10-POINT GUIDE TO HUMIDITY CONTROL IN TEXTILE MANUFACTURING

Humidification and Evaporative Cooling

condair

MANAGE HUMIDITY, INCREASE PROFITABILITY

Every textile product is affected by the relative humidity of the environment in which it is produced, particularly natural fibres.

Low air humidity can dry a fibre causing its internal moisture content to fall. If this moisture content drops below the optimum level during processing, a manufacturer can experience a drop in productivity for a number of reasons.

As fibres dry their tensile strength is impaired, they become less flexible, thinner and more brittle. If a fibre or thread breaks while being processed, textile machinery needs to be manually rethreaded, leading to downtime and reduced efficiency.

During weaving, every time a machine needs to be rethreaded and tied-off, loom stop marks are produced, resulting in a lower quality yarn. Drier fibres during spinning causes a higher hairiness of the yarn, lower strength and a low pilling resistance of the end product. This all contributes to a reduced market value for the textile.

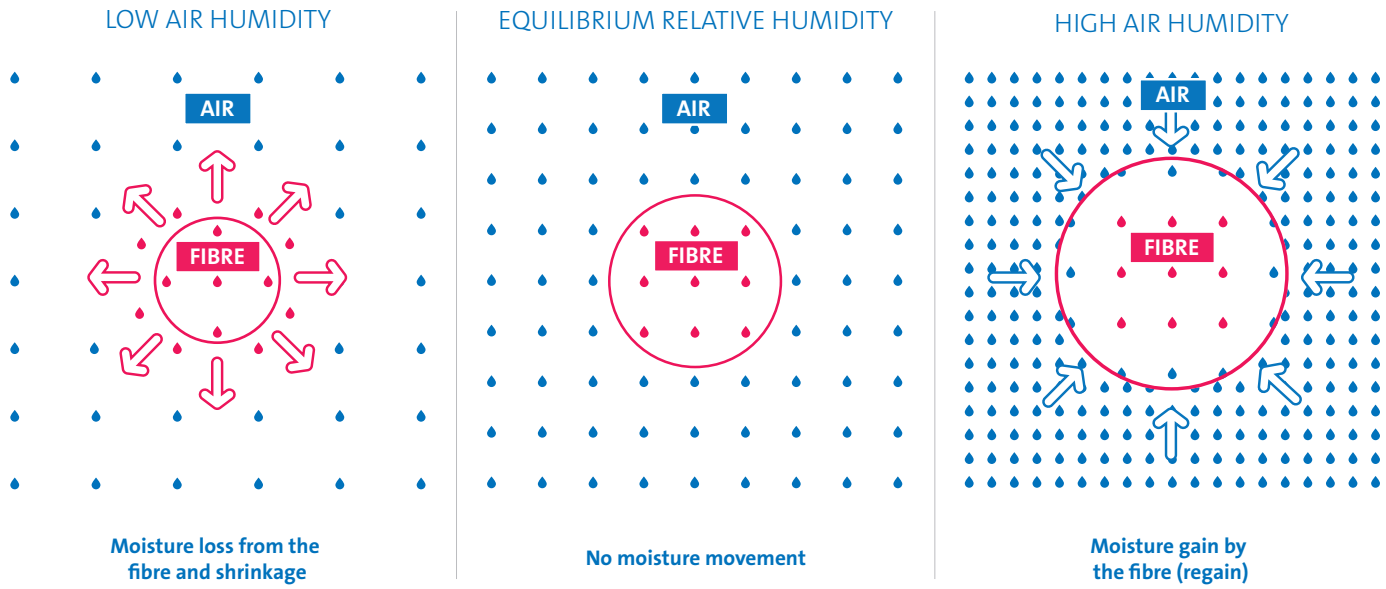
As well as impairing quality, low humidity during production will also directly reduce yield. A 4% evaporation of a textile's internal moisture content requires 4% more product to be manufactured to meet a required production weight. As dry fibres are more prone to shedding, this again reduces yield, as more fibres are lost to the atmosphere.

Both these factors contribute to a textile manufacturer requiring more raw materials, energy and labour to satisfy an order, thus increasing overheads and reducing profits. By correctly humidifying a textile production facility, product yield is optimised and quality improved.

