per hour, for the area to be humidified. The following Table 2-A shows the grains of moisture per cubic foot of air at specific temperature.

There are basically three (3) humidification load factors and two (2) humidification reduction factors:

HEATING LOAD: For desired R.H. at maximum indoor temperature maintained when outdoor temperature is at minimum heating design level.

COOLING LOAD: To replace moisture removed by condensation from cooling process -- air conditioning and/ or refrigeration.

PRODUCT LOAD: To condition product to final desired Regain when received under other conditions. This load could be plus or minus.

PROCESS REDUCTION: Moisture vapors emitted by processes decrease humidification load.

PEOPLE REDUCTION: People give off 0.2 lbs. per hour when seated; 0.9 lbs. per hour when active, thereby decreasing humidification load. We shall take a more, in depth, look at these factors in this section.

Table 2-A

MOISTURE CONTENT OF AIR

Grains Per Cubic Foot – 100% R.H.

°Fahrenheit	Grains	°Fahrenheit	Grains
-10	.29	52	4.41
-5	.37	53	4.56
0	.48	54	4.72
5	.61	55	4.89
10	.78	56	5.06
15	.99	57	5.23
20	1.24	58	5.41
25	1.56	59	5.60
30	1.95	60	5.80
31	2.04	61	6.00
32	2.13	62	6.20
33	2.21	63	6.41
34	2.29	64	6.62
35	2.38	65	6.85
36	2.47	66	7.07
37	2.56	67	7.31
38	2.66	68	7.57
39	2.76	69	7.80
40	2.86	70	8.10
41	2.97	71	8.32
42	3.08	72	8.59
43	3.20	73	8.87
44	3.32	74	9.15
45	3.44	75	9.45
46	3.56	76	9.75
47	3.69	77	10.06
48	3.83	78	10.40
49	3.97	79	10.80
50	4.11	80	11.04
51	4.26	81	11.40
82	11.75	107	24.26
83	12.11	108	24.93
84	12.49	109	25.62
85	12.87	110	26.34
86	13.27	111	27.07
87	13.67	112	27.81
88	14.08	113	28.57
89	14.51	114	29.34
90	14.94	115	30.13
91	15.39	120	34.38
92	15.84	125	39.13
93	16.31	130	44.41
94	16.79	135	50.30
95	17.28	140	56.81
96	17.80	145	64.04
97	18.31	150	72.00
98	18.85	155	80.77
99	19.39	160	90.43
100	19.95	165	101.00
101	20.52	170	112.60
102	21.11	175	125.40
103	21.71	180	139.20
104	22.32	185	154.30
105	22.95	190	170.70
106	23.60	195	188.60

Heating Load

To determine the maximum demand load due to heating observe the following steps.

Step 1. Determine the amount of moisture which must be added per cubic foot of air to be humidified. As you know, heating air lowers its R.H., but does not obliterate it, so the moisture already in the cool air before heating must be determined and subtracted since this moisture is already available in the heated air. Using Table 2-A, first determine the maximum design indoor temperature and record the grains of moisture listed to the right of that temperature, then multiply the grains (at 100% R.H.) times the desired level of R.H. (a percentage) to arrive at the grains of moisture per cubic foot of air necessary to maintain the desired R.H.

ALWAYS CONSULT AN EXPERT AT THE START!

Now take the minimum design outdoor temperature (you are essentially heating infiltrated outdoor air) and its grains of moisture (at 100% R.H.) times the minimum expected R.H. to arrive at the moisture content already available before heating.

Next simply subtract the outdoor design moisture from the indoor design moisture and arrive at the grains of moisture per cubic foot of air needed to be added to the heated air to reach design conditions of R. H.

Example: (From Table 2-A)

Indoor Design Moisture @ 70°F 65% R.H.
8.10gr. x .65(%) = 5.2 gr./cu. ft.

Outdoor Design Moisture @ 0°F 50% R.H.
.48gr. x .50(%) = .24 gr./cu. ft.

Indoor Design Moisture = 5.26 gr./cu. ft.
- Outdoor Design Moisture = .24 gr./cu. ft.
Moisture to be Added = 5.02 gr./cu. ft.

Step 2. Determine the maximum volume of air per hour that will need to have moisture added to it. Natural ventilation, exhaust and makeup air must be considered. You should use the largest of these, but not all three.

Example: A large woodworking plant.

