Humidity & Temperature control for Print
Humidity Solutions has been delivering humidity control solutions to the print industry for many years. At the 2010 IPEX exhibition, we introduced the Airtec high pressure water system to the UK print market. At the 2015 Print Show, we launched Eiger, an all-in-one heating and humidification product specially designed for the digital print studio owner to simplify integration between temperature and humidity control.

Providing practical and cost-effective solutions for the print industry isn’t just about products, though. It’s also about combining an understanding of the specific needs of printers with extensive experience of humidity control to ensure the right products are implemented in the best way.

Humidity Solutions Ltd was established by John Barker, the author of this guide, with Lindsey Henderson to provide excellent customer care to the wide variety of industries that require humidity control. Each of the founders has over 25 years of experience in providing stable and precise humidity control for the print industry and many other applications.

This document brings together our many years of experience to provide prospective and current print company owners with a resource to support successful implementation of humidity and temperature control systems while avoiding the pitfalls that others have experienced.

Humidity Solutions is the only UK company to specialise in Humidification and Dehumidification whilst not being owned by a single manufacturer. We have access to a range of high quality products supplied from leading producers throughout the world, including Neptronic Canada, Devatec France, Airtec Denmark, Destech Lithuania and Hidros in Italy.

About the author

John Barker studied Mechanical and Production Engineering and spent 21 years specialising in humidity control before setting up Humidity Solutions with Lindsey in 2008. Since then the company has enjoyed year-on-year growth on the back of its expertise, ability to tailor solutions for each project and focus on customer support.
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Introduction

Since 2008 Humidity Solutions has provided humidification and/or heating solutions all over the UK and Europe, gaining years of experience on how to achieve good temperature and humidity control.

It has become evident that while we are very familiar with environmental control, most printers are learning from scratch. Consequently, they often don’t know the right questions to ask to ensure they get the best climatic solution for optimum productivity and quality. It is also clear that once owners have been through this traumatic learning experience they are reluctant to pass on this knowledge and knowhow for fear of losing commercial advantage.

The purpose of this book is therefore to provide a simple guide through the process and to show the variety of equipment that can create a controlled temperature, humidity and air quality in their press area, while also complying with building regulations.

Humidity Solutions offers advice on humidity and, as the UK’s only independent supplier of humidifiers, can offer a comprehensive range of humidifiers to ensure that we match the equipment to the application. Our purpose-designed Eiger heating / cooling, filtration and humidity system is easy to install and meets all the requirements to achieve a stable climate in the studio.

Covering the whole of the UK and Ireland, our team of experienced engineers offers expert advice, including site visits where required. From these discussions, we can develop a specification of required temperature and humidity levels and note design issues such as noise and visual impact. This ensures we recommend the best solution for you, taking account of these important issues to match your application and, of course, your budget.
Health and profit via humidity

Humidity control of the indoor environment is as important as temperature control. Work places are commonly humidified to overcome the drying effects of air conditioning and the low humidity levels experienced during the cold winter months. Having correct Relative Humidity (RH) prevents sore eyes, dry mouth and throat and, most importantly, keeps our protective respiratory membranes healthy to reduce risk of infection.

Press manufacturers know the importance of humidity control to ensure that at 21°C 50% RH the air is pleasant to work in, creating a productive environment without feeling dry and dehydrated. Paper stock is kept in good condition and static is eliminated.

The cost of these problems through lost production and poor quality can be very high - and return on investment in presses, plant and paper stock depends on maximum efficiency. Yet loss of production due to paper problems, for example, can be resolved simply. Dry air is the cause; putting the moisture back into the air is the solution!

Paper is a natural material and is hygroscopic, which means that it is very susceptible to changes in RH. Low humidity environments are typically created between October and March in the UK, as heat generated by machinery and heaters dries the air. In the depths of winter, RH levels as low as 15-20% are not uncommon.

Changes in humidity can also cause the physical dimensions of the paper to change, albeit by tiny amounts, but enough to result in mis-registration of colours in multi-pass jobs. Any change in the dimensions of the paper, however small, between runs of a two or more-colour process will result in colours not lining up.
Humidifiers come in many shapes and sizes so it is important to team up with an experienced company to identify the right humidification solution for your space - whether that is a small digital print studio or a large press hall.

In the increasingly competitive print market where return on investment really matters, humidity control is essential to maintain quality and productivity at all stages of production.

**Humidity effect on process / profit in print**

**Paper and ink**

As noted above, paper is very hygroscopic; which means it loses moisture rapidly when exposed to dry air. Sheet and web roll paper is typically produced and wrapped to stay in equilibrium with air with a relative humidity of 50% RH ±5%.

When the ambient humidity falls below this level, paper loses water to the environment from exposed surfaces, changing its shape, dimensions and physical properties. Below 40% RH, the movement of paper on paper and other surfaces generates electrostatic charges, attracting dust and making it difficult to handle (see below). These problems are most pronounced in hot summers and cold winters, when the RH can fall below 20%, even in temperate climates.

Where water-based inks are used, a higher RH of 55% ±5% is typically recommended, and some ink manufacturers recommend 60%.

**Static**

Static electricity can be a major problem. When the relative humidity drops below the electrostatic threshold of 40%, the build-up of static is enhanced. This results in sheets of paper sticking and mis-feeding, not lying flat on each other or stacking properly as they emerge from the other end of the press.

