10-POINT GUIDE TO REDUCING PRIMARY CHILLING WEIGHT LOSSES WITH HUMIDIFICATION

Humidification and Evaporative Cooling

condair

MANAGE HUMIDITY, INCREASE PROFITABILITY

When reducing the temperature of a freshly slaughtered meat carcass, evaporative weight losses can account for between 1.5 to 3% of total product weight.

This has a significant effect on the overall product yield and profitability of an abattoir operation.

Cold store humidity has been widely accepted as having a great impact on evaporative weight losses during this process. However, being able to manage humidity levels in a primary chilling area is complex given EU regulations on spray chilling and the very low moisture content of the supply air from the refrigeration system.

As a global leader in humidification technology and expertise, Condair has developed a humidification strategy that successfully manages the air humidity within a primary chilling area. By maintaining a high air humidity with this humidification system, evaporative weight losses can be reduced to around 1%.

This document presents an introductory 10-point guide for abattoir managers on how to correctly humidify a primary chilling area.

> “evaporative losses can be reduced to around 1%”

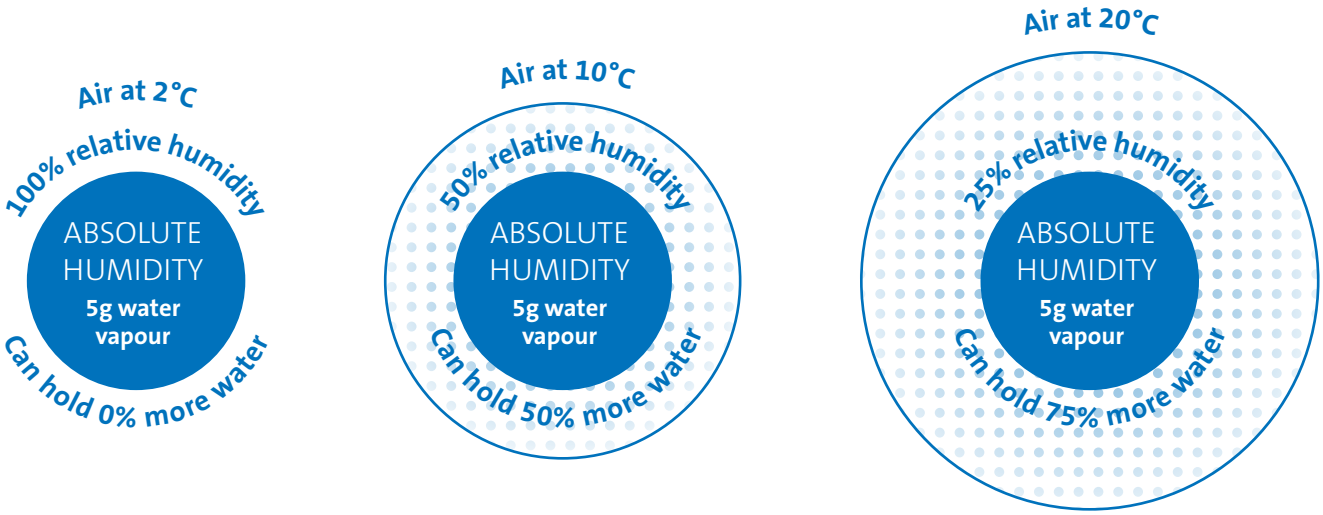
1 WHAT'S HUMIDITY? A QUICK PHYSICS LESSON

What is "absolute humidity"?

The amount of water air contains, e.g. 5g

What is "relative humidity"?

The amount of water air contains, expressed as a percentage of the maximum amount it could contain at the same temperature, e.g. 50%RH@20°C



The amount of water air can hold depends on its temperature. Cold air can physically hold less water than hot air. So heating cold air causes its relative humidity to decrease.
The heat does not remove water from the air. It "dries" the air by increasing the volume of water it could potentially hold.