(1) The area of the plant is 100' x 200' x 15'H = 300,000 cu. ft. - If it is tight construction, you would use one air change per hour. If it is loose or old construction - 1-1/2 air changes per hour. Three or four exposed walls and shipping doors - 2 air changes per hour. Never use less than one air change per hour unless sealed off with no traffic in or out. In this example, the building has four exposed walls and two shipping doors. Volume of air to be humidified is 300,000 cu. ft. x 2 = 600,000 CFH.

(2) The plant contains exhaust equipment exhausting 20,000 CFM to the outside. This volume would be 20,000 CFM x 60 min./hr. = 1,200,000 CFH. (Note that this volume is greater than the volume calculated by plant area.)

(3) The plant has a makeup air system that supplies 15,000 CFM of outside air to the plant. This volume is 15,000 CFM x 60 min./hr. = 900,000 CFH.

The greatest volume of air is due to the exhaust - 1,200,000 CFH. This is the maximum volume of air that must be humidified in any given hour. You will note that we are exhausting 1,200,000 CFH but making up only 900,000 CFH. The balance of 300,000 CFH is brought in by forced infiltration through cracks around doors, windows, etc. It is not this exhaust that we wish to humidify but rather, the air replacing it. Step 3. THE MAXIMUM HEATING DEMAND LOAD is now calculated using the following formula:

(step 1) (step 2)
gr. Moisture Needed/cu. ft. x CFH Air =
7,000 gr./lbs.

lbs. of water per hour required.

or, from the example:

5.02 gr./cu. ft. x 1,200,000 CFH = 860 lbs./hr.water
7,000 gr./lbs.

So, the MAXIMUM HEATING DEMAND LOAD for the woodworking plant in the example would be 860 lbs. of water needed to be added per hour when the outside air is at 0°F.

Traditional heating systems are rather easy to calculate humidification demand loads for, however, with the advent of economizer cycle heating and cooling systems this calculation gets a bit more complicated as we shall see.

Heating Load: Economizer Cycle

In air handling systems using the economizer cycle, outside air is added to return air in varying quantities to provide a set mixed air temperature reaching the heating/cooling section of the system. The amount of outside air added is based on the outside air temperature and the desired mixed air temperature to be maintained. This volume of outside air is added automatically in varying amounts as the outside air temperature changes. THE MAXIMUM DEMAND LOAD FOR HUMIDIFICATION is based on the desired indoor conditions the moisture content of the outside air added and the volume of outside air being introduced.

Weather Data and Design Conditions (from the ASHRAE Handbook) do NOT give sufficient information to determine the moisture content of outside air at various temperatures. It is necessary to seek assistance from the U.S. Weather Bureau, Aviation Weather or the like in the area in which the plant is located. You will need to know the MINIMUM level of relative humidity experienced at the outside design temperature in the area and for 1O°F increments up to the temperature at which I00% outside air is admitted. With this data and the characteristics of the system, you can then calculate the demand load for each outside temperature. The highest load calculated becomes the maximum demand load for humidification. This maximum demand load will occur at some outside air temperature OTHER THAN design temperature when the Economizer Cycle is used. Following, in Tables 2-B and 2-C, are typical characteristics of two economizer cycle systems.

TABLE 2-B: ECONOMIZER WITH 70°F RETURN AIR

Mixed Air Temp. °F	% OUTSIDE AIR REQUIRED AT TEMP. SHOWN °F									
	-10°	0°	+10°	+20°	+30°	+40°	+50°	+55°	+60°	+65°
50°	25	29	33	40	50	67	100			
55°	19	21	25	30	38	50	75	100		
60°	12	14	17	20	25	33	50	67	100	
65°	6	7	8	10	13	16	25	33	50	100

TABLE 2-C: ECONOMIZER WITH 75°F RETURN AIR

Mixed Air Temp. °F	% OUTSIDE AIR REQUIRED AT TEMP. SHOWN °F									
	-10°	0°	+10°	+20°	+30°	+40°	+50°	+55°	+60°	+65°
50°	30	33	38	45	56	71	100			
55°	23	26	31	36	44	57	80	100		
60°	18	20	23	27	33	43	60	75	100	
65°	12	13	15	18	22	29	40	50	67	100

The above information must be provided for the system being used. Tables 2-B and 2-C are typical only. Therefore the HUMIDIFICATION DEMAND LOAD for an economizer system such as that shown in Table 2-B could be calculated as follows:

EXAMPLE:

Indoor Design Conditions: 70°F 40% R.H. (8.10x.40=3.24 gr/CF)
Outside Design Temperature: -10°F

Mixed Fair Temperature: 55°F
System CFM: 30,000

Outside Temp. °F	% R.H. Minimum [1]	Outside gr/CF[2]	% Air[3] (Outside)	CFM Air (Outside)	gr to Add*	Load lb/hr
-10	70	.203	19	5,700	3.037	148
0	65	.312	21	6,300	2.928	158
+10	60	.468	25	7,500	2.772	178
+20	55	.682	30	9,000	2.558	197
+30	50	.975	38	11,400	2.265	221
+40	45	1.260	50	15,000	1.980	254
+50	40	1.644	75	22,500	1.596	308
+55	35	1.712	100	30,000	1.528	393

[1] From Weather Bureau; [2] From Table 2-A; [3] From Table 2-B above; *7,000 gr/lb.