As a global leader in humidification technology, Condair has developed successful humidification strategies for textile manufacturers around the world. This document present an introductory 10-point guide for production managers looking to enhance their factory's profitability with improved humidity.

> "product yield is optimised and quality improved"

1 WHY HUMIDIFY?



Textile fibres have an internal moisture content and will gain or lose water to the air depending on whether there is equilibrium between the air's relative humidity and the textile's moisture content.

If a fibre's surface is exposed to the air and there is balance between these two factors, no moisture movement will occur. This is referred to as equilibrium relative humidity and is the ideal processing environment for textile manufacturing.

However, if the air's relative humidity is lower than this ideal level, moisture will be drawn from the textile's exposed surface and evaporate into the air.

Moisture loss from a textile can happen quickly during processing (see fig. 1). Cotton and wool can lose up to 4% in under 10 minutes when exposed. Carding, spinning, winding and weaving expose a huge amount of the fibre's surface area to rapidly moving air. This provides great potential for evaporative losses from the fibre should the ambient humidity be lower than the equilibrium relative humidity.

The objective of humidifying a textile factory is to maintain equilibrium between the air's relative humidity and the textile's moisture content.

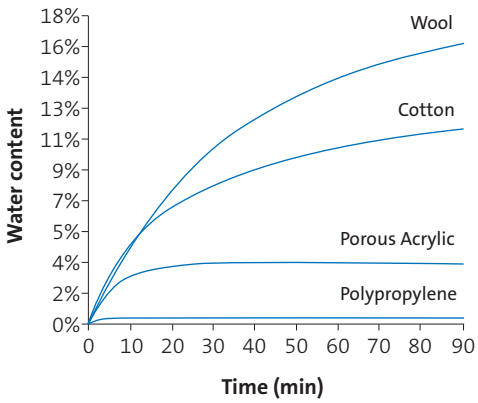


Fig. 1 - Speed of change for moisture loss from different textiles when exposed to dry air

> "maintain equilibrium between the air's relative humidity and the textile's moisture content"

2 WHAT'S THE IDEAL MILL HUMIDITY LEVEL?

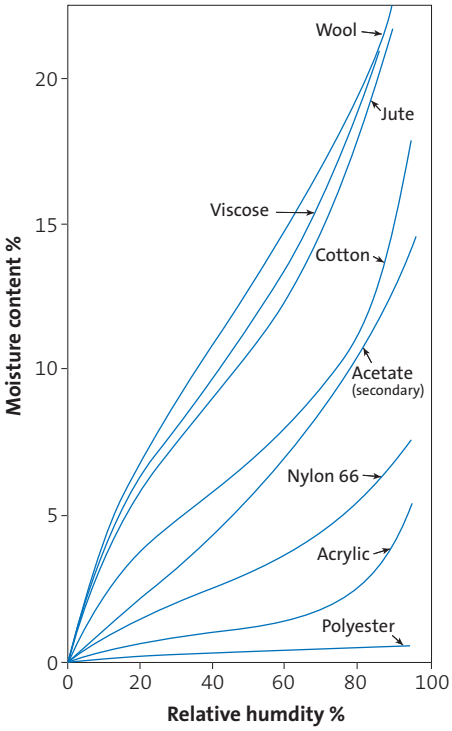


Fig. 2 - Moisture sorption data (median values between wetting and drying) in atmospheres of various relative humidities

The ideal humidity level for any textile production area will depend on the moisture content of the textile being processed and the production process itself.

Natural fibres are far more susceptible to moisture changes than manmade fibres, in terms of performance. At the correct internal moisture content there is less yarn breakage in spinning and twisting, and higher efficiencies in weaving.

To achieve the required internal moisture content for any textile product, a sorption isotherm graph is used to calculate the correct air humidity (see fig. 2). The curved line shows for any given moisture content of the material what the corresponding air humidity ought to be for perfect equilibrium.

The table below shows a general guide to the ideal humidity levels for processing different textiles at various stages of production.