The problem is magnified when it comes to the giant web presses used by national and regional newspapers. During storage, and particularly in the lay-down and reel stand areas, the exposed edges of the reels dry. As the web runs at speed through the press, the dry edges are under higher tension than the centre. The slightest disruption of the edge will result in a ‘web break’, with the paper tearing right across its width, causing production downtime when deadlines are crucial.

So, if low humidity is the culprit in all these situations, what can be done to counteract it? The answer, of course, is to fit humidifiers within the building.

Humidifiers have been around in the printing industry for many years but the technology has changed with more efficient and healthier solutions now available which also provide better moisture distribution and humidity control.

**50% RH is the level**

Web breaks can be dramatically reduced in web press applications such as gravure presses – as evidenced by a frequent web-break problem at a site in Liverpool. Slow motion filming showed a flash of static charge which made the paper rip. Moreover, splicing of the new reels on to the old failed due to the wave on the paper due to drying so that the high-speed
splicing did not work reliably. Installation of a high-pressure water humidifier resulting in a dramatic reduction in web breaks.

Normal printing conditions require a relative humidity of around 50-55%, but some situations demand higher levels. Where water-based (as opposed to oil-based) inks are used, RH levels of around 60-65% are more appropriate. And with more and more printers switching to water-based inks, it is becoming even more important to maintain humidity at the correct level.

Humidifier system design is critical as it is essential to ensure that the humidity is within the required range without causing wetting. This could occur if a spray is wrongly positioned so that the moisture condenses on a cold surface or is buffeted by airflow or air conditioning.

The correct sizing of the system must consider air movement, temperatures, size of the space, height of ceiling, type of process and system restrictions such as available power, water and drains.

Every system is different and designed to fit the application even when using standard equipment. The following sections consider in more detail how the potential problems described above can apply to various print activities.

Platemaking
When the protective film or paper is removed from plates, electrostatic charge is generated if the relative humidity drops below a threshold of 40%. This attracts dust and grit to an otherwise unblemished surface, makes handling difficult and generates sparks. Maintaining an environment of 45% RH prevents this.

Digital printing
The paper problems experienced elsewhere in printing apply equally to digital printing but electrostatic problems associated with machinery can also be an issue. To counter this, a relative humidity of 50-55% is recommended.

Most of the major digital print machine manufacturers insist on humidity control within the environment to ensure that warranties are honoured and that print quality is maintained. This is often referred to as the Q (quality) zone and if temperature and humidity parameters are outside the Q zone this can jeopardise support from the manufacturers.

Sheet fed offset
A dry press hall means the edges of unwrapped paper lose moisture rapidly. Tight edges result, making the paper curl, which causes mis-feed, with misregister, dot doubling and creasing as the paper passes between blanket and impression cylinders.

Mis-feed also occurs due to electrostatic build-up, which also causes stacking difficulties coming out of the press. Printed work awaiting another pass continues to change, with mis-register being a problem.

In dry air, work passing to finishing suffers from paper sticking and creasing due to static electricity and paper cracks on folds.
The impact of dry air can be so severe that printing stops altogether. Maintaining a relative humidity of 50-55% in the press hall and bindery resolves these issues.

Web printing

If air is too dry in the paper store, laydown area and reel stand, the exposed edges of the paper rolls lose moisture and shrink. On the web press, the paper is under greater tension at its edges than the centre, which causes the edges to tear, leading to web breaks. The result is substantial downtime as the paper is spliced or re-threaded through the press.

In a dry press hall, the rapid passage of paper through the press generates electrostatic charge, which becomes a problem as the printed work passes to finishing for cutting, trimming and folding, due to sticking paper.

Web printing is highly productive and any loss of production is costly, but problems relating to dry air can be addressed by maintaining the relative humidity at 50-55%. In flexographic printing, with water-based inks, 55-60% is required.

Low humidity results in conditions where moisture is drawn from the exposed surfaces of stacks of paper and they shrink, while the centre of the paper still has its original moisture content. This causes “tight edges” and the paper begins to curl. As a result, the paper misfeeds and creasing occurs.

Screen printing

High temperatures and low humidity disrupt the smooth flow of ink through the screens of the screen printing equipment, with the ink drying too quickly and blocking the screens. This had a negative impact on productivity.

The boring bit – calculations.

What temperature and humidity do I need to achieve in the print studio?

It is strongly recommended that a professional heating / air conditioning or humidification engineer calculates this duty but you do need to provide several pieces of information.

Many factors need to be known to calculate the amount of temperature and humidity that your press area will require. We will go into more detail later with regards to the construction of the space and its potential impact on these figures. Basically, the better sealed and insulated the studio is, the less temperature control and humidity you will need to put in. The smaller and cheaper the equipment provided, the less energy you will use, so that running cost are reduced – to the benefit of your profitability. For a press hall, the same rules apply but normally the space is less well sealed or insulated but, equally, will require fewer air changes.

Is the space heated or do you rely on the equipment in the area to provide the heat? Do you require heating in the winter? Cooling in the summer? Or cooling all year round?

You now need to know the amount of fresh air that will be brought in from outside, as this will need to be conditioned (heated, cooling and/or humidified).
This value is determined by the amount of fresh air which must be brought into a space where people are working, as laid down by the Building Regulations. For an area where people are active this should be 8-10 litres/second of fresh air [CIBSE (Chartered Institution of Building Service Engineers) Guide B2005 Section 2.3.21]

For small print studios of 4 people this equates to 0.04 m³/second of fresh air (the amount of air brought in through a standard domestic ventilation fan is around 20 litres/second (0.02 m³/s). This fresh air is brought in to replace the stale air, which could be high in carbon dioxide, to ensure operators are alert and working in an oxygen rich environment. It is probable that the print machine extract units will require more fresh air than is required for the operators.