Information in (1) above is the key to the solution. The maximum demand load for Humidification for systems using the Economizer Cycle is almost always at some outside temperature other than the design temperature for the heating system.

Notice that the MAXIMUM HEATING DEMAND LOAD in this example is 393 lbs./hr. which occurs at 55°F, not at design outdoor temperature as with traditional heating systems. Therefore, any humidification system installed to handle this load will have to have a maximum capacity of 393 lbs./hr. water output.

Cooling Load

As we have seen, moisture is removed by condensation during the cooling process as the air is cooled below its dew point and then reheats to room temperature. This condensed moisture must be replaced when its loss causes the R.H. to fall too low. To determine the maximum demand load due to cooling observe the following steps:

Step 1. Determine the amount of moisture per cubic foot of air that will be removed by condensation during the cooling process as this will have to be replaced. This is done by using Table 2-A to determine the grains of moisture per cubic foot of air at indoor design temperature and R.H., then determining the grains of moisture per cubic foot of air after it has been cooled and subtracting this figure from that obtained for the design temperature and R.H.

In determining the amount of moisture in the air after it has been cooled, it is necessary to know the air temperature drop across the cooling coils. This is usually a 15°F drop with standard air conditioning equipment, but can vary from manufacturer to manufacturer. It is best to check. Further, the R.H. of the air after cooling will be about 85% rather than 100% because, only that portion of the air in contact with the cooling coils will be cooled to coil temperature with condensation resulting. The coil temperature will be less than the exit air temperature. The following example will illustrate Step 1.

Example: 60 Tons Air Conditioning (Standard) Maintaining 70°F at 65% R.H.

Moisture Content of Air at Design
70°F, 65% R.H. = 8.10 gr./CF x .65(%) = 5.26 gr./CF
- Moisture Content After Cooling
55°F, 85% R.H. = 4.89 gr./CF x .85(%) = 4.15 gr./CF
Moisture Removed During Cooling = 1.11 gr./CF

Therefore we must replace 1.11 grains of moisture per cubic foot of air to return the air to the desired condition of 70°F, 65% R.H. after cooling in this example.

Step 2. Determine the volume of air passing over the cooling coils per hour. This is usually about 400 CFM per ton of rated capacity for standard air conditioning equipment, but this may vary with the make of equipment. It is always best to check. Computer room air conditioning equipment is often designed for 500-800 CFM per ton of rated capacity.

Example: 60 Ton Air Conditioning

60x400 CFM = 24,000 x 60 min./hr. = 1,440,000 CFH

Step 3. Since almost all standard air conditioning equipment is usually slightly overrated to allow it to shut down periodically and defrost, it is necessary to determine the maximum “ON” time during any given hour, since this is when moisture is being removed from the air. This is usually 80%, but should be checked, as special equipment may be designed to cool rapidly and use less “ON” time.

Step 4. The MAXIMUM COOLING DEMAND LOAD for humidification can now be calculated using the following formula:

$$\frac{\text{gr./CF Needed x CFH x “ON” Time}}{\text{7,000 gr/lb.}} = \text{lbs./water req.}$$

Using the preceding examples in Steps 1-3:

$$\frac{\text{1.11 gr./CF x 1,440,000 CFH x.80 “ON”}}{\text{7,000 gr./lb.}} = \text{183 lbs. water/hr.}$$

In this example, the MAXIMUM COOLING DEMAND LOAD is 183 lbs. water/hr. Therefore, any humidification system installed to handle this load will have to have a maximum capacity of 183 lbs./hr. water output.

Cooling Load- Low Temperature (32°F-47°F)

In special applications, such as cold storage, the cooling equipment (refrigeration) is usually designed to have an air temperature drop across the coils of less than 15°F, to move a greater volume of air across the coils than the 400 CFM per ton experienced with standard air conditioning equipment and to have a definite “OFF” cycle for defrosting.