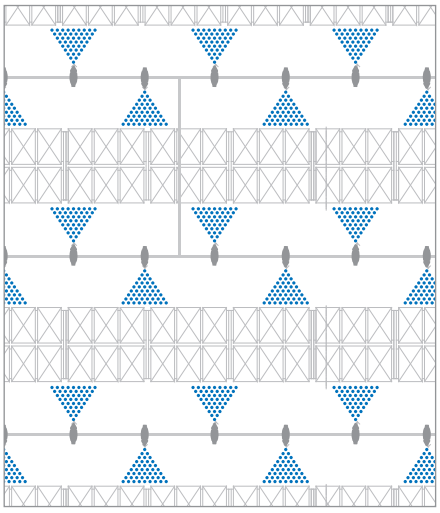
Optimal humidity levels

	Spinning	Twisting	Winding	Weaving
Wool	50-85%RH	60-65%RH	55-60%RH	50-60%RH
Cotton	35-65%RH	50-65%RH	55-65%RH	70-85%RH
Man-made fibres	45-65%RH	45-65%RH	60-65%RH	60-70%RH
Silk	60-65%RH	60-65%RH	60-65%RH	60-65%RH
Jute	75%RH	75%RH	75%RH	75%RH
Linen	80%RH	80%RH	80%RH	80%RH

> use a sorption isotherm graph to calculate the required air humidity

3 HOW CAN HUMIDITY BE CONSISTENTLY MANAGED ACROSS A LARGE FACTORY?

The characteristics of the atmosphere across a single production area can vary greatly. Any change in temperature will impact on the relative humidity (RH). Hot spots on machinery will cause a localised drop in RH that can rapidly decrease product weight and quality.



To achieve a consistent level of humidity, across areas that can be hundreds of metres long, it is important to have a humidification system with many points of moisture injection. Single "spot" humidifiers that introduce a large amount of humidity from one or just a few units, cannot maintain room humidity as evenly as a system with many lower capacity outlets.

Varying the quantity of moisture introduced at different points of injection, given the room's specific characteristics, can also help produce a more even moisture distribution. For example, it is important to introduce more moisture close to where the dry air enters the room and avoid over humidifying areas near to the points from where air is extracted.

> "many points of moisture injection"

Condair offer free expert advice on humidity levels and system design

4 WHAT TYPE OF HUMIDIFIER IS BEST FOR A TEXTILE FACTORY?

Spray humidifiers that combine compressed air and water to create a series of fine aerosols are a popular choice for large textile production areas. This type of humidifier has many advantages over high pressure or spinning disc systems for a textile factory.

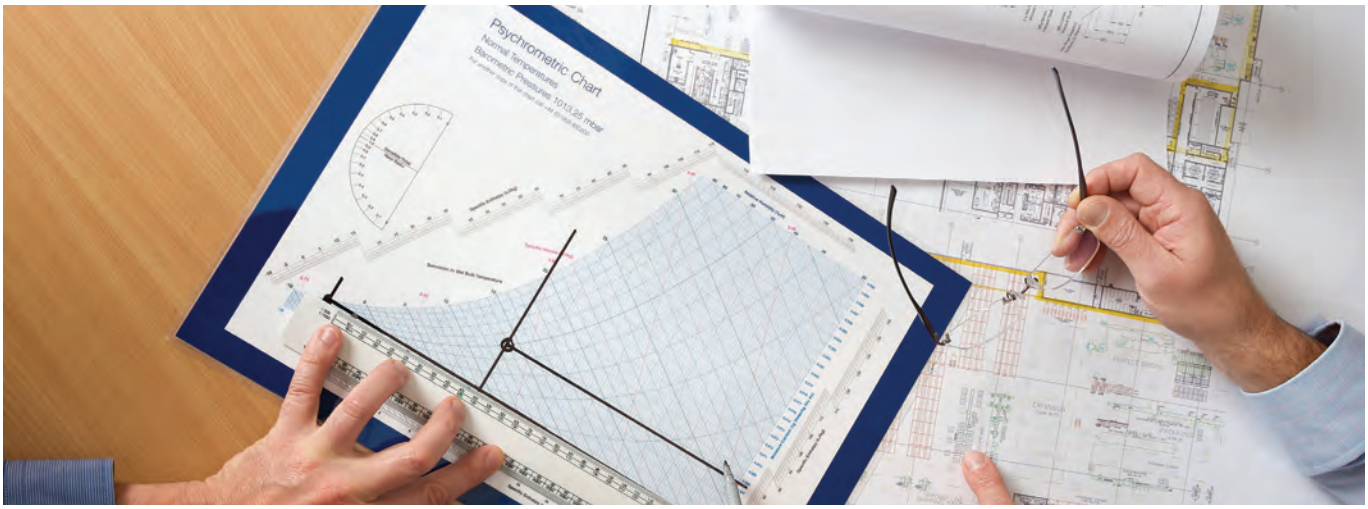
The compressed air creates highly directional sprays that evaporate without needing fans, which can frequently block and require maintenance in very dusty production environments. The droplet size of a compressed air and water humidifier is very small at between 5-7 microns, so evaporates rapidly without drips or wetting onto machinery, walls or the floor of the room.

