Information guide

Building drying technology

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Comprehensive Support

Comprehensive engineering support is provided by our experienced and well qualified team.

Calorex units are designed, tested and manufactured in the UK, and supported by our comprehensive customer service organisation

Introduction

Calorex is a leading British manufacturer of heat pumps and dehumidifiers. With nearly 40 years of design expertise, Calorex is renowned for its innovation, range and quality of products with an expert sales and services team dedicated to meeting our customer's requirements. Our presence is international with thousands of Calorex units operating in over 60 countries worldwide.

The company

Based in Essex, Calorex is a privately owned company specialising in designing and manufacturing heat pumps and commercial/industrial dehumidifiers and is acknowledged as being one of Europe's largest producers of refrigerant dehumidifiers and associated equipment.

Calorex, in conjunction with Andrews Sykes pioneered the concept of building drying as long ago as the early '80s and whilst the companies are now separately owned, Calorex has continued to develop the concept of building drying both in technical understanding and machine design.

Today Calorex are able to offer a complete turnkey service from sizing, supply, service and maintenance of a range of building dryers and associated equipment such as air movers and portable electric heaters that are especially designed for construction sites.

The concept

A vast majority of materials that are used to construct new buildings are applied as a wet process. Concrete slabs, screeds, plaster, wall and floor coverings are all applied in this way.

As these processes cure, vast amounts of excess moisture are liberated into the building space. The speed at which this moisture is released will dictate the curing or drying time of the material. Controlling the building space temperature and humidity will effectively control the speed at which this happens.

Traditionally, simply ventilating the space to allow the moisture to escape was accepted as a means of drying and more recently ventilation with heat is adopted, but with unpredictable results and high energy costs. Either ventilation or heat and vent will remove moisture from the building space, but unless the incoming air is able to act as a means of drawing moisture from the wet processes, little is achieved. Heating the incoming air to artificially improve its ability to remove moisture will provide some effect but fundamentally do little to improve the overall performance, as heat does not dry the air rather simply changes its temperature (see psychrometric chart). Further it is important to realise that the use of direct fired gas heaters will introduce into the building 1.6kg of moisture per kg of gas burnt – a reverse action to drying the space.

It can be easily understood that by controlling the space conditions in an economical way that is not affected by outside air conditions will prove to be the most effective and consistent method of drying. Building dryers provide the ideal means to effect this.

Building dryers are refrigerant dehumidifiers that can be controlled to provide desired humidity and temperature. They recirculate the building space air, rather than continuously replace it and in doing so remove moisture from it. As an added bonus building dryers will reheat the air and provide up to 2.5 kW of heat for every 1kW of electricity they consume, this is achieved by the refrigeration circuit's unique ability to convert latent into sensible heat.

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From the below tables, it can be seen that conditioning the space air by recirculating it through a building dryer will not only provide consistent drying but at a fraction of the cost associated with heat and vent.

If we take a building dryer that costs £1000, payback time against heat and vent will be approximately ten weeks – quite amazing considering the life cycle of a building dryer is over ten years.

Relative humidity in London

	Relative humidity (%)	
	0700-1400 hours	1400-0600 hours
January	88	89
February	72	89
March	60	86
April	54	81
May	54	79
June	54	81
July	55	85
August	60	90
September	69	93
October	78	91
November	82	90
December	84	93

Ventilation assists dehumidification

Ventilation has no effect

Ventilation leads to rehumidification

Air changes to dry a screed floor

Weather conditions	Outside air conditions	Temp. difference	Inside air conditions	Required total air changes	Cost	
					Conventional heat&vent	Building dryer
Summer day, blue sky	24°C/50% RH–9.5g/kg	0°C	24°C/90% RH–17.0g/kg	426	£56	£36
Summer day, overcast	24°C/80% RH–15.2g/kg	0°C	24°C/90% RH–17.0g/kg	1777	£231	£36
Autumn day, blue sky	10°C/50% RH–3.8g/kg	0°C	10°C/90% RH–7.0g/kg	1000	£131	£36

Example data: room size 150 m^2, 375 m^3 volume, 40mm concrete floor

Understanding the properties of air

In order to fully appreciate the physics of drying, it is important to understand some basic properties and behaviour patterns of air. The psychrometric chart is a graphical means of displaying the physical properties of air at differing atmospheric conditions. An example psychrometric chart can be seen on page 7.