Air temperature drop across the coils can be considerably less than 15°F and must be known to accurately calculate the humidification demand load for cooling. Also, the CFM air flow across the coils is high and combined with the small temperature drop, across the coils, will result in less moisture being condensed out of the air onto the coils. Generally, its safe to figure the exit R.H. at about 90%-95% R.H. The “OFF” cycle for defrosting is a definite and planned period during each 24 hours and is usually expressed as “Runs 16 hours out of 24.” You should NOT correct for the “OFF” cycle in this case since the equipment runs continuously for 16 hours and will remove moisture that must be replaced, continuously.

Example: Design Conditions: 34°F 95% R.H.

Cooling Capacity: 30 Tons
24,000 CFM Across Coils
10°F Air Temperature Drop

Room Air: 34°F 95% R.H. = 2.29x.95(%) = 2.18 gr./CF
- Exit Air: 24°F 90% R.H. = 1.50x.90(%) = 1.35 gr./CF
Moisture removed by Cooling = .83 gr./CF

Using Humidification Demand Load Formula:
24,000 CFM x 60 min./hr.x.83 gr./CF = 170 lbs/hr. water
7,000 gr./lb.

Therefore, a humidification system designed to handle this demand must be able to supply a maximum of 170 lbs. water per hour. The above factors are for illustration. The individual factors must be determined for each special application. It is helpful to consult a humidification expert who, no doubt, has had prior experience with these special applications.

TRION/HERRMIDIFIER has had extensive experience in all fields of low temperature humidification, including cold storage as low as 34°F. For a list of previous installations or sizing and recommendations for your own application consult your TRION/HERRMIDIFIER Representative.

The dual-pneumatic atomizing system is particularly adaptable to cold storage humidification applications. It has been used successfully to maintain levels as high as 95% R.H. at temperatures as low as 34°F without wetting of floors.

Product Load

Many products made of or containing hygroscopic materials will absorb or give up moisture and as such will need to be conditioned to the proper Regain for shipment. This load only occurs as a viable factor in the overall MAXIMUM HUMIDIFICATION DEMAND LOAD when large amounts of products are being conditioned rapidly, such as textiles. The procedure for determining the product load is relatively simple if you observe the following steps.

Step 1. Determine the MAXIMUM change in Regain of the material during processing, using Table I-C to determine the Regain of the material before and after conditioning and find their difference.

Example: A plant processing 40 tons/hour of product received at 4% Regain and shipped at 5% Regain will need to add 1% gain as follows:

Shipping Regain = 5.0%
- Regain when received = (4.0%)
Gain = 1.0%

Step 2. Determine the MAXIMUM amount of product, in pounds, to be processed in any one hour.

Example:
40 tons/hr. x 2,000 lbs/ton = 80,000 lbs. hr.

Step 3. Calculate the MAXIMUM PRODUCT LOAD by taking the maximum amount of product processed per hour times the gain needed.

Example:
80,000 lbs./hr.x.01 (% gain) = 800 lbs. water/hour

Therefore, any humidification system designed for this application will have to have a maximum capacity of 800 lbs. water per hr. IN ADDITION to any heating or cooling load.

Process Reduction

From measurement or design data, determine the amount of moisture vapor being given off by any sources in the plant, such as hot water washes, steam curing, etc. This will decrease the maximum demand load for humidification whenever the process is in operation. Be sure it is effective at all times that the maximum demand load for humidification is being experienced.

People Reduction

People present in an area will give off moisture and, if enough people are present, can affect the maximum humidification load. People give off moisture at a rate of approximately .2 pounds per hour per person if seated and .9 pounds per hour per person if active. This moisture can be deducted from the maximum humidification demand load. Be sure these people are present at all times when the maximum humidification demand load exists, because when they leave, the maximum humidification demand load will increase by that amount and if the humidification system was designed for the load with people present, it will be undersized and unable to maintain the desired level of R.H. which could result in product damage.

Maximum Demand Load For Humidification

THE MAXIMUM DEMAND LOAD FOR HUMIDIFICATION for a plant or building consist of: the Heating or Cooling load, whichever is greater, plus or minus the Product load (if any), minus the Process reduction (if any) and the people reduction (if any). There are several other factors and pitfalls to be aware of. These will be discussed next.

Helpful Guidelines

1. Area to be humidified must be isolated from non-humidified areas as moisture travels to dry area by Dalton's Law of Partial Pressures. Open doors, elevator shafts, etc. will allow moisture to escape.

2. When a common air handling system is in use and the area to be humidified is served by a part of the system, you must consider the air and moisture lost to non-humidified areas in figuring demand load, or you must humidify all the air delivered to the humidified areas by the system; also, this moisture loss to other areas can cause problems in those areas if not properly controlled.