Heat losses and heat gains occur through windows (even if double glazed), doors and poorly insulated walls or ceilings. The number of windows, doors and the construction of each need to be identified to be able to produce an accurate heat/cooling load figure.

Humidity is calculated by taking the lowest natural moisture level which occurs externally, taken from the humidity level required (40 -50% RH) at the temperature you require.

50% RH at 15°C has a far lower moisture content then 50% RH at 23°C. For this reason, we use the psychrometric chart shown on the right to determine the start and finish moisture content required. This is then multiplied by the total air volume entering the space, plus what is known as the ‘specific volume’ of the air.

Again, by providing the figures detailed below a calculation can be made.

**Required conditions:**

- Start temperature (assume 10°C).
- Temperature required (20°C).
- Humidity start condition (0°C, 80% RH – humidity on a cold crisp winter morning is naturally dry) 0.0028 kg/kg.
- Humidity set point (normally 20 -50% RH) 0.0075 kg/kg.
- Total air volume (room = m³ or air movement = m³/s).
- Fresh air volume (m³/s). Number of fresh air changes per hour (doors, mechanical ventilation or extraction)
- Number of windows / doors.
- U Value of insulation of walls and ceiling.
- Number of doors – frequency of opening (more unconditioned air entering the space).
Temp calculations

Your local air conditioning engineer can take your site information and put it into a computer modelling software to measure heat loads. They will consider many of the factors detailed above; for example shading of windows, location of premises and building construction plus thermal properties. A figure will then be produced showing the kW of cooling required for the space. This is then used to select the air conditioning or heating required to maintain the temperature that you require.

Information required
1. The size of the area to be cooled
2. Window sizes and positions
3. The number of people who occupy the space
4. Heat from electrical equipment, machinery and printers.
5. Heat from lights
6. Air changes per hour

Humidifier calculations

What level of humidity is required and what level of control is acceptable?

Different applications will require different levels of humidity control. For most common applications, the target requirement will be 40-60% RH. At this level people are comfortable, static build-up is reduced and hydroscopic materials are stable. Printers may need to control humidity to a tighter 50-60% rH.

Information required
1. Size of room
2. Amount of fresh air (untreated air changes per hour)
3. Amount of air conditioning (kW) as this can dry the air.
4. Humidity conditions required and at what temperature.

\[(\text{Air volume (m}^3) \times \text{moisture to add (kg/kg)} \times \text{air changes per hour}) \div \text{specific volume m}^3/\text{kg} = \text{moisture to add in kg/hr}\]

Utilities

Power
Climate control equipment will require a suitable power supply. This will usually be electrical power and often 3 phase (400V) for an industrial / commercial property. It is important to know what power you have available to use. Other devices can use 230V power and some can use gas. Be aware of the site limitations as this can greatly affect the selection of equipment.
Water
Mains water is required to serve the humidifier. This should be supplied to the property in a minimum of 22mm copper pipe and be at an operating pressure of over 2 bar minimum. You may well require a greater pressure for your hot water boiler and the flow rate should be checked. A good plumber or heating engineer will be able to advise.

Drain
The humidifier requires a drain which can take water up to 100°C, normally a copper drain pipe leading to the normal waste drain. Humidifier and air conditioning drains should not be put into rain water drains.

Things you will need to know before speaking to a heating / humidity contractor

1. What are the temperature and humidity conditions required?
2. How much heat energy will the equipment give off?
3. Do you have a floor plan? Do you have a proposed digital print studio layout?
4. Who is going to project-manage the climatic equipment installation?
5. Where will the cooling / heating, humidifier and air movement system be located?
6. Where are the services located? What is the maximum rating of the services?
7. Are you planning to condition the whole area or, in the case of a larger press hall, are you looking for localised humidity control?
8. What is your budget for providing the heating, humidity and air movement?

Digital press studio budgets
Purchase costs for studio approx. 200m³
Heating / cooling- £15,000 - £20,000.00
Humidity control £3,000 - £6,000
Ductwork and installation £2,000 (all in one system)- £10,000

Litho press hall
Purchase price of a press hall of 8,000m³
Heating - £20,000- £30,000.00
Cooling – only practical via adiabatic cooling and or ventilation = £40 - £60,000.00
Humidity control £10 - £20,000.00 (can provide some of the cooling if required)

Humidifier running costs
Typical temperature / humidity costs for a 200m³ print studio:

Temperature would be approx. 18kW
Humidity control approx. 12kW

For budget purposes if we assume the worst-case scenario where the system is operating at full output for the whole time, we can estimate the electrical running costs to be.

All electric
30kW of electrical energy per hour at 10p per kWh
10p x 30kW x 8 hours
Total = £24 per day

Print hall climatic conditioning and design 11
This could be halved as the temperature and humidity units will modulate down when condition is required.

**Gas heating and electric humidifier (steam humidifier)**
18kW of gas energy at 8p per kWh
Heating 8p x 18kW x 8 hours = £11.52 per day
Humidifier (steam) 10p x 12kW x 8 hours = £9.60
Total = £21.12 per day

**Heating with gas and cold water adiabatic humidifier**
18kW of gas energy at 8p per kWh
Heating 8p x 18kW x 8 hours = £11.52 per day
Humidifier (adiabatic) 10p x 2kW x 8 hours = £1.60
Total = £13.12 per day
Temperature control

Two basic types of heating are possible – radiant / infra-red or warm air heating. The radiant panels are generally ceiling-mounted units which heat the objects in the room rather than the air. Warm air heaters do as the name suggests, heating the air and distributing it around the space.