The principles are as follows:

Dry bulb temperature

Shown along the horizontal axis of the graph – this represents the actual air temperature that we know as air temperature.

Wet bulb temperature

Shown along the left-hand vertical axis of the graph – this represents the actual air temperature after the chill factor caused by moisture within the air is taken into account. The wet bulb will always be lower than the dry bulb unless there is zero humidity present.

Relative humidity (%)

This describes the amount of moisture contained within air at a specific condition as a percentage of what it could contain if completely saturated. It is important to realise that air is capable of containing differing amounts of moisture – the warmer the air, the more moisture it can contain. It therefore stands to reason that if air is heated or cooled without removing moisture from it the humidity will either fall or rise accordingly.

Moisture content

Shown along the right hand vertical axis – this shows the amount of moisture which air contains at differing conditions. It is expressed as weight of moisture per kg of air. Its value does not change if the temperature of a given quantity of air is changed.

Saturation line

This is the curve, which runs along the far left-hand side of the graph – it shows the point at which air can contain no more moisture. It is the same line as the 100% relative humidity curve. At this condition any cooling effect of the air will result in precipitation of moisture (condensation).

Specific volume

This refers to the volumetric quantity of air (m^3) per kg of weight. Useful when converting moisture content which is shown by weight to a volumetric value (m^3).

Summary

A basic understanding of the psychrometric chart will enable the user to determine how effective air at differing moisture contents, humidity's and temperatures would be for drying, how much moisture needs to be removed in order to achieve a particular moisture equilibrium and at what point condensation will form on surfaces.

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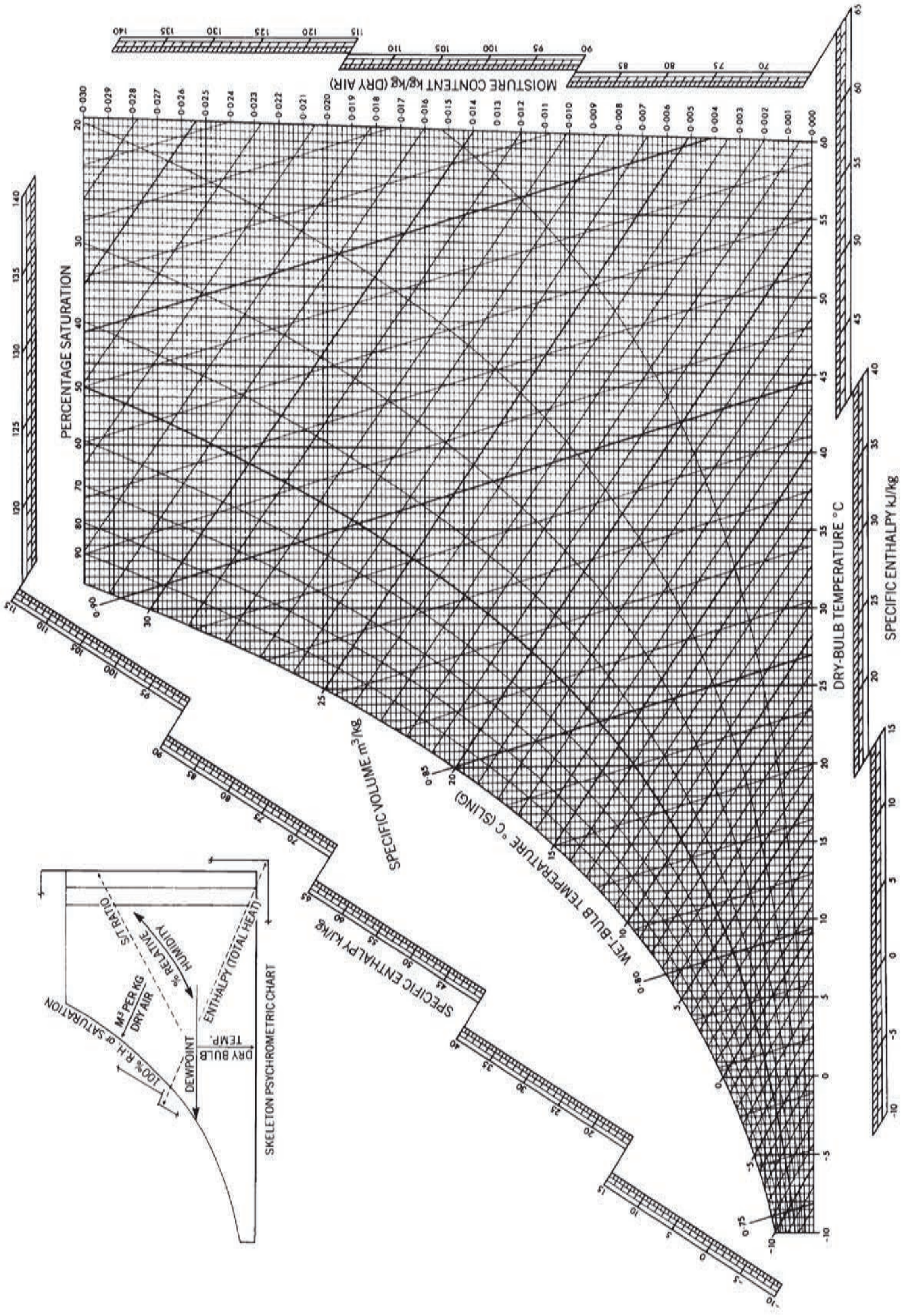
Psychrometric chart