3. Be sure the structure will handle the level of relative humidity desired without damage due to condensation, etc. Moisture migration into wails with no vapor barrier can create problems. Vapor barriers must be installed properly to be effective in preventing moisture migration from humidified areas. All barrier joints must be air tight.

4. Consider the dew point of the humidified atmosphere and be aware of condensation problems that can occur on cold surfaces such as: steel roof deck, single glazed windows, aluminum window and door frames, etc. Dew point is the temperature at which condensation will begin to occur when the humidified air is cooled to that level.

5. Check the psychometrics and be sure the volume of air can absorb the amount of water vapor you will be adding. (DO NOT EXCEED 100% R.H.)

6. Cold air is difficult to humidity as it does not give up heat as readily. Special equipment must sometimes be used.

7. Cold fresh air make-up can cause condensation problems in ducts. Be careful where humidity is introduced.

8. "Free Cooling" using cold outside air can be costly by adding greatly to the maximum demand load for humidification. It is usually more economical to recirculate the humidified air and cool it, as required, using air conditioning or refrigeration equipment.

9. Be sure adequate services are available, or can be obtained; i.e., water, water pressure, electrical, compressed air, steam, etc.

10. It is critical to understand your water prior to selecting a humidification system. Forward a complete water analysis or water sample to TRION/HERRMIDIFIER and we can help you optimize your equipment selection or suggest water pretreatment to minimize maintenance and maximize performance.

11. For ducted applications, atomization systems require special application considerations to insure complete evaporation and no duct wetting. Proper selection of controls, modulation technique and installation location is critical to satisfactory performance. Please contact TRION/ HERRMIDIFIER for a copy of our "Herrmidicool Technical Manual" prior to designing your system.

12. Consider first cost, operating cost, installation cost and the equipment's ability to maintain your design conditions under your system psychrometric limitations. Water quality is vitally important as well. Simply using DI or RO water with a system does not eliminate potential water problems!

13. Any humidification system must be accessible for maintenance, especially periodic cleanings. Energy consumed in humidifying is of great importance. Be sure to consider the efficiency of the equipment you select.

TRION/HERRMIDIFIER is ready to assist you in selecting the proper equipment for any project-large or small. Call your TRION/HERRMIDIFIER Representative or send the "I/C DI-5 Design Information" form in this Guide to the Industrial/ Commercial Division.

Section IV Types of Equipment

There are basically three types of humidification equipment: Atomizing, Evaporative and Steam. The type of humidification equipment used for any application is extremely important and should be carefully selected with regards to the level of R.H. desired to be maintained, the amount of moisture needed to be added, services available, use of the area being humidified, feed water equality and energy efficiency. Following is an overview of each type of humidification equipment.

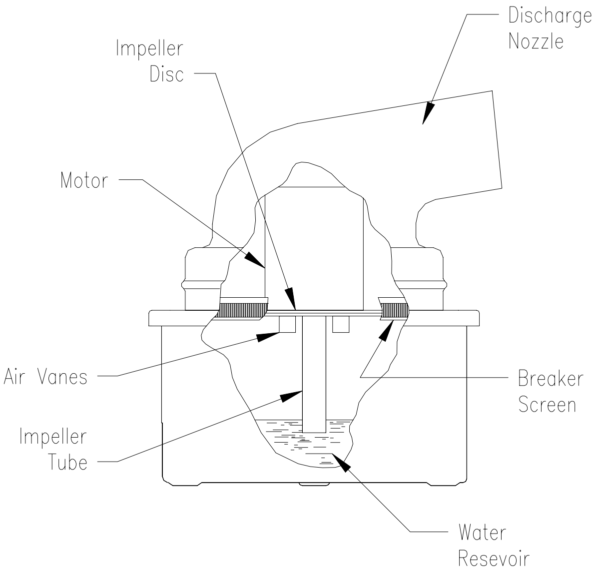
Atomization

This type of humidification equipment uses either CENTRIFUGAL or PNEUMATIC forces to break water up into a fine mist which is discharged into the atmosphere where it evaporates to the vapor state. This process is endothermic and takes latent heat from the air to evaporate the mist. (1 000 BTUs are required to evaporate one pound of water.) Because atomization takes only enough heat from the air as is needed to evaporate the water, it is usually a very efficient process. Atomizing equipment must be able to deliver tiny droplets of a consistent size over a relatively narrow size range. No large droplets should fall before turning to the vapor state as this may cause damaged goods, wet floors, etc. This puts physical limitations on capacities that can be realized and/or successfully applied in given situations under known conditions.

