

# **KONTROLDRY®**

**Eliminates rising humidity**

## **PHYSICAL PRINCIPLES**

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The masonry is affected by various alteration and degradation phenomena, mainly related to the presence of water, primarily in the form of humidity contained in the materials, which, over time, can cause a progressive deterioration.

- During construction, the necessary presence of water in building material preparation remains incorporated into the masonry, with formation of residual moisture or construction due, in general, to lack of evaporation.
- A permeable outer plaster or even the presence of cracks cause infiltrations due to atmospheric precipitations which, impregnating the masonry, determine the meteoric or precisely moisture infiltration.
- Even the accidental humidity, resulting from unforeseen causes, such as the breaking of hydraulic pipes or sewers, is responsible for water infiltration into the masonry.
- Thermal and humidity conditions of indoor and outdoor environments, thermal insulation and the ability of the separation walls of the two environments, to resist the passage of steam, cause condensation humidity.
- Rising damp, directly connected to capillary rising phenomena in all the walls in direct contact with damp soils or with aquifers, occurs in correspondence of ground floor or basements.

The capillarity is a part of physics that studies the whole of properties of liquids contained in extremely thin tubes called "**capillary tubes**".

This study originates by observing numerous natural phenomena that do not obey hydrostatics classical laws. (such as the spontaneous drawing up of water in a sugar lump or in a thin tube, such as petrol in a lighter, oil in the wick, sap in the trunk of a plant, water in the subsoil, etc.).

Consequently, new analyses must be made to understand these particular phenomena that depend on the intimate structure of matter.

Capillarity phenomena may be observed at the contact zone between a liquid and solid surface.

When the lower end of a thin tube is immersed in a liquid, such as water, the liquid level inside can be higher or lower than that of the free surface outside, depending on whether the liquid inside adhere to the sides, as in the case of **water**, or doesn't, like the case of **mercury**.

In the first case, we usually say that the liquid **wets** the tube, in the second it **doesn't**.

The reason why we experience this phenomenon is attributable to adhesion and cohesion forces that occur among the molecules of the liquid and between these ones and capillaries internal surface.

The physical quantity that describes these interactions is known as "**surface tension**" and depends largely on the liquid-solid system considered.

In the case of water inside capillary tubes, a surface tension  $\gamma$  is generated, which tends to attract  $H_2O$  molecules upwards, until it is opposed by earth gravity action, thus reaching a height  $h$  which can be calculated using the following **Jurin formula**:

$$h = \frac{2 \times \gamma \times \cos \theta}{\rho \times r \times g}$$

$\gamma$  = surface tension at the interface between water and internal capillary surface;

$\theta$  = angle between the direction of  $\gamma$  and the surface;

$\rho$  = water density;

$g$  = gravitational constant;

$r$  = capillary tube radius.

The angle  $\theta$  is called wettability angle and, in the case of contact of water with the capillaries, it assumes values less than  $90^\circ$  (while in the case of mercury it assumes values greater than  $90^\circ$  resulting in negative  $h$  values and therefore the liquid does not wet the surface).

The level  $h$  also depends on the surface tension which, in turn, depends on the **temperature** and the **saline concentration** of the liquid.

This explains, when all other parameters are equal, the different level  **$h$**  reached by water as a function of the exposure of the masonry considered, and of saline concentration degree of the water in the masonry.

Capillarity phenomenon alone is not sufficient to explain rising damp.

In fact theoretically, through **Jurin's formula** there are heights  **$h$**  of even 10 meters and more, which in reality is not reflected (in fact we experience heights not exceeding 2-3 meters).

To explain this discrepancy we must also consider evaporation phenomenon in coexistence with capillary rising phenomenon: the water near the outside masonry surfaces tends to evaporate while other water from below replaces the evaporated one, thus creating a dynamic equilibrium which in turn determines the real height reached by the rising water.

Another factor influencing rising damp level, less known but very decisive, is the Electric Potential of the wall.

The "flow" of the aqueous component, due to continuous evaporation phenomena, generates a liquid current inside the masonry.

This flow is associated with an electrokinetic phenomenon that generates a difference in electrical potential inside the porous septum (the masonry).

This is confirmed by experience, and shows that when a wall is damp it takes on electrical properties.

Another factor of greater force, due to the presence of weak negative terminations  $O^-$  (Van Der Waals forces), acts on capillaries internal surfaces (common feature for silicate-based building materials), which attract and "bind" positive ions (first layer), which in their turn attract negative ions (second layer) present in the water (which is not pure but is actually a saline solution): this charges distribution, also known as double layer of charges, strongly influences surface wettability, in particular above angle  $\theta$ .

In conclusion, between the floor and the highest wet part of the wall there is a difference in electrical potential that can be measured with an electrical tester.

This measure can range between tens mV and a few hundred mV.

The functional and identifiable methods to block rising water phenomenon from the ground towards the walls, are essentially two:

- 💧 invasive methods, which involve heavy interventions on the masonry, such as the interposition of an insulating layer able to create a barrier for rising water, after making a horizontal cut of the walls; or the use of electrodes (to be drowned in the interested masonry) electrically powered by a control unit (active electro-osmosis);
- 💧 non-invasive methods, consisting in creating the conditions, through the use of specific equipment, for reducing the wettability of capillaries internal surfaces.

With the aforementioned methods water is prevented from rising from the foundations towards the walls, or rather the "tap" is practically closed.