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The principle of concrete drying

For the purpose of understanding the physical drying process of floors Anhydrite and traditional concrete can be considered together. Either substance is laid as a wet process and cure to their respective strengths during drying. It is extremely important to understand that there are effectively three drying phases and that the drying technique will affect all three.

Phase one

Immediately after a floor is laid initial excess water will lay on the top and gradually evaporate into the building space. This water is easily removed, as there is no resistance to hold it into the floor. After this water has evaporated (which may be anything up to 24hrs) the floor is generally solid. During this process the floor should be allowed to dry through natural methods. If the air temperature is higher than 24°C it is advisable to control the drying speed by damping the floor with water to prevent drying too quickly.

Regardless of the floor condition, neither building dryers nor heat should be applied to the process until the floor has laid for 48hrs and three days for Anhydrite and concrete floors respectively.

Phase two

As the floor is solidifying its strength is gradually increasing. This is due in part to a chemical reaction, which is bonding the crystallised structure together. During this phase the floor will contain 1000s of arteries that allow moisture to run through them to the surface. This is known as capillary action and provides a means for most of the excess moisture to leave the floor.

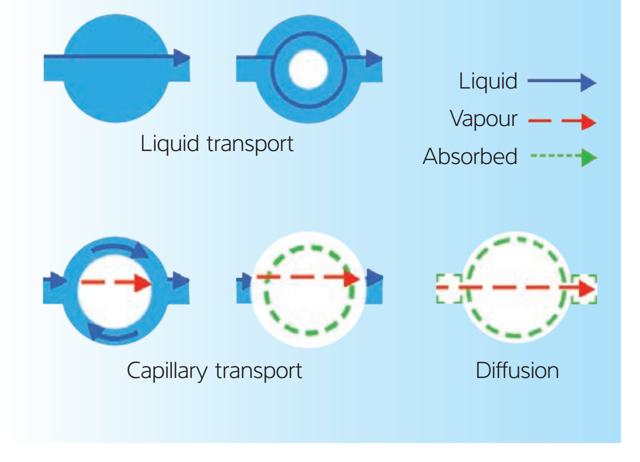
The difference and thickness of the vapour pressure barrier between room and floor will dictate the speed at which moisture moves during this process. At this point building dryers play an important part as they create a controllable vapour differential and in the case of Anhydrite floors can minimise the vapour barrier thickness which has proved to substantially increase the final strength of the floor (by up to 50% over a floor which is dried in an uncontrolled way).