Compressed air and water systems, such as the JetSpray from Condair, also have the benefit of self-cleaning nozzles. A tiny pin is regularly forced through the spray orifice, greatly reducing the possibility of nozzle blockages. This reduces necessary maintenance and the associated downtime.

Textile laboratories that need to precisely control humidity in smaller areas, often use electric steam humidifiers. They can deliver humidity either directly to a room with a fan unit or to a ducted air conditioning system.

> “combine compressed air and water to create a series of fine aerosols”

5 HOW MUCH WATER NEEDS TO BE INTRODUCED TO THE AIR?



Once the ideal level of air humidity has been understood (see point 2), the volume of moisture required to maintain this humidity will need to be calculated, given the production area's specific characteristics. This volume of moisture is typically expressed in kilograms per hour and is referred to as the "humidity load".

In order to calculate an area's humidity load, and therefore what capacity humidifier is required, the following parameters need to be noted:

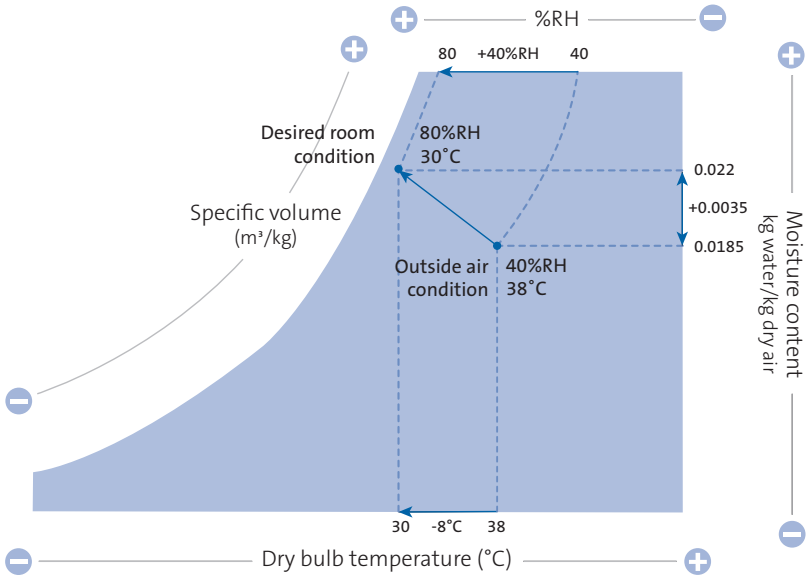
- The desired humidity level (see point 2)
- The air volume of the room (room height x width x length)
- The temperature of the room
- The temperature of the outside air
- The humidity of the outside air
- The number of air exchanges the room experiences per hour

By plotting the internal and external 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.

The following equation is then used to calculate the required humidity load for the room.

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

To ensure the humidification system is capable of meeting the needs of the factory throughout the year, the internal and external air conditions should be based on the hottest and driest times.