Understanding relative humidity is very important when considering the evaporative losses from a carcass in a cold store. If air with a low moisture content comes into close proximity with the carcass that has a high water content, moisture will be absorbed by the air. The amount of water absorbed depends on how great the difference is between the moisture content of the air and the carcass.

This is why the majority of evaporative losses during primary chilling occur during the earliest stages, while the carcass is at its warmest. Air coming into contact with the carcass will warm to its highest temperature and lowest humidity. It is at this stage that the difference is greatest between the meat's moisture content and the air's relative humidity.

> "cold air can physically hold less water than hot air"

Get expert advice on your abattoir's humidity control, email uk.sales@condair.com

2 HOW DO YOU MANAGE A COLD STORE'S HUMIDITY LEVEL?

In a primary chilling area, the air coming from the chillers will typically be around 0-2°C and saturated at 100% relative humidity (%RH). At this condition, a cubic metre of air will be able to hold a maximum of 4.5g of moisture. It is impossible to increase the volume of water vapour in the air beyond this amount while it is at this low temperature.

When warmed towards 37°C, in the micro-climate next to the surface of a freshly slaughtered carcass, the same air would be capable of holding around 40g of water vapour. If no additional moisture is available to the air, its relative humidity would drop from 100%RH to 10%RH. However, this doesn't happen, as moisture is available, and it is drawn from the surface of the meat.

To inhibit this evaporative process an alternative source of moisture needs to be made available to the air as it is warmed by the carcass. In the EU it is not permitted to spray water that comes into direct contact with carcasses during the primary chilling process. So to humidify the air without spraying near or wetting onto the carcasses, a cold store's humidification system must introduce a very fine mist to the airflow, while it is still saturated at 100%RH.

If the humidifier's emitted droplet size is small enough, it will remain suspended in the atmosphere without precipitating out or wetting on to carcasses. It is then carried on the airflow to the point where the air's temperature rises, whereby it is absorbed by the air, reducing the amount of water drawn from the carcasses.

> "introduce a very fine mist to the airflow"

3 WHAT TYPE OF HUMIDIFIER IS BEST FOR A PRIMARY CHILLING ENVIRONMENT?

In order to achieve the fine mist necessary in a primary chilling area, a compressed air and water spray humidifier needs to be employed, such as the Condair JetSpray.

By combining compressed air and water, the aerosol released from the spray nozzles has a droplet size of around 5-7 microns. This ultra-fine mist is easily carried by the frigid air without wetting out on to surfaces and is instantly absorbed by the air as soon as its relative humidity allows.

This type of humidification system is capable of fully modulating the output through the complete range of the humidifier's capacity. This is unlike high pressure spray humidifiers that rely on water pressure alone to create an aerosol and control output by turning on and off at full pressure.

A fully modulating humidifier provides the exact amount of humidity at any given time and gives the precise level of control needed to prevent over-humidification and wetting on to surfaces within the room.

Further benefits of compressed air and water spray humidification are guaranteed drip-free operation and a highly directional spray profile, which is important when considering the location of spray nozzles (see point 6).

> "compressed air atomises the water into an aerosol"

Get expert advice on humidifier selection,
email uk.sales@condair.com

4 WHAT HUMIDITY LEVEL SHOULD BE MAINTAINED IN THE COLD STORE?

The purpose of primary chill store humidification is to minimise the difference in moisture content between air and carcass. When an atmosphere's moisture content is in balance with a product's moisture content, the product will neither lose nor absorb water from the air.

Defining an "ideal" humidity level in a primary chilling area is fundamentally about ascertaining the best humidity set point to control a humidifier's operation and achieve the equilibrium moisture condition.

However, as the humidity profile across a primary chilling area can vary, due to the chill process being used, the airflow, air velocity and the carcass presentation, defining a humidity set point will depend on many variables, including where the sensors are located.

Typically an optimum humidity set-point is between 85-95%RH, measured on the return air to the chiller (see point 7).

