

Engineering Humidification

F O R A B E T T E R E N V I R O N M E N T

from DRI-STEEM® Humidifier Company

Education Series

How to design for proper humidification steam absorption

The subject of indoor air quality continues to occupy the spotlight in the HVAC industry. Numerous studies have opened new vistas of thinking by pointing out health hazards that stem from what have recently been discovered to be improperly designed or maintained HVAC systems. These discoveries have led to new industry standards. These, along with the possibility of air contamination lawsuits, have resulted in changes in certain HVAC design criteria for public buildings. There is little question that today even higher demands have been placed on engineers to eliminate the possibility of standing water in ducts or air handlers.

Wet HVAC systems lead to problems

When asked what problems they encounter with humidifiers, HVAC engineers frequently cite condensation of steam on internal duct elements as a major problem. If severe enough, the water accumulation can leak from the ducts and cause damage to objects/equipment below. This is an immediate problem that is easily noticeable. A less visible and potentially more harmful situation is a small amount of standing water or condensation on the duct floor. A warm, air handling system containing moist dust becomes an ideal environment for the propagation and distribution of harmful germs.

In the past decade certain manufacturers have made significant advances in steam humidifier designs. As a result, engineers can now design humidification systems with predictable steam absorption distances.

Prevent wet HVAC systems

Several elements will affect how quickly steam is absorbed by an airstream. Generally speaking, the higher the relative humidity that must be produced in the airstream the more difficult the problem. Lower temperature systems of 50–55 °F are more difficult to deal with than systems with higher temperatures. And of course, the desired room or space RH enters into this discussion as well.

There are solutions

The solution involves proper placement of the steam humidifier distribution device, especially in challenging applications. In all cases, steam must be introduced at a point where there is sufficient length of straight, unimpeded duct downstream to permit steam absorption before wetness-producing impingement can take place. However in some buildings, because of structural confines, it is not possible to design long straight sections of ductwork. To facilitate absorption of steam in these instances, use a multiple-tube steam dispersion assembly.

Multiple tubes provide the answer

A bank of closely spaced multiple steam tubes is far superior to a single duct tube. In the example shown on the next page, the absorption distance of 9' can be reduced to less than 2' simply by using multiple steam tubes. With multiple tubes, steam is more evenly distributed

into the airstream. This causes a more rapid homogenization of the steam/air mixture, which results in a faster re-evaporation or second change of state. DRI-STEEM® has a variety of steam dispersion devices that deal with absorption requirements ranging from the simplest application to the most difficult.

Back to the basics

Performing the following steps when designing a humidification system will ensure proper steam absorption.

Step 1. Determine the humidification load.

As a general rule, the humidification load is based only on the amount of outside or makeup air entering a building or space.

In buildings without mechanical ventilation systems, the load is usually calculated on the air change (natural) method.

There are different methods for calculating load depending on the ventilation system used in the building: mechanical, natural or economizer.

A few tips to keep in mind when calculating humidification load:

1. **Building construction.** Take into consideration the construction of the building, how often outside doors are left open, and other elements that will affect the air quality in the building.
2. **Outside air percentage.** For buildings with ventilating systems operating with a low percentage of outside air (10% or less), it is wise to calculate the load twice. First, calculate load based on mechanical ventilation and second, calculate load based on natural ventilation. Use the larger of the two results for determining the load.

Step 2. Understand factors that affect absorption.

Absorption is affected primarily by three things:

1. **Duct or AHU temperature.** Cool air absorbs less than warm air and will require a longer absorption distance.
2. Δ RH (the difference between entering and leaving RH). The more humidity that needs to be dispersed into the airstream, the longer the absorption distance.
3. **Mixing of air and steam.** Uneven airflow, non-uniform mixing of steam with air, and the number of steam discharge points on a dispersion assembly affect absorption distance.

Step 3. Determine the absorption distance.

Depending on the manufacturer selected, there may be a chart or calculation available to determine the minimum distance required for absorption to occur while meeting the desired humidification level. Without this information the engineer will not know if the steam coming from the humidifier has sufficient distance to absorb into the airstream before contacting internal duct objects and condensing.

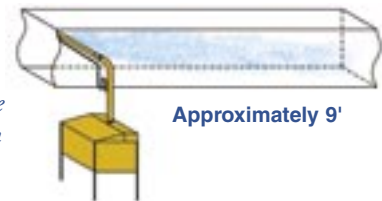
This critical step will determine the location of the steam dispersion device and if multiple steam dispersion tubes are required.

Steam absorption comparison

The drawings below show how increasing the number of steam discharge points and/or number of dispersion tubes, shortens absorption distance.

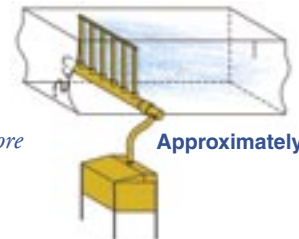
Single-tube dispersion

Of the three examples shown here, the single-tube will have the longest absorption distance.