**KontroIDRY® "Capillary Rising Humidity Control System"** technology is an **advanced method of non-invasive action** on masonry.

The electrical potential is the physical quantity at the base of **KontroIDRY®** technology.

But what is the electric potential? To understand this magnitude we must first talk about **electric field**.

The existence of electrical forces has been known since ancient times.

In particular, it was discovered that a piece of amber rubbed with a cloth attracted the cloth to itself, and repelled other pieces of amber previously rubbed.

Similar forces were also observed by rubbing other substances.

Although there were many substances that showed to attract or repel each other once rubbed, after many experiments it became clear that in reality there were only two types of electrical behavior assumed by the various substances that could be identified as type "**A**" and type "**B**".

In particular we have seen that equal types repelled each other, while different types attracted. These experiments convinced that:

- 💧 bodies are composed of electrical charges that globally neutralize each other;
- 💧 the rubbing moves the charges, generating an excess of charge on both bodies;
- 💧 the excess charge produces attractive or repulsive forces;
- 💧 the electric charges are only of two types ("**A**" or "**B**").

Precisely as the two types of charges cancel each other out, Franklin conventionally indicated them with the arithmetic signs "-" and "+" and, in a completely arbitrary way, defined **negative** the excess charge in type "A" bodies, **positive** the excess charge in type "B" bodies.

The rubbing then, in a certain way polarized the material and facilitated the passage of electrons from the atoms of one body to another's.

So, for the first time, the existence of an **current of electrons** from one body to another one, that is from a **potential** to another one, was hypothesized.

In 1909 **Rutherford** proposed a "**planetary model**" of the **atom** and, thanks to this discovery, it is possible to understand many electrical phenomena.

*"Planetary model" of the atom, according to Rutheford.*

According to this model the atom is composed of a nucleus, very small but massive, made up of protons (relatively high mass particles with positive charge) and neutrons. Around the nucleus the electrons rotate like planets around the Sun.

The electrons have a mass much lower than protons, but the same electric charge, even if of opposite sign.

The bodies composed of atoms, therefore, contain a large amount of electrical charges of both types and, since normally the same number of positive and negative charges are present, the body is generally electrically neutral.

Rubbing the amber with cloth "unbalanced" this balance of positive and negative charges.

Now, let us now suppose to take two hypothetical charges of "equal value" and agreed signs (equal sign charges) or discord (charges of opposite sign): the configurations we can obtain are the following.

***Direction of forces that interact between two electric charges of opposite sign (above) or the same sign (below)***

Each charge experiences a force **F** attractive or repulsive depending on the signs.

This force rises because each charge "creates" an electric field in the surrounding space and is "detected" by other charge.

The force **F** depends on charge **q** spatial position (**x, y, z**), sign and value.

The **electric field** is defined as the ratio between the force acting on the charge **q** and the value of the charge **q** itself, that is:

$$\mathbf{E} = \mathbf{F} / q$$

The electric field **E** is thus a vector, function only of the position in space: **E (x, y, z)**; therefore, given the electric field **E (x, y, z)**, the force exerted by the field on a generic charge **q**:

$$\mathbf{F} = q \mathbf{E}$$

An electric field **E** is represented by drawing the "**field lines**", which are lines tangent to the force **F**.

### ***Examples of electric fields***

*Field generated by opposite sign charges (dipole)*

*Field generated by two plates with + Q and -Q charge*

*Field generated by a positive charge*

*Field generated by a **negative charge***

*Field generated by a **positively charged plate***

Closely related to electric field concept is that of **electric potential**.

Considering a charge **Q** in a certain spatial position generating an electric field **E**, we can say, in a simplified way, that in every point it is possible to define an electric potential **V** with the characteristic of decreasing (in absolute value) as we move away from the charge.

Electric field **E** is linked to the potential **V**: in substance field **E** is the higher (in absolute value) the bigger potential difference between two points.

This potential difference is measured in practice by an electrical tester.

As previously stated, the higher potential difference, the higher electric field value and the greater electric force exerted on the charges "immersed" in electric field itself.

So if in some way it is possible to decrease potential difference produced on masonry, then it will be possible to reduce electrical nature force coming into play in rising humidity phenomenon.

**KontroIDRY® - Capillary Rising Humidity Control System** technology is based on the spatial diffusion of an electromagnetic field pulsed at low frequency and intensity that contrasts the potential difference produced into the masonry.

Top quality and latest generation surface mount components, dual microprocessor, production in an industrial sector with numerical control automatic machines and both functional and parametric testing, guarantee a very high reliability standard of "**Capillary Rising Humidity Control System**".

In this way a technologically advanced device is realized, but in a small size, which, by activating a protection zone, stops the humidity capillary rise from the ground.

KontroIDRY®, thanks to its technical characteristics (operating frequency, pulses, polarization signal, etc.), have a contrasting effect on spontaneous electric potential produced on the masonry.

This results in the blockage of the ascent hydraulic flow and therefore the drying of the masonry affected by humidity.

**KontroIDRY®** technology is **Green-building**, totally **reversible and non-invasive**.

**Patent Certificate for Industrial Invention No. 0001419907 granted by Ministry of Economic Development - General Directorate for Counterfeiting - Italian Patent and Trademark Office**

**KontroIDRY® - Capillary Rising Humidity Control System** devices for the electro-physical dehumidification of masonries, are produced and marketed by **SKM LTD Soluzioni Kalibrate per Murature**, through its own sale organization.

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