Heat
- **Warm air ducted electric heating**

Air is heated with an electric heater and transported into the studio by a fan. Generally, the air will be recirculated to maintain temperature control, with the possibility of adding fresh air. This system provides constant air flow and conditioned air moving into and around the studio providing a stable air condition. Ductwork should be positioned to allow a flow of air from the supply to the return air.

This warm air flow allows for the addition of humidity, which is normally delivered via a steam humidifier.

The temperature of the air means that the moisture evaporates very quickly to achieve the required moisture content in the air.

Return air allows the studio air to pass through a filter to maintain good air quality in the studio.
Fresh air can be added and this can be pre-heated by using a heat exchanger, which would remove heat from the extract air and pass it into the incoming fresh air. This reduces the heating load on the system but is not essential. Fresh air ensures that CO₂ is kept to a minimum and oxygen levels are kept high.

Using electric heating means that installation is relatively straightforward and does not require a flue, as would gas heating - which would also require planning consent.

At current energy prices, electric heating will result in higher running costs than gas.
- **Ducted warm air gas**

This is possibly the most commonly used heating system as it is favoured by many heating engineers and would commonly be used for heating large areas such as press halls. The units are normally suspended at high level with the heat entering the space directly from the heater. Convection or ceiling stratification fans provide the air movement and distribution.

These systems can also be adapted for use with ductwork, allowing the gas heater to be situated outside the studio. Warm air is then introduced to the studio via ductwork, in a similar way to the electric duct heater. This arrangement can also incorporate humidity control. Return air would be via ductwork into the plant room and back into the heater.

The issue with some of these systems is that modulation of the burner is crude, so when the system reaches the required temperature set-point the burner and fan turn off. This start and stop airflow can be irritating to the operatives and provide erratic control. Re-ignition of the burner may also be noisy.

Installation of these units must be by gas specialists and may also require planning consent. However, they are economical to run and straightforward to use.

- **Direct air electric wall or mobile**

This is by far the simplest system to use as these units sit in the space and produce heat until their internal thermostat registers that the required temperature has been reached. There is no installation as they are plugged into the mains and are therefore excellent for moving from studio to studio where temporary solutions are required.

This is probably the best system for temporary or very small, low budget applications.
- **Infra-red heating**

Infra-red heating is described as a more natural heat, replicating the sun’s rays. Radiant / infra-red panels heat the object and not the air within the room. Radiant panels are usually about 25mm thick and approx. 60mm x 120mm in size with a resistive wire embedded inside the panel. These provide an alternative to warm air heating and are often used in applications where heat is continually lost through open doors or windows – or in spaces that are only occupied infrequently.

**Infra-red panels** may be selected for the following principal reasons:

1. They are easy to install - no pipework, no moving parts, they come with brackets.
2. They are easy to control - one thermostat connected to one circuit.
3. You can move them if you want to change the design of the room.
4. They blend in with the design of the room - they are designed to be discreet.
5. The heat is instant - you can feel the infra-red heat when you stand directly under the heater.
6. They are energy efficient and green - no harmful gases or emissions, perfectly safe.
7. The infra-red waves emitted from the heaters will be absorbed by the surfaces and the people within the room. It has been stated that the human body can absorb 98% of the infra-red waves that are emitted from the heaters, meaning you can literally feel the heat from within and the heat will not be wasted.
Advantages and disadvantages of warm air vs radiant heating

Advantages of warm air
1. Adjusts to room conditions quickly.
2. Suitable for gas or electric.
3. Additional requirements can be met within the system such as fresh air supply, essence, filtration, humidity control.
4. Even air temperature throughout the studio.
5. Easy to control and adjust set point.
6. Can be portable if an all-in-one system.

Disadvantage of warm air
1. Requires specialist design.
2. Can be noisy.
3. Requires regular maintenance and spares.
4. Can be expensive to run in a poorly insulated studio.
5. Requires duct work and installation.

Advantages of radiant heating
1. Can heat people in the space quickly.
2. Quiet.
3. Simple to operate.
4. Ideal for home use – portable units available and inexpensive.

Disadvantages of radiant heating
1. Expensive to operate for large areas.
2. Can be 60% greater energy use compared with warm air heaters.
3. Uneven heating – heats the head first which can cause health and comfort issues.
4. Provides different intensities of heat – tall people will be effected in different ways to shorter people.
5. Can cause burns or fires if not installed correctly – some panels heat up as well as down so insulation is required above the panels.
6. Some units glow red or orange causing a distraction.
7. Difficult to regulate.
Evaporative (Adiabatic) cooling

To evaporate 1 litre of water into the air at any temperature takes 680W of energy.

Steam humidifiers get the energy to boil the water from the fuel source (electricity or gas). The 100°C water then has enough energy within it to change its state without changing the air temperature.

Cold water humidifiers do not have this external energy source, so take it from the surrounding air as heat energy which causes the temperature of the air to fall. This energy matches the energy required for evaporation, so equates to 680W of cooling in the air.

Cold water humidifiers can therefore be used to provide cooling with very little energy use. For instance, a cold-water spray humidifier or an evaporative matrix humidifier will only require a small pump to create the effect. The energy used will therefore be far less than the heat energy taken from the air, making this process very efficient and cost-effective for cooling large air volumes, compared to traditional air conditioning.