To discover the ideal humidity set-point for any chill store, it is best to start at a low humidity and gradually increase, monitoring the impact on evaporative losses and ensuring there is no wetting within the store or on the product.

> "optimum humidity set point is between 85-95%RH"

5

HOW MUCH HUMIDITY NEEDS TO BE INTRODUCED?

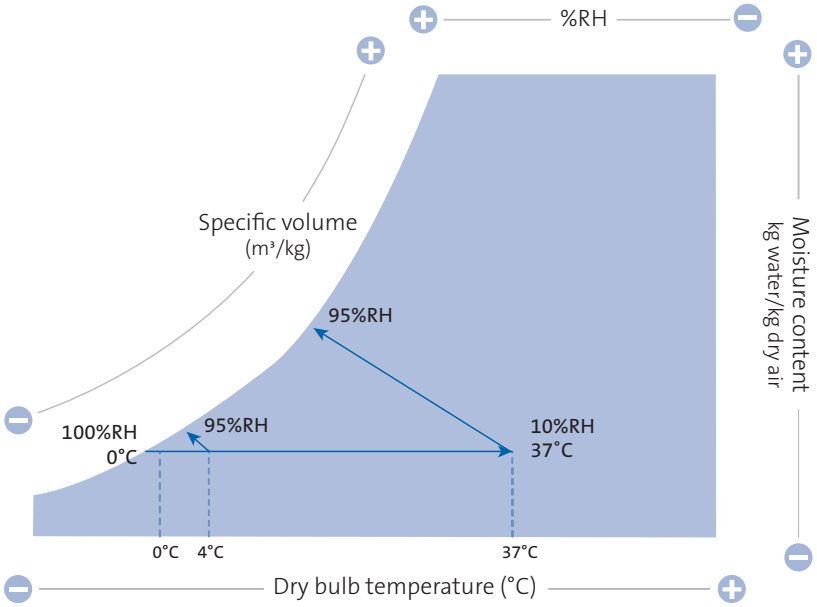
The volume of moisture needed to maintain a humidity level within a room will depend on the characteristics of the room and its airflow. This volume is typically expressed in kilograms per hour and is referred to as the "humidity load".

In order to calculate a chill store's humidity load and correctly size a humidification system for the area, the following parameters need to be noted:

- The required humidity level
- The air volume of the room (room height x width x length)
- The maximum air volume from the chillers
- The air temperature from the chillers
- The required store temperature
- The average number of carcasses
- The average weight per carcass

By plotting the air conditions on a psychrometric chart, the volume of moisture needed per kilogram of dry air can be determined along with the specific volume in m³/kg.

$$\frac{\text{Moisture x air vol x no. of air changes}}{\text{Specific volume}} = \text{Humidity load}$$



Example psychrometric calculation

"calculate the required humidity load"

For advice in sizing your humidifier system, email uk.sales@condair.com

6 WHERE SHOULD THE HUMIDIFIER BE LOCATED?

In order to successfully use the airflow from the chillers as a transport mechanism for the aerosols into the room, it is important to locate the spray nozzles correctly.

The aerosol plumes should not come into contact with the meat so correct positioning will depend on the layout of the primary chilling area, the location of the chillers and the direction of their airflow, and any obstacles in the room like overhead rails.

Typically, spray nozzles are placed directly in front of the chillers, spraying with the airflow, if there is sufficient clearance in the room at a high level. Alternatively, they can spray into the airflow, should the velocity be sufficient, as this can shorten the overall spray plume length.

The humidification system must have numerous points of injection to ensure humidity is spread evenly across an area. Spot humidifiers that introduce a large quantity of moisture from one or a few points are not appropriate for the application. Due to the high velocity of the air flowing through a primary chilling area, the injected humidity from a spot humidifier will not have time to disperse evenly around the room, resulting in areas of low and high humidity.

> “nozzles are placed directly in front of the chillers”

7 WHAT TYPE OF SENSORS SHOULD BE USED AND WHERE?

> sensors are typically placed on the return air

A sensor measures the humidity level in a room and sends a control signal to a humidification system to control its output. In this way the humidifier is controlled based upon feedback from the sensor, depending on whether more or less moisture is required to maintain the humidity set-point.