As the floor continues to dry and the crystal structure bonds together the capillary action will gradually slow down as the arteries are blocked. It is important to remember that over drying by oversizing equipment will cause the arteries to block prematurely and that the net result will be a slowdown in the overall drying time.

Phase three

Capillary action will cease before the floor is fully dry. The final phase of drying is performed through diffusion. This is a process where water vapour molecules find their way to the floor surface, again by vapour pressure differential but instead of running through capillaries they find their way individually threading themselves through the concrete pores. This process is substantially slower than the capillary action and explains why the overall floor drying time will increase if the capillary drying speed is not carefully controlled.

Moisture transport in building material during the drying process



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Drying speeds

Anhydrite

This material benefits substantially from drying in a controlled environment (low humidity) and by being smoothed off as soon as solid. The use of air movers to break down the vapour barrier between floor and air will further reduce the drying time. The comparison chart below shows differing drying times with/ without building dryers for different floor thickness.

Concrete

This material benefits substantially from drying in a controlled environment (low humidity) and by being smoothed off as soon as solid. The use of air movers to break down the vapour barrier between floor and air will further reduce the drying time. The comparison chart below shows differing drying times with/ without building dryers for different floor thickness.

Floor drying time

Conventional ventilation drying	Screed thickness	Anhydrite	Concrete	Remark
	40-50mm	6-8 weeks	6-8 weeks	up to 16 weeks
	50-60mm	8-16 weeks	8-16 weeks	
	70-80mm	12-18 weeks	12-18 weeks	sometimes more

Dehumidifier drying	Screed thickness	Anhydrite	Concrete	Remark
	40-50mm	1-2 weeks	1-2 weeks	if more than 2 weeks, wrong content
	50-60mm	2 weeks	2 weeks	
	70-80mm	3 weeks	3 weeks	if more than 3 weeks, wrong content

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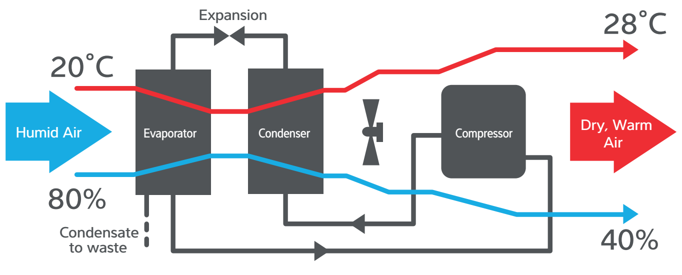
Operation and selection of building dryers

Refrigerant dehumidifiers

The preferred type of building dryer operates by the refrigerant principle. Similar in operation to a refrigerator, room air is drawn into the unit by an internal fan. Firstly the air passes across a cold coil where its temperature drops to dew point. At this point water is condensed out of the airstream and collects in a drip tray where it is fed away to waste. The air then passes across a warm coil where it is reheated to several degrees above its initial temperature.

The secret of a refrigerant dryer's ability to provide more heat than it consumes in energy input is in its ability to convert latent into sensible heat. This means that all of the energy removed as moisture during the dehumidification process is converted into useable heat and is further combined with the input energy to give out approx. 2.5 times more heat than it consumes in electricity.

How a Calorex dehumidifier works



The process of dehumidification involves moisture-laden air being drawn into a dehumidifier where the air passes across a refrigerated coil. The air is rapidly cooled below its dew point, condensing the water vapour and recovering its latent heat energy for re-use. The cooled air is then passed across the condenser where it is reheated and returned to the served area at the required lower relative humidity.