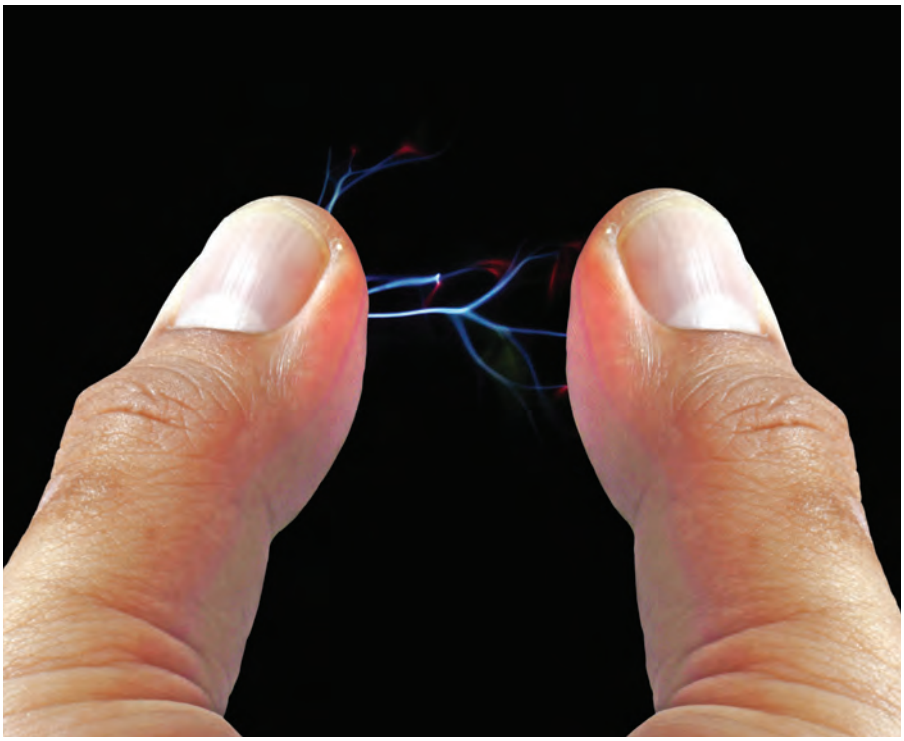


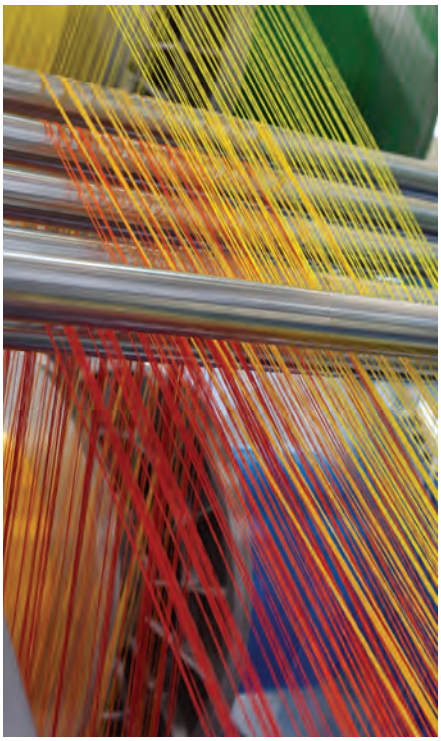
Example psychrometric calculation

> "calculate the required humidity load"

Condair offer free expert advice on product selection and sizing

6 HOW DOES HUMIDITY AFFECT STATIC ELECTRICITY?





The occurrence of static can be a major problem when processing textiles and it is directly related to levels of relative humidity. The electrical sensitivity that determines whether static electrification will occur is dependent on the moisture content of the air and fibres. As fibres lose moisture, they increase their electrical resistance. They no longer readily dissipate electrical charge that is generated by frictional contact on machinery.

In a textile production facility with low humidity, static discharges can jump up to 4-5 inches. Although they have a low current, discharges can be several hundred thousand volts.

This presents a danger to staff working with the machines, as it is not only uncomfortable but it can cause a person to jump and fall, which presents extreme risks when working with textile machinery. Static discharge is also a risk to people with weak hearts or pace-makers fitted.

As well as the danger to staff, static electrical build-up will cause materials to stick together and be less manageable. This in turn will slow machinery, directly affecting production schedules. Also, as most machines are now microprocessor controlled, an uncontrolled electrical discharge in the wrong place can damage the electronics of the unit resulting in expensive repair bills and significant downtime.

By maintaining humidity at around 50%RH static build-up is naturally dissipated and these associated problems are alleviated.

> “at around 50%RH static build-up is naturally dissipated”

7 WILL HUMIDIFICATION AFFECT FACTORY WORKERS?

A cold water humidifier will provide the additional benefit of 680W of evaporative cooling for every 1kg of water absorbed by the air. Across a textile production area, this cooling effect can reduce the ambient temperature by between 5-12°C. This is a welcome improvement to the working conditions for staff in the area.

An increased air humidity will encourage airborne lint, dust and fly to fall out of the atmosphere and settle faster. Maintaining the correct air humidity also reduces the amount of fibres shed during processing, therefore fewer particles are introduced to the air. These benefits combine to make the air much less polluted, more pleasant to breathe and healthier to work in.