Every droplet in the fine mist has the same chemical makeup as the water supplied to the equipment. When the droplets evaporate to the vapor state, minerals are left behind in the form of a white powder-referred to as Mineral Fallout. Use of softened water does NOT alleviate this problem because in softening one mineral is simply being substituted for another. Demineralizers and use of the Reverse Osmosis Process will remove the minerals and prevent Mineral Fallout. This Mineral Fallout is usually not a problem except that it is undesirable in certain applications such as computer rooms and hospitals. There are basically two types of atomizing equipment: Centrifual and Pneumatic.

CENTRIFUGAL ATOMIZERS pump water from a reservoir onto a rotating disc impeller. The centrifugal force created throws the water against a breaker screen to form tiny droplets. Some type of air moving method, usually air vanes, is needed to pick up the mist and convey it into the air space to be humidified. This type of equipment works well in the lower capacity ranges (a few pounds of water per hour) both as free standing or installed in an air handling system. Larger capacities run into droplet size problems. If this type of equipment is used in a dirty atmosphere serious clogging problems result and considerable maintenance is required to keep its efficiency at a satisfactory level. Also, since there is usually a reservoir and air movement through the equipment, algae formation and drying minerals can result in clogging and the need for frequent maintenance. Water spray nozzles that do not use air are considered to be centrifugal atomizers and are NOT suited for humidifying since their droplet size

and



Centrifugal Atomizer

PNEUMATIC ATOMIZERS use air pressure to break up water into a fine mist. A much smaller droplet size in the mist is more readily attained with pneumatic atomizers than with centrifugal atomizers. Pneumatic atomizers are usually manufactured as heads which can be installed on a ceiling or in a duct. Some pneumatic atomizers use only air under pressure, and others use air and water under pressure.

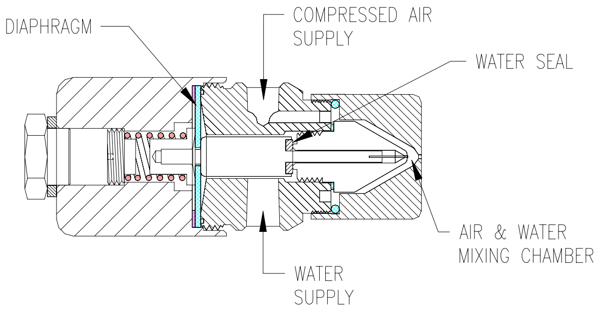
A Pneumatic Atomizing System that uses only air under pressure and draws water from open, nonpressurized tanks is called a GRAVITY SYSTEM. This type of system uses about 25 CFM of air per 100 lbs. of water atomized per hour, or more. It is highly susceptible to algae and bacteria growth in the tanks and clogging is a constant problem. Atomizing heads of this type often drip at the end of an “ON” cycle and therefore should not be placed over valuable equipment or material.

Pneumatic atomizing heads that use air and water under pressure are called DUAL-PNEUMATIC ATOMIZING HEADS. This is generally a closed system that works well in unclean atmospheres. Air consumption is much less than that for the gravity system, and there are no tanks to collect algae and bacteria. Most of these systems however, will drip on “start up” because the air and water line are pressurized at the same time and water will split out of the head before sufficient atomization pressure has built up in the air lines. On “shut down” dripping may also occur because of residual pressure in the water lines. Although most dualpneumatic atomizing heads contain a cleaning pin which effectively cleans the water orifice, droplets of water left in the atomizing section of the head will evaporate and leave minerals behind which can eventually clog the head. A frequent maintenance schedule must be followed to insure that the heads will continue to operate satisfactorily.

The DUAL-PNEUMATIC ATOMIZING SYSTEM uses a dual-pneumatic head which is activated by water pressure so that no water can flow without being pressurized. The design of the head allows the use of only 12 CFM of air per 100 lbs. of water atomized, not the 25 CFM required by some others! A special control system prevents water from flowing until sufficient air pressure has been reached to atomize every drop of water allowing not one drop to fall to the floor! A stainless steel cleaning pin cleans the water orifice at the end of each “ON” cycle and the special control system blows the atomizing section of each head dry to prevent dripping and clogging. The no-drip feature of this ingenious system permits it to be installed right over production areas with no fear of water dripping on equipment or materials. The self- cleaning mechanisms of the system is so effective that YEARLY MAINTENANCE is all that is required. The low air and energy consumption of this system make it especially attractive with today’s energy shortage.

Applications would include: woodworking, leather working, textiles, bakeries, cold storage, printing, paper and investment casting. (See Bulletin I/C DP.)