Sensors are typically located on the return air to the chillers, as this provides an accurate and consistent reading following the air's complete absorption of the moisture from the humidifier.

The sensor employed must have a high precision and be able to cope with the environmental conditions of a primary chilling area. These include extremes in temperature and direct contact with water during cleaning processes.

Depending on the size of the primary chilling operation, it may be beneficial to use multiple sensors that provide an average humidity level back to the humidification system. This will help achieve the optimum system operation and avoid under or over humidification.

8 WHAT HYGIENE MEASURES ARE REQUIRED?

The hygienic operation of any food production environment is paramount. A humidification system used in a primary chilling operation must be capable of maintaining exceptionally high hygiene standards.

To ensure minerals are not introduced to the cold store, the supply water needs to be purified using reverse osmosis water treatment plant. This removes particulate matter and bacteria from the humidifier's supply water.

As a secondary measure, ultra-violet sterilisation should be used to treat the water prior to use for humidification. This kills or inactivates any remaining microorganisms.

Alongside purification of the supply water, the humidifier itself ought to have an automated flush and drain mechanism to ensure water cannot remain in the system to stagnate. This reduces the risk of microbial growth during periods of in-operation.

Compressed air blow-through extends this protection and leaves the pipework dry at the end of a drain cycle.

Any pipework used inside the chill store environment ought to be stainless steel and the design of the pipework system must be carried out by a competent party. Lengths need to be kept as short as possible (max. 5m) and dead legs, where water can settle, must be avoided.

> "exceptionally high hygiene standards"

9 WHAT ON-GOING MAINTENANCE IS NECESSARY?

Alongside professional design, installation and commissioning, a commercial humidification system will need routine servicing and maintenance in order to remain efficient and hygienic. A maintenance schedule ought to include not just the humidifier but any associated plant, such as reverse osmosis water filters.

Alongside servicing, Condair recommends that routine disinfection of cold water spray humidifiers should take place at the initial commissioning and every six months. Cleaning and disinfection is a specialist operation and should not be conducted by staff without evidence of a suitable risk assessment, method statement and staff competence.

As part of a building's water system, scheduled water testing should also be carried out on the humidifier every six months to record water temperatures and bacterial activity.

10 ARE THERE OTHER BENEFITS OF HUMIDIFICATION?

The objective of primary chilling is to remove heat from the carcass and transfer the thermal energy to the air travelling through the cold store. The specific heat capacity of humid air is greater than dry air. Therefore, an additional benefit of increasing the moisture content of the air is that it absorbs more energy from the meat as it comes into contact with it.

This improved thermal transfer effectively reduces the time it takes the carcass to reach its target temperature and the overall length of the chill cycle. This in turn lowers the energy consumption of the refrigeration system and impacts on the microbial growth, as the meat's temperature is reduced faster.

> "improved thermal transfer"

Request a free on-site consultation.
Email uk.sales@condair.com

ASK FOR A FREE
ON-SITE CONSULTATION

WORLD LEADING HUMIDIFICATION SPECIALIST

Condair is a world leader in humidification and evaporative cooling. It has manufacturing facilities in Asia, Europe and North America, sales operations in 19 countries and distributors in over 40 more.

As well as benefiting from the most advanced humidifier technology available, clients are supported by local specialist humidification engineering teams, which can offer installation, commissioning, maintenance and spares support.

The company has been serving global industry for many years and helps manufacturers achieve rapid return on the investment in their humidification systems through improved productivity.

Contact us today for a free expert assessment of your abattoir's environment and discover how improved humidity can enhance your profitability.

Condair plc
Artex Avenue, Rustington, Littlehampton, West Sussex, BN16 3LN, UK
Tel: +44 (0)1903 850200 - uk.sales@condair.com - www.condair.co.uk

03/2018