Cooler temperatures and reduced airborne pollution has a positive impact on productivity, as staff are healthier and happier.

> “cooler temperatures and reduced airborne pollution”

Condair offers free expert advice on static control and evaporative cooling

8 WHAT HYGIENE MEASURES ARE REQUIRED?

As workers come into close proximity to the sprays released from a textile humidification system, and can potentially inhale the aerosols, it is vital the system is designed with hygiene as a primary concern.

Systems should always be fed by a water supply that is of drinking water quality and correctly filtered to remove particulate matter.

The humidifier's water pipelines should not incorporate any runs where water could potentially rest for an extended period of time without draining away. Stagnant water is a potential breeding ground for microbes that can be dangerous to health if inhaled. The humidifier should therefore have automatic flush and drain cycles to ensure water does not remain in the system or in the building's pipework feeding the system.

Alongside these necessary requirements, water treatment systems can also be used that either filter the water to remove bacteria and viruses or sterilise the water through dosing or exposure to ultra violet light.

> "exceptionally high hygiene standards"

9 I HAVE AN AIR WASHER IN MY AIR HANDLING UNIT. DO I STILL NEED A HUMIDIFIER?

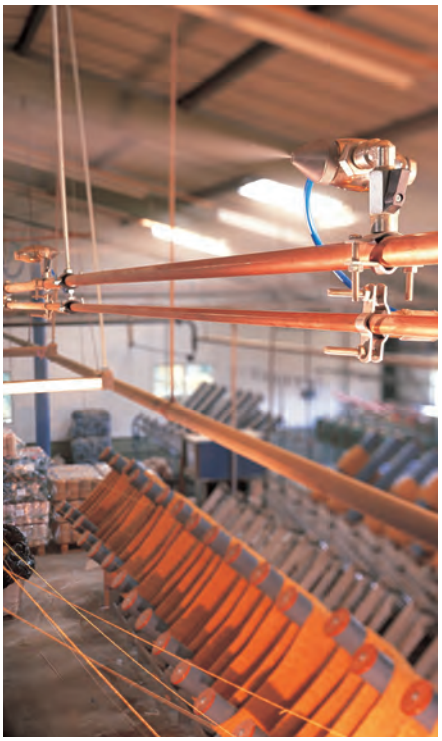
Many textile production facilities will incorporate a spray system or air washer inside the air handling unit that feeds conditioned air into the building. However, these older air treatment systems are inefficient and rarely able to control humidity to the ideal level evenly across a production area.

Frequently, machinery upgrades within a factory will also change the characteristics of the air profile across a room and result in a greater humidity load being required than the room's air handling unit was originally designed for.

In-room systems, such as the JetSpray from Condair, accurately maintain humidity levels across an area, efficiently and economically. As a factory's capacity increases, additional humidification systems can be added to precisely meet the needs of the production machinery.

> "systems can be added to precisely meet the needs of the production machinery"

10 WHAT'S THE PAYBACK OF A HUMIDIFICATION SYSTEM?



There are many benefits in maintaining the optimum humidity in a textile mill, including increases in yield, machine uptime and product market value. It is therefore difficult to precisely quantify the financial implications of them all in advance but an informed estimate can be made.

The most obvious financial benefit is the reduction in evaporative weight loss from the raw material during processing. If a 4% loss is experienced, the cost could be calculated on the market value of 4% of end product but is most typically calculated on 4% additional raw material cost. As well as the raw material cost, the production cost to process the fibres should also be considered.

Fibre shedding will reduce yield but to quantify this reduction and humidity's impact upon it, will depend on the textile in question and its susceptibility to damage from drying and shedding.

Production efficiency based upon machine uptime is a factor that ought to be considered when looking at a payback period for maintaining optimum humidity levels. How much time is spent rethreading machines due to fibre breakage and what is the estimated cost of this inefficiency?

Lastly, an assessment of the potential increase in market value of the end product should be made. This can take into account improvements in yarn hairiness, tensile strength, pilling resistance and a reduction in loom stop marks.

> "increases in yield, machine uptime and product market value"

Condair offers free expert ROI projections for humidifier installations

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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 20 countries and distributors in over 50 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 the global textile 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 manufacturing environment and discover how improved humidity can enhance your profitability.

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