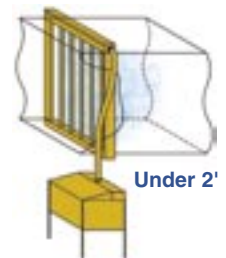
RAPID-SORB® dispersion

With the same conditions, absorption will occur in a shorter distance with a multiple-tube dispersion assembly because it has more steam discharge points.



ULTRA-SORB® dispersion

With the same conditions, this dispersion assembly will provide the shortest absorption distance. It not only has multiple tubes—it has two rows of discharge points on each tube, and also, an additional header for managing condensate.



ULTRA-SORB® — absorption within inches

ULTRA-SORB provides virtually instantaneous absorption, allowing steam to be discharged into tight duct spaces where it previously would have been impossible.

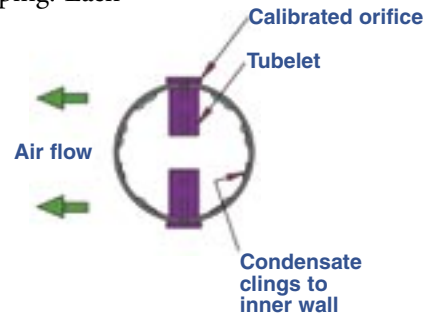
The ULTRA-SORB has a dual header design so that it may function at any steam pressure. It can be used with boiler steam as well as with steam from evaporative humidifiers.

The ULTRA-SORB is available in a wide range of sizes, and ships preassembled within a mounting frame for easy installation in air handlers, large duct systems or small duct spaces.



Steam escapes drip-free through tubelets

All DRI-STEEM® dispersion tube units discharge steam through thermal-resin tubelets fitted into dispersion tubes. These tubelets extend from the center of the tube, where the steam is driest, through the tube wall, to the duct airstream. In essence, the tubelets provide a temperature-neutral escape tunnel for steam, allowing steam to cross over lower-temperature metal without condensing or dripping. Each tubelet contains a calibrated orifice sized for steam capacity. These tubelets are a DRI-STEEM exclusive, and are essential for drip-free steam dispersion.



Steam absorption in feet or inches

DRI-STEEM provides numerous steam dispersion devices to meet a variety of steam absorption requirements. For large capacity applications with limited space for absorption, DRI-STEEM offers RAPID-SORB® and ULTRA-SORB® steam dispersion tube humidification systems.

The custom-sized RAPID-SORB is an excellent option for applications with limited space for steam absorption.



RAPID-SORB — mid-range steam absorption

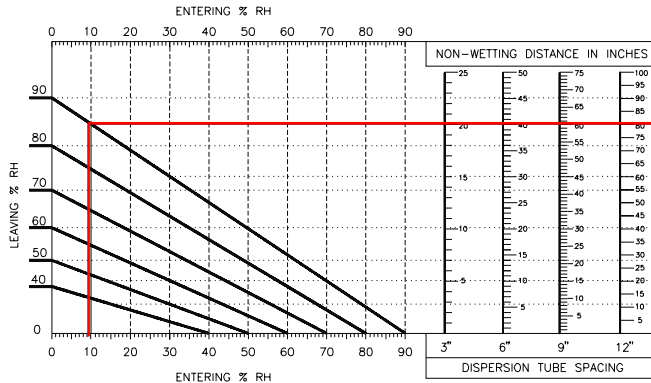
The RAPID-SORB design is an excellent choice for medium capacity systems where multiple tubes are needed to handle the load and/or when the available non-wetting absorption distance is limited.

RAPID-SORB has a steam upflow single header design, and is frequently used with DRI-STEEM evaporative humidifiers such as STS®, GTS®, LTS®, VAPORSTREAM®, VAPORMIST®, or CRUV™ humidifiers.

RAPID-SORB tubes are not steam jacketed, so they are hot only when humidifying. The dispersion tubes feature DRI-STEEM's unique tubelet design for delivery of only the driest steam.

We guarantee steam absorption

DRI-STEEM® has developed charts to determine the steam absorption characteristics of our dispersion devices. The charts are backed with extensive research and development, over 35 years of experience, and thousands of proven applications. We believe so strongly in properly calculating steam absorption distances that we guarantee the values derived from our charts and selection software.



Sizing and selection software

Properly sizing and selecting a humidification system can easily be achieved through DRI-STEEM's DRI-CALC® Humidification Sizing and Selection software. DRI-CALC will take you from the initial steps of load calculation all the way through to final product selection and printing of a detailed specification. The software allows you to adjust conditions or locations at any point in the selection process providing an excellent time saving tool.



The graph at left shows an example where absorption (non-wetting) occurs within 20" of steam discharge when the entering RH is 10% and the leaving RH is 90%, using 3" tube spacing.

Visit the on-line humidification resource center.

Check out our web site to learn more about humidification systems, types of humidifiers on the market today, and current humidification issues. You'll also find information about DRI-CALC® — DRI-STEEM's exclusive software that sizes loads, selects equipment, writes specifications, and creates equipment schedules for DRI-STEEM products.

www.dristeem.com

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