This is not a new concept – nearly all Mediterranean village squares have a fountain. This is effectively an evaporative cooler which allows the locals to sit comfortably in the summer sun.

When employing this in modern day installations the options are to introduce the moisture directly into the air (in the room or an air handling system) - or to use the evaporative effect but to then pass this cool humid air over a heat exchanger to achieve cooling without an increase in moisture.
Direct air Cooling

Adiabatic (evaporative) cooling via ceiling or floor mounted evaporative coolers can provide direct air cooling. Direct cooling would also add humidity to the space and would require ventilation to extract the moisture to retain the cooling effect. These systems are best suited to larger litho or press room applications as they offer the best value for money per kW of cooling.

Evaporative humidifier for space cooling / humidity.

Wall mounted factory evaporative cooler.

Spray humidifiers also achieve adiabatic cooling in the space and can create a cooling effect for a fraction of the cost of traditional air conditioning. However the addition of moisture must be considered, so this form of cooling is often employed with extract fans to remove the humidity and to allow the spray to continue running.
Factory high pressure water spray humidifier – at high level below the duct.

This method can also be employed in an air handling system where a spray or evaporative cooler is positioned in the airflow. This allows the cooler air to be distributed through ductwork and vents to the areas that require cooling.

Evaporative humidifier in duct

INDIRECT EVAPORATIVE COOLING

This method uses a heat recovery unit to remove the temperature from the supply air by passing it through a heat exchanger where the opposite air flow has been cooled by adiabatic means. This is sometimes achieved by cooling the exhaust air or by using a separate air flow to be cooled by the addition of evaporated moisture. This method ensures that the airflows do not mix, thereby ensuring the supply air has the benefit of the drop in temperature but without the negative effect of high humidity. This is a very energy efficient way to cool a large air volume such as that serving a press hall, although it does generally require purpose designed equipment and is not easy to retrofit to existing systems.
**DX splits systems**

Air is cooled by passing it over a series of pipes called a cooling coil which reduce the air temperature. The evaporator (located inside the room air conditioning unit) absorbs heat from the air through the process of expanding the refrigerant flowing within it. The refrigerant then flows to a compressor which compresses it causing it to condense in the condenser and release the heat it removed from the supply air. The condensed liquid refrigerant then flows through the thermal expansion control device which controls the flow and pressure of the refrigerant back into the evaporator.

This is the most frequently used solution as it is the simplest to install and operate. The down sides are the energy they consume and the drying of the air as it is passes over the cooling coil. This may not be a welcome effect for a printer.

These are commonly supplied to many digital print applications as they are simple to install and are relatively low cost. They do have a high energy usage but offer good temperature distribution throughout the room.

They are generally positioned on the wall or on the ceiling.
**Fan coils**

A fan coil unit (FCU) is a simple device consisting of a heating and/or cooling heat exchanger or 'coil' and fan. It is part of many HVAC systems found in residential, commercial, and industrial buildings. A fan coil unit is a diverse device sometimes using ductwork, and is used to control the temperature in the space where it is installed, or serve multiple spaces. It is controlled either by a manual on/off switch or by a thermostat, which controls the throughput of water to the heat exchanger using a control valve and/or the fan speed.

Due to their simplicity and flexibility, fan coil units can be more economical to install than ducted 100% fresh air systems (VAV) or central heating systems with air handling units or chilled beams. Various unit configurations are available, including horizontal (ceiling mounted) or vertical (floor mounted).

The air delivery is generally through grills in the ceiling to deliver cooling directly over the machine or heat load to deliver best comfort. They have a higher capital cost than split systems but offer more flexibility and can deliver fresh air into the space. They are ideal for larger digital print rooms.
Unique all in one cooling and humidity tower for digital printers

Eiger

Description
The Eiger tower is designed to be an all-in-one solution for providing a controlled environment for a print application.

Temperature and humidity controlled air is delivered into the space to ensure that the ideal condition is achieved and delivered to the space, thus maximising production in an optimum environment.

Heating, cooling, humidity, air movement, air filtration and fresh air are all delivered by this single, easy to install unit, which is positioned in the space and delivers the conditioned air via flexible fabric duct. Air is returned via the Eiger’s return air grill, where is it mixed with fresh air, conditioned and delivered back to the space. Close control is provided by internal air sensors and the state-of-the-art controller, which can be set by the operator to the desired conditions.

Designed with digital print studios in mind, the cooling removes the heat generated by the digital print machine (max 12kW) and then adds the humidity required to overcome low ambient moisture content and the moisture removed by the cooling process. This ensures
that the room is kept at a stable 22°C +/- 3°C, 50% RH +/- 10%, ensuring the digital print machine is at its optimum recommended climatic conditions (the Q zone) to ensure maximum machine speeds and quality of print - leading to maximum profits. Additionally, paper is kept at a stable condition, reducing paper curl and ensuring dimensional stability whilst also eliminating static.

Installation is straightforward. The Eiger unit is mounted on casters so is simply wheeled into position, connected to the services and connected to the external air conditioning condenser unit. Fabric ducting can be connected to the air outlet spigot and positioned to provide good air distribution in the space and around the printer.

**Ventilation**

Controlled ventilation is useful as it will ensure that sufficient fresh air is added to the space for employees, allows the removal of heat to help control temperature (dependent on external conditions) and can remove fumes from processes.

It is normally achieved by taking the ventilation directly off the machine or via roof vents with or without fans.