Figure 4



The HERRMIDICOOL IN-DUCT AIR/WATER ATOMIZING SYSTEM incorporates our patented Dual-Pneumatic atomizing heads and utilizing a system of either pneumatic, electric or electronic control provides for the installation with an airhandling ducted system. This system automatically adjusts its output to exactly match demand. The adjustment is accomplished by either modulating the flow rate of the water to the heads or by individually modulating each head. Multiple systems installed within one air handier can be staged to insure maximum energy efficiency. Humidity receivers and transmitters installed within the air handler and monitored through the Herrmidicool controls cabinet insures the maintenance of precise levels of relative humidity and provide that saturation and condensation will not occur.

The need and the preference for an induct atomization humidification system is evident for both the benefits of controlled humidification, as well as evaporative cooling. The evaporative cooling benefit is derived from the energy required to evaporate a pound of water. With a Herrmidicool system, this energy is drawn directly from the ambient air and is properly referred to as a conversion of sensible heat to latent heat. As this energy is drawn from the air, a corresponding depression of the dry bulb temperature occurs and thus “free cooling” is provided. This can be directly translated to savings in mechanical cooling. The use of either de-ionized or reverse osmosis processed water allows for the use of this system in clean room environments. Applications would include: Office Buildings, Clean Rooms, Computer Rooms, and Manufacturing Areas. (See Bulletin I/C-HC.)

Evaporation

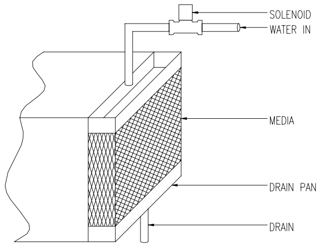
This process actually evaporates the water to the vapor state before it is discharged into the air. No droplets of water enter the humidified air. Minerals contained in the water are left behind in the humidification equipment and must be removed by periodic cleaning. No mineral fallout is experienced with this type of equipment. Generally a bleedoff or blowdown mechanism is built in to flush away concentrated minerals and lengthen maintenance periods. Evaporative equipment will work well on any quality of water.

Evaporation will occur off the surface on an open pan of water or off a saturated sponge. Since it requires 1000 BTU's to evaporate one (1) pound of water, heat is often added to the water or air to enhance evaporation. There are four types of evaporative humidifiers: heated water and media, pan-coil, heated air and media and air washers.

HEATED WATER AND MEDIA humidifiers use a wetted media through which heated water is poured and air blown through to pick up the moisture. Although effective, large amounts of heated water and energy are poured down the drain in the necessary constant blowdown process. These units are usually placed on a supply duct and therefore add to the static pressure and blower costs. Overall energy efficiency of this type of evaporative humidifier is very poor.

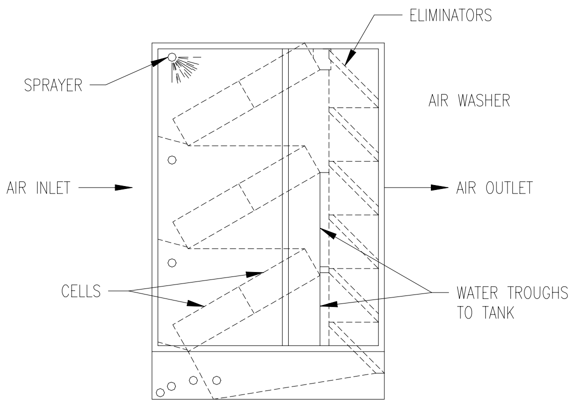
AIR WASHERS use the evaporative process by passing air over a continuous film of water flowing over deflectors which present a large surface of water in contact with the air. The resulting surface evaporation raises the R.H. of the air. Because of the evaporative cooling and their large size and cost, air washers are usually used as evaporative coolers, purifiers AND humidifiers. It is necessary that efficient "de-mistors" be placed in the air stream after the washer section to remove and drain any water droplets that may have become entrained in the air stream. This often results in high static loss across the washer. High levels of R.H. usually cannot be attained by this method of humidification. (Upper limit is about 55% R.H.)

Figure 5



HEATED WATER AND MEDIA

Figure 6



Steam

This process injects live steam into the air to be humidified either via manifold in a ducted air system, or direct discharge into the area. Where good quality steam is available in sufficient quantities, a central steam humidification system will have a very low "first cost." Where a steam boiler must be installed for humidification, its first cost is comparable to other forms of humidification. A steam boiler for humidification must be able to supply good quality steam with very little droplet entrainment. Any droplet entrainment will result in mineral clogging of the humidification equipment since these droplets contain the same chemical makeup as the water in the boiler.

