WATER DAMAGE
RESTORATION

Drying Fundamentals

Property Damage Restoration | Temporary Humidity Control | Property Damage Prevention

Overview

Drying out a construction after flooding, or drying sensitive content after water damage is a skill. Materials are often soaking wet, or damp moisture has made hygroscopic materials sensitive to vapour absorption. In turn this moisture may create damage like the corrosion of metal parts, the chemical breakdown of glue and microbiological activity like mould growth in organic materials.

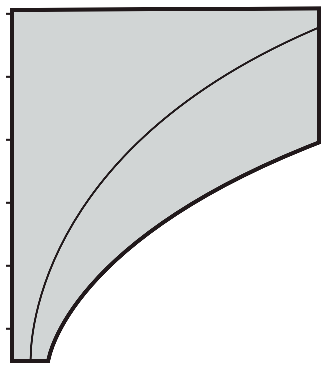
The challenge for the damage restorer is to dry out the construction and content with as little disruption as possible, while also allowing considerations for the drying of the different materials. For example materials like wood should not be over dried as this could cause cracking or bending. Therefore, it is of great importance to fully understand the behaviour of moisture in the air as well as materials. Drying times, climate and limits all relate to the physical properties of the materials dried.

This document tries to describe shortly in a few pages:

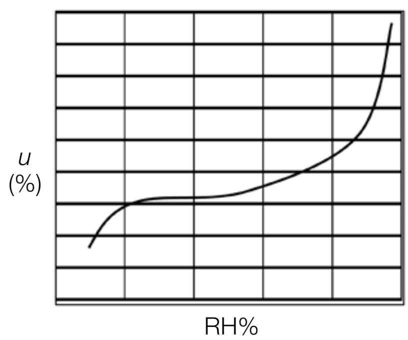
- The fundamentals of moisture in air and in materials
- The basic principles for drying moisture
- The basic principle for drying a wet construction.

SUMMARY

- Moisture is a combination of H2O, gas (vapour), liquid (water) and/or solid (ice)
- The vapour content in air circa 0-2% depending on climate
- Relative humidity (RH) is the amount of vapour in the air compared to the maximum content of vapour that air will hold at that particular temperature
- Temperature and vapour content are key factors in moisture, air and in materials.



The Mollier chart describes the relationship between the temperature of air, its vapour content and other properties.



The isotherm expresses the relationship between the water content in a porous material and the vapour content.

Munters

PART ONE

Moisture in air and in materials

Atmospheric air

Air in the atmosphere is composed primarily of fixed proportions of nitrogen, oxygen and water vapour and small quantities of inert gases. Other gaseous and particulate contaminants may also be present.

WHAT IS AIR?

Constituents of Atmospheric Air (in STEADY Concentrations)

77.5% Nitrogen

20.5% Oxygen

1% is: Argon, Neon, Helium, Methane, Krypton, Hydrogen, Nitrous Oxide & Xenon

Constituents of Atmospheric Air (in VARIABLE Concentrations)

0-1% Water Vapour

0-.5% Other Gases

The Other 1% is of Variable Concentrations

Water vapour and contaminants vary in their proportions. Under natural conditions, water vapour can vary from 0.01% to 2.0% by weight of the total mixture. Psychometric analysis is based on treating air as a gas composed of two substances, dry air and water vapour.

Dry air is defined as air from which all moisture and contaminants have been removed. Moist air, on the other hand is defined as consisting of the standard gaseous components (nitrogen, oxygen and inert gases) plus a varying measure of water vapour.

Humidity

Another important parameter is the humidity ratio, also called specific humidity. This is the ratio, by weight, of water vapour to a sample of dry air. Air has a considerable capacity for retaining moisture and this capacity varies directly with the temperature of the air. As the temperature increases, the capacity for holding moisture increases. If air at a certain temperature has absorbed all the moisture it can hold at that temperature, it is said to be saturated. Relative humidity is the ratio of the vapour pressure of water in a given mixture compared with the vapour pressure at saturation at the same temperature. Relative humidity is the most commonly used measurement for expressing water content in air.

Dew point

If air is saturated with water vapour at a given temperature a drop in temperature will force the air mass to relinquish some of its moisture as condensation. The temperature at which moisture condenses out is the dew point temperature.

Moisture in materials

Most materials contain a certain amount of water, except for glass and metals. Other materials such as insulation and paper can absorb and retain water if they get wet.

Moisture in a pore

In air with a certain relative humidity and temperature a porous material after a while will reach a state of equilibrium within the environment. For example the vapour content and the temperature of the vapour in the pores of the material will become the same as in ambient air. The porous material will exchange moisture with the ambient air until the point of equilibrium is reached.
The vapour in the pores will condensate to the pore walls due to surface tension effects in liquid water.

In other words: It is a direct correlation between the vapour content in the ambient air and the water content in the material. This correlation can best be described in the Sorption Curve or Isotherm.

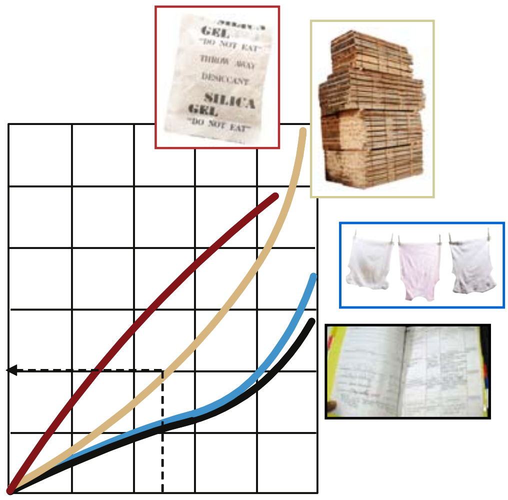
The Sorption Curve

Moisture content and relative humidity (RH) at equilibrium and at a constant temperature is called the sorption isotherm or simply the isotherm.