Air stratification can also be of use to ensure that the air temperature is even throughout the height of the press hall. This is achieved by a large fan gently forcing the hot air downwards, preventing it gathering at high level (thermal stratification).
Roof mounted evaporative cooling unit.

Air curtains

Pleasant climate control and climate separation

Manufacturing plants often have several requirements concerning working conditions and the environment. Air curtains offer solutions for spaces where physically demanding work is carried out. Fast and easy transport is always important, preferably without any draughts.

Powerful industrial air curtains effortlessly create a good climate separation where employees can work in a pleasant environment with forklifts and trucks driving in and out, while the doors are wide open without loss of environmental control. Systems can keep the indoor climate at the correct temperature whilst supplying the required fresh air.

An ideal scenario for many companies would be to effortlessly create comfortable working conditions and easy access at the lowest possible energy costs. Fully automatic industrial air curtains and air heaters make this possible.
Plastic curtains

Plastic curtains are an inexpensive solution for controlling air movement from a conditioned space to an unconditioned space, helping to prevent energy wastage and save money. A good divide over doorways is ideal for controlling temperature, dust, smoke, heat loss and humidity issues in industrial, commercial and warehouse environments.

Humidity

General information on humidity control – why, how

Humidifiers come in many shapes and sizes ranging from large industrial units down to porcelain humidifiers hanging on radiators. The latter are a good choice for increasing humidity in a dry house in the winter months but they are not a viable solution for print applications.

The correct humidifier type and duty is essential, as is controllability.
Humidity is expressed as a percentage relative humidity (RH). For example, 21°C 50% RH is the ideal condition for a home or office – it is the condition that humans are most comfortable with as much of our body consists of water and at 50% RH our bodies give up very little water so we do not become dehydrated. At 20% RH at 21°C you would see paper start to curl and feel dryness in the mouth.

50% RH means the air is holding 50% of its maximum moisture carrying capacity. 100% would be fog – saturated with no additional moisture-carrying capacity.

What is sometimes misunderstood is that when the outside air in winter is say 2°C and raining heavily – this is clearly 100% RH. However, when this air is brought into a building and heated up, whilst its moisture level stays the same, the moisture-carrying capacity of the air increases as it is heated. In this example, this outside air condition would result in air at 21°C being at 27% RH. Even though the air was saturated when cold it is low humidity when heated – therefore in winter humidifiers work their hardest as the natural humidity is at its lowest.

This is also why to achieve 40% RH at 24°C you require a lot of water to be evaporated, so a good commercial or industrial humidifier is required.

**Sword hygrometer**

Used to measure the moisture content within a stack of paper. Widely used in the print industry to ensure that stock is kept in good condition.
Outside air WITHOUT humidification during winter time
If 1 m³ of outside air with an average temperature of –5°C and 80% relative humidity is brought into a space and heated up to 20°C, the relative humidity will fall from 80% to approx. 14% RH. The water content remains the same.

Outside air WITH humidification during winter time
To preserve a relative humidity of 55% RH at 20°C each cubic metre of fresh air at –5°C must have 6.97g water added after heating up to 20°C.
Dehydration

The human body is about 70% water and this is essential to the normal working of the body. It lubricates the joints and eyes, aids digestion, flushes out waste and toxins and keeps skin healthy.

Dehydration occurs when the normal water content of the body is reduced. This leads to a change in the vital balance of chemical substances in the body, especially sodium and potassium. To function properly, many of the body's cells depend on these substances being maintained at the correct levels.

Even though your body is mainly made up of water, the amount of water in your body only needs to decrease by a few percent for dehydration to occur.

Symptoms - dehydration occurs when there is a 1% or greater reduction in body weight due to fluid loss. Depending on the percentage of body weight lost, dehydration can be described as mild, moderate or severe.

Humidifiers

- Steam electric (electrode, resistive or gas) in-duct
These are the most common humidifiers used in digital print studios as they increase the humidity with excellent control. Evaporation is fast so there are no problems of wetting or condensation. Evaporation distance in the ductwork or in the room under these conditions is typically less than 1m.

Electrode, resistive or gas humidifiers all produce the same result, which is sterile steam generated in a controlled manner with modulating output in response to a humidity sensor working to a set-point which is set on the humidifiers.

Electrode boiler

This is an entry-level steam humidifier but the most frequently used. It is powered by electricity and passes electrical current through the water contained in a polypropylene cylinder to generate heat / steam. The water level is varied by means of the water being boiled off or being regulated by the inlet and drain valves to proportionally vary the amount of current drawn and therefore the output of the unit. The more water, the more current, the more steam generated.

As the pure H₂O is boiled off as steam, creating the humidity in the space, the minerals contained in the mains water precipitate out as limescale. This stays in the cylinder and generally forms sheets of scale which must be removed as part of the maintenance programme. This can be by using a cleanable cylinder or more commonly by replacing the disposable cylinder.
In a hard water area where the units work regularly scale removal could be required as frequently as once every 6 weeks. In a soft water area, the cylinder could last for a year. However, this is a good workhorse humidifier that is simple to use and provides excellent control.

**Resistive steam**

These work like a kettle, in that a heating element heats up the surrounding water to produce the steam. As the unit does not pass current through the water a stainless-steel tank can be used, making this type of unit robust and more tolerant of scale build-up.

The tank is designed to have the scale removed by cleaning, with the elements mounted on the tank lid making them easy to remove and for the tank to be cleaned. Thus, fewer consumables are required and maintenance is less frequent than on the electrode boiler but the capital cost is higher.
Gas fired humidifier
Gas is burned to generate hot gases which pass through a heat exchanger, heating the water in the tank. These are suitable for large projects as the minimum duty of the gas humidifier is 40kg/hr. Whilst the fuel is less expensive than electricity, the installation requires more design and expense as a flue needs to exit the building - which may require planning permission and will limit options for positioning the humidifier.