A central steam humidifier consists of a condensate separator (to remove slugs of condensate) and a distribution manifold (for insertion in ducts) or outlet (for area dispersion). Generally the steam flows through the control value into the separator manifold. This is where any solid water particles fall out of the steam providing a good quality steam for humidification. The Herricane CS Series is designed for low steam velocities in the distribution tubes resulting in very low noise levels. The distribution tubes are also engineered to return any condensate to the header. The stainless steel nozzles receive their steam from the middle of the distribution tube where the driest steam is available. Care must be taken to ensure that any spitting, caused by heavy slugs of condensate, will not damage duct work or materials positioned beneath an area steam humidifier.

The HERRICANE CS SERIES provides the ultimate in performance and cost effectiveness in four distinct product families. Each Herricane CS series humidifier offers energy efficiency with its standard nonjacketed design, noise minimization compliments of an exclusive nozzle design and “Guaranteed Evaporative Distance” (G.E.D.) as a result of its total system design. For complete details of the Herricane product family, ask for the “Herricane CS Series Application Guide.”

Figure 7

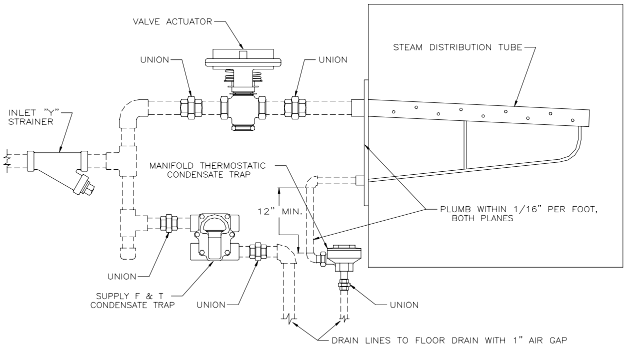
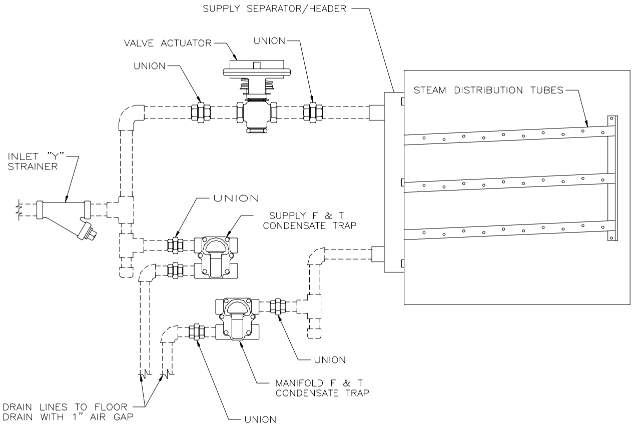


Figure 8



HERRTRONIC electronic steam humidifiers provide the features required for a variety of needs. The Herrtronic AD adjusts to incoming water conditions, has diagnostics to aid troubleshooting, indicator lights to show operating conditions and is controlled by an on-off device. The Herrtronic MD is microprocessor based. It has a user friendly key pad and features diagnostics, networking up to 29 units, P & I control and can proportion off a control or a limit input! Both units are backed by a limited 2-year warranty and are ETL and CSA listed. (See AD/Bro or MD/Bro.)

As we have seen, there are various types of humidification equipment, each with various advantages and disadvantages according to application.

ATOMIZING equipment is the most energy efficient. It is ideal for industrial plants, printing plants, bakeries, woodworking, etc. Also, since it adds evaporative cooling, it will reduce cooling loads and is excellent for use in cold storage or textile where humidification is needed year round. This type equipment is also installed in the duct, as Herrmidicool.

EVAPORATIVE equipment is both energy efficient and dust free, but cannot attain high levels (over 65% R.H.) of R.H. as needed in cold storage or baking. It is best suited for computer rooms, offices, schools, libraries etc. Dusty industrial atmospheres can easily cause clogging of medias - this application should be avoided. Air washers because of their size and cost, are almost always used for evaporative cooling and filtering as well as humidification.

STEAM equipment is the least energy efficient due to low boiler efficiency, transmission losses, condensate losses and heat addition, but is the most sterile thereby lending itself useful for hospitals, nursing homes, laboratories, etc. The use of the new self-contained steam humidifiers increases the energy efficiency of this type of equipment.

The type of humidification equipment used is often as important as the amount of equipment needed. It is best to consult the experts at TRION/HERRMIDIFIER, and let them determine both the amount and type of humidification equipment best suited to your needs.