Building dryers are mobile dehumidifiers specifically designed to withstand the rigours of building site use. Primary points that all building dryers should include are:

- Rotary compressor to alow unit to be transported without damage
- Defrost system that allows the unit to operate at low temperatures. This is generally a hot gas defrost system that allows operation down to 0°C
- Sturdy mobile construction for case of transportation and longetivity
- Condensate pump options
- Non CFC or HCFC refrigerant. Generally the accepted refrigerant is R407C

Building dryer sizing

Air can absorb little moisture below 10°C. It is therefore advisable to size the machine for 10°C as a minimum temperature.

With this in mind the following maximum room volumes are suggested:

Porta-Dry sizing guide

	Porta-Dry 150	Porta-Dry 300	Porta-Dry 600
Internal temperature above 15°C	175m^3	350m^3	700m^3
Internal temperature below 15°C	150m^3	300m^3	600m^3

for drying buildings following construction, fire&flood damage, or simply preventing damp

In the event that heating ¡s considered necessary to maintain 10°C, the following heater sizes are recommended:

Porta-Cal sizing guide

Porta-Cal 25	3kW	Rooms up to 100m^3
Porta-Cal 65	12kW	Rooms up to 375m^3
Porta-Cal 95	18kW	Rooms up to 550m^3

or up to 110W/m² of floor

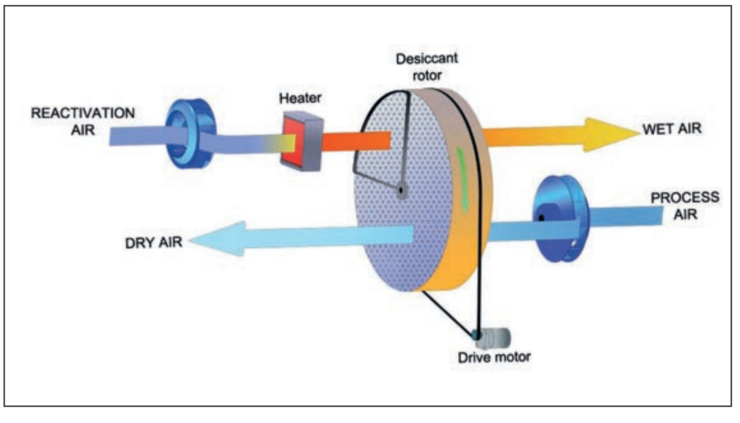
Air movers

Additional air movement across a drying surface is always recommended in order to maximise the building dryer's efficiency. Drying times will substantially improve if the vapour barrier thickness between floor surface and room air is minimised. Typically drying times will accelerate and floors etc. will dry uniformly, including corner sections, which are notoriously difficult. Ideally air movers should be selected to give 0.5 m/s airflow across the area to be dried.

Desiccant dehumidifiers

Desiccant dehumidifiers were developed to control extremely low humidity/temperature (below 30%RH or 0°C) applications. A desiccant dehumidifier contains a slowly rotating wheel which is impregnated with silica gel. Room air is drawn through the wheel that adsorbs moisture from the air stream. Dried air then returns to the room. In order to maintain a constant process a section of the wheel is constantly regenerated by outside air that is heated to approx. 120°C and passed across the regeneration section of the wheel. This process removes and discharges moisture from the wheel to outside the building. As some of the regeneration heat will carry over into the whole wheel, dry air returning to the room will be warmer than its entry temperature to the dehumidifier. Desiccant dehumidifiers are less suitable than refrigerant machines for building drying as they:

- May over-dry the room, ultimately slowing down the drying process (capillary action will cease prematurely)
- Consume four times more power than a refrigerant type dehumidifier
- Are high capital cost
- Contain a wheel that is sensitive to airbourne dirt



Summary

- Building dryers significantly reduce drying times for any wet process or water damage
- Building dryers don't dry by heating, which could cause over-drying and cracking
- Building dryers are efficient – they output 2.5 times the energy input as heat
- Building dryers do not rely on open windows or doors and are self-contained
- Calorex has 40 years of experience of drying using dehumidification – get in touch for technical advice for your application

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