Steam humidifier water treatment
These are maintained in a similar way to the resistive & gas humidifiers and both can operate with reverse osmosis water, which removes the scale from the water. This makes the humidifiers virtually maintenance free – however the capital cost of this water treatment may mean that it is not an economical solution.

Water softeners should not be used, as when the water is boiled it acts like boiling milk, creating a foam on the top of the water which can create problems with water level control. Also, in the absence of calcium, the minerals in the water create sheets of hard scale forming a ‘mud’ which will eventually block the water inlet and outlet ports. This leads to rapid deterioration in the time between required maintenance procedures so no advantage is gained.

Steam electric in room
Where space is an issue and the humidifier cannot be housed in a separate room, or if no warm air ductwork is available, then the advantages of the steam humidifier can still be accommodated by either installing the humidifier outside the space with a fan unit in the room, or by introducing the moisture through a wall mounted grille. This method does not achieve the same degree of distribution within the space but still maintains an even control of humidity. Fan noise can be a concern but there are many examples where this approach has worked very successfully.

VGL – steam humidifier wall mounted with fan head mounted on top of the humidifier.
A humidifier with two fan units to help with moisture distribution can be put on the wall. This method is controlled using a room humidistat or sensor.

Humidifier mounted externally with vent into studio

Room mounted humidifier, vent on humidifier.

HP indigo with humidifier on wall to the left of the press
Live steam

Not often used unless the site has a central steam boiler, from which the humidifier can take a steam supply - which is then controlled by the steam valves to control the volume of steam entering a duct.
Cold water spray in room

High pressure water is a quiet energy-efficient way to humidify a studio or larger press hall, with the humidifier pressurisation pump being mounted outside the studio and the humidifier heads mounted on the walls, pillars or suspended from the ceiling at high level.

Above is a studio which has fresh air ducted in and wall mounted heaters with the humidifier heads positioned on each pillar in the centre of the room to give good moisture distribution.

These systems are extremely energy-efficient, requiring only 2kW of power compared to 24kW 3 phase for a 30kg/hr steam humidifier.

These systems do require more design and installation but the effect can be very cost effective and provide free adiabatic cooling. When selecting this type of unit care should be taken that the ceiling height is sufficient to allow for the sprays to disperse before reaching the head / raised hand height.

For large areas, the heads are installed as shown which allows for a large duty to be evaporated in to the press hall without concerning the operators or machinery.
Low pressure compressed air and water humidifier

Uses compressed air to generate the atomising energy rather than the high-pressure pump. The air and water is mixed in the nozzle head which creates the atomised water. The spray water droplet size is generally larger than the high-pressure water system so the evaporation distance is longer. These systems are rarely installed today as they require compressed air and two pipes to serve each head (compressed air and water). The compressed air is expensive to run, the installation is more complex and the heads produce noise as the compressed air exits the nozzle. This technology has been superseded by the high-pressure water systems but can still be seen in some large press halls where compressed air is plentiful.
**Spray in-duct**

Using the same technology as the in-room high-pressure nozzles, the in-duct system pulses the different zones to provide a modulating output within the duct or air handling unit, responding to the controlling sensor and the condition of the air in the return duct. It provides excellent control but is generally only installed where the plant has been designed to accommodate a cold-water humidifier.
Evaporative Humidifier

Relies on the warm air passing over the wet matrix to evaporate moisture from its surface to humidify the air. It has the same design considerations as the in-duct nozzle system in that it is an adiabatic system. It does not have to incorporate the spray pattern so uses less duct / air handling unit length.

- **Rotary atomiser in room**

  This is ideal for print areas where the ceiling height is above 4m to allow for the spray pattern to be incorporated without wetting. This is an adiabatic (cold water humidifier) so cools the air slightly whilst creating the humidity required.

  The spray is cruder than the high-pressure spray unit and the device is not as aesthetically pleasing but, nonetheless, is effective. This system must be installed with water hygiene processes to ensure that the water does not stagnate and to prevent bacteria breeding.

- **Mobile evaporative / ultrasonic**

  Only suitable for small print or storage areas where there is little airflow and the space is enclosed.

  This would fall into the domestic / office humidifier bracket and whilst they will create a comfortable environment they don't offer precise control. But with a small amount of fresh air entering the room they still offer a great solution. They normally use a 13-amp domestic power supply and can operate off a tanked water supply.

  Evaporative units such as the one shown in the picture below should be positioned close to a heater source to increase the effectiveness of the evaporation process and to put the...
maximum amount of water in the air. The hotter and drier the air, the more moisture will be given off by the humidifier.

Small ultrasonic units also work well as they positively spray moisture into the air – however do be aware that unless they are used with demineralised water they become scaled in a hard water area and fail after a short period of time.

Options

Heat recovery units

HRUs (heat recovery units) work by adding fresh air to the room through ductwork whilst removing an equal amount of stale air. The heat recovery unit will retain up to 90% of the heat being expelled from the room by transferring this heat energy into the cooler fresh air entering the room. This pre-heats the incoming air, thereby reducing the amount of new heat energy required to bring it up to the desired room condition.

The heat recovery unit does have a capital cost, a cost of installation and a small running cost but the payback time is usually short when compared to the heat energy that would have been required to heat the incoming air without any pre-heating.