At low RH, condensation of vapour only occurs in the smallest pores in the material.

At higher RH, condensation of vapour starts also in the bigger pores.

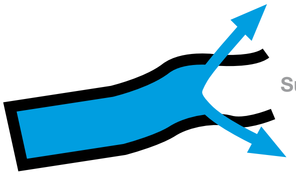
As a summary the water content increases with increased RH.



Different materials have a different relationships with relative humidity and water content

PART TWO

Principles for moving moisture

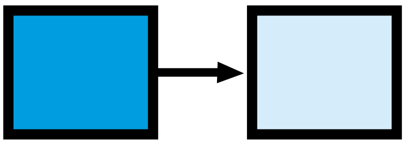


Capillarity suction

When water meets the entrance of a small tubular hole or pore in material, it can get sucked into it by what is known as capillary forces. In general, the smaller the pore, then the stronger the force is at sucking the water into it.

In very fine pores of a smaller material, all the water in the pore is affected by the capillary forces. In larger pores, only the water close to the surface of the pore that is close to the walls is bound tightly to the material and the water along the centre is free to move under other applied forces.

Capillarity suction is only of interest when the damage occurs and is the main principle for distributing water into a material fast.

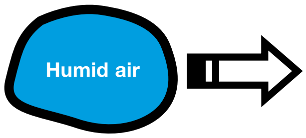


Diffusion

Is the slowest transport mechanism. Vapour transport through a material is encouraged by the difference in vapour content and by the temperature in the material.

Diffusion is the key factor when dehumidifying in depth solid materials like concrete or brick. It is practically the only way to move the moisture up to the surface where convection will remove the moisture.

If you want to read more about how a dehumidifier and other equipment dehumidifies materials and air, please read our “Drying in practice” datasheet.



Convection

The transport of water vapour on account of movement in the air, caused by differences in atmospheric pressure. Convection is a relatively fast course.

Convection is the key factor when drying surfaces. A rapid airflow removes the saturated air nearest the surface and replaces it with dryer air.

More in detail:

If the air is dry and the wind is blowing, then the water which is evaporated will be carried away, bringing more dry air in contact with the surface, allowing further evaporation and after a while, drying the surface.

Porous screeds absorb water slowly transporting it into the concrete through capillarity suction.

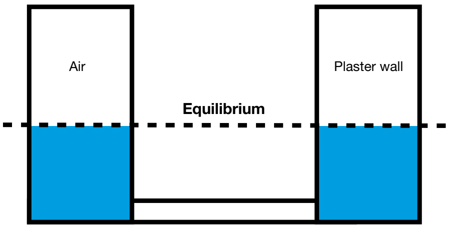
It is impossible to show diffusion in a picture since the mechanism relates to atoms or molecules. The second law of thermodynamics states that everything wants to move to a lower state of energy, which occurs when materials mix.
If there are varying densities of atoms in a material, the atoms will start to move from high density to low density.
In solid materials the atoms move through diffusion and the driving force is the difference in density of the atoms.

Wind transporting condensed vapour i.e. clouds - a perfect example of convection.

PART THREE

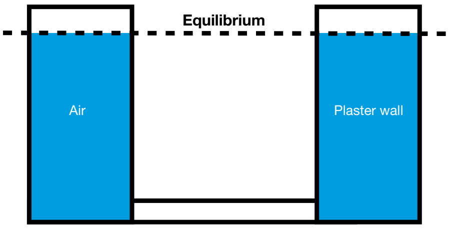
Principles for drying constructions

1



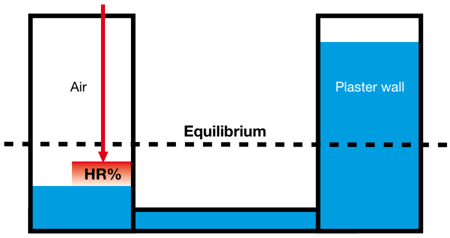
At normal circumstances the wall and surrounding are in equilibrium.

2



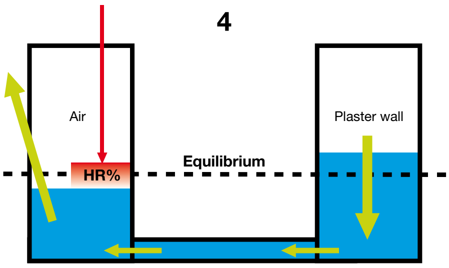
After water damage, both the wall and surrounding air saturated to the maximum.

3



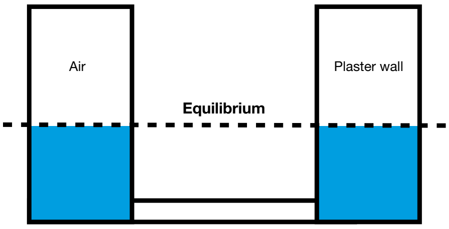
The dehumidifier lowers the moisture content in the air.

4



The difference in vapour content between the pores in the material and the surrounding air creates a moisture transportation, lowering the moisture content in the wall.

5



After finishing, equilibrium is established.

WDR08/06/08