Within the heat recovery unit, there is a cross flow heat exchanger which allows the two air flows to transfer heat energy without any mixing of the two airstreams. The air is normally moved via a small fan built into the heat recovery unit.

Reverse osmosis water

Water treatment is the other possible requirement for this unit. The pure H₂O will be evaporated into the air to create humid air but any dissolved solids (scale) in the mains water will precipitate out as a mineral dust. This can be removed prior to the humidifier with water treatment such as reverse osmosis, which removes 98% of minerals from the water, prevents the dusting and extends the life of the nozzles. This is an option to be discussed with your provider. What does need to be included is an ultraviolet sterilizer and a built-in water management system within the humidifier to ensure that the system is hygienic.
Dependent on the water quality it may be necessary to run these plants with a water softener and or a carbon filter to remove the hardness and chlorine from the water respectively. Both can reduce the life of the reverse osmosis membrane. Other dissolved solids such as iron and silica can also be of concern.

**Ductwork**

**Steel ductwork**

Steel ductwork is simple to use and can be put above or below the ceiling dependent on the design and look of the studio you wish to create. If it goes above the ceiling then ceiling grilles can be positioned to provide supply and return air pathways for the heating system.

Alternatively, the ductwork can be exposed, giving a more industrial appearance.
Ductwork lagging

When the duct carrying the hot air for your studio runs outside the studio area, whether this be above the false ceiling or through some other part of the building, it is essential that the duct is lagged as much as possible to prevent heat loss. This will reduce energy bills and ensure that heating demands are met. It is also possible that with good insulation the size of the generating equipment could be reduced in size and capacity at design stage.

Fabric ductwork

Instead of using traditional metal ductwork, custom-made fabric ducting allows air to be dispersed uniformly throughout the studio and can be colour matched to your studio decor. It can be laundered and is antimicrobial so is both practical and visually interesting.

Low in capital cost and with a wide selection of styles and outlets to suit airflows and velocities, the fabric duct is a versatile solution.
Different air outlets in fabric ducting

Different shapes to suit the studio layout

Half circle fabric duct – in red

Controls

The best equipment in the world is useless unless it is controlled properly. It is a good idea to make sure that the sensors and controllers controlling your heating, humidity, air movement and fresh air are providing what you require. It is very easy to complicate the controls technology or philosophy - but be clear in your mind what you need and want to achieve with regards to conditions and stick to this. 'Nice to haves' often cost a lot of money for no real gain in control or conditions.

Be mindful that if you ask for very tight control (40°C +/-1°C) you will have to pay for high specification equipment where realistically +/- 5% around the set point is usually satisfactory.
Also bear start-up times in mind. If you want your studio to go from 20°C to 40°C in 5 minutes this is possible but the heater will have to be 3x bigger than required to heat the space in, say, 30 minutes. Having the larger heater will cost more to purchase and install, probably take up more valuable space and cost more to run and maintain.

In addition, all the components (filters, fans, humidifiers) will have to be sized accordingly and power supplies will need to be enlarged.
Dehumidifiers

Choosing between a desiccant dehumidifier and a refrigeration dehumidifier

There are pros and cons to both types of dehumidifiers. The important thing is to understand what the differences are and then make sure you choose the right one for your needs. As a general rule desiccant dehumidifiers perform better at very low temperatures and humidity’s, and are therefore more suitable for storage areas or properties which are unoccupied, or have below average levels of heating. A desiccant dehumidifier will cost more in energy to run. This is because it uses heat to dry out the material which absorbs the water. A desiccant dehumidifier will also be lighter and quieter because it does not contain the refrigeration circuit. However most of the noise from any dehumidifier comes from the fan and this will be similar for both.
A refrigeration dehumidifier will perform better at higher temperatures and lower humidities, which are the conditions normally found in occupied homes in Britain. They are also more energy efficient because they rely on refrigeration rather than heat to extract the moisture.

If your property has consistently below average levels of heating, then a desiccant dehumidifier would be the right choice for you.

If you have normal levels of heating throughout the day, then a refrigeration dehumidifier is by far the best choice for you. It will perform better and cost you significantly less to run.

Applications: store rooms, staff changing rooms, wash down areas

Maintenance

As a printer, you will be spending your hard-earned cash in setting up the press hall to make it as good as you possibly can. Like a car or boiler, the equipment heating and humidifying your space will require maintenance from time to time. This is vital to ensure the smooth running of your studio.

Qualified engineers can provide valuable planned maintenance
Emergency call-outs can be expensive, disrupt productivity and damage your reputation with customers. It is therefore strongly recommended that you take out a maintenance contract with your supplier.

You will then receive planned maintenance, which can fit around your schedule, at a considerably lower price than the cost of an emergency call out, while also providing peace of mind. Not putting this in place is really a false economy.

**Project Management**

Project management of the studio build should not be underestimated. If you are not an experienced project manager, or do not have the time to be fully involved, then it is worth employing a professional. If you undertake this position then you will be taking a lot of the design responsibility, checking the compatibility of various suppliers’ equipment, ensuring they will operate and communicate with each other. A project manager will handle all liaison between suppliers and allow you to manage the budgets and studio design – wherever your strengths lie.

A good project manager will be able to plan the construction process and arrange for relevant trades to attend site at the most appropriate times and in sequence to reduce their on-site time – which helps to keep expenses down and accelerate the overall project schedule.

Stick to the agreed design – changes will slow progress and incur costs.

With efficient management and planning the project has every chance of being completed on time and on budget.
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