Air stratification in an electrical cabinet

Air stratification inside an electrical cabinet should not be underestimated. It is directly related to variations in temperature **t_{BS} (dry bulb temperature)** and **U.R. (relative humidity)**, terms explained in the white paper "HUMID AIR AND PSYCHROMETRIC DIAGRAM", in a vertical direction.

According to this phenomenon, cooler air forms in the lower part of the electrical cabinet and tends to remain below the warmer air, localised in the top part. It is wrong to consider only two air layers, upper and lower zones, as having different and separate temperatures that change abruptly at the middle of the height of the electrical cabinet. It is more correct to think that there are many air layers, that range from the coolest, situated at the base of the cabinet, to the hottest near the ceiling.

When designing heating and cooling systems for electrical cabinets, the goal is to keep **t_{BS}** and **U.R.** far from critical conditions, which could cause problems for the correct function of the electrical panel:

- excessive overtemperatures can cause damage to and reduce the life span of components inside the electrical panel;

- relative humidity at near saturation level (over 90%) could cause condensate to form, which could in turn cause short circuiting or, over a longer period of time, the oxidation of components inside the electrical panel.

The temperature and relative humidity selected during the design phase are the average of those present in the electrical cabinet when it is installed and complete with the selected air conditioning systems. Still, there are warmer and cooler zones inside the cabinet due to air stratification. The designer's objective is to ensure that **t_{BS}** and **U.R.** are always between a range of values that never includes climate conditions that could damage the electrical panel.

The highest temperatures can be found in the top part of the electrical cabinet.

The highest relative humidity readings are, instead, found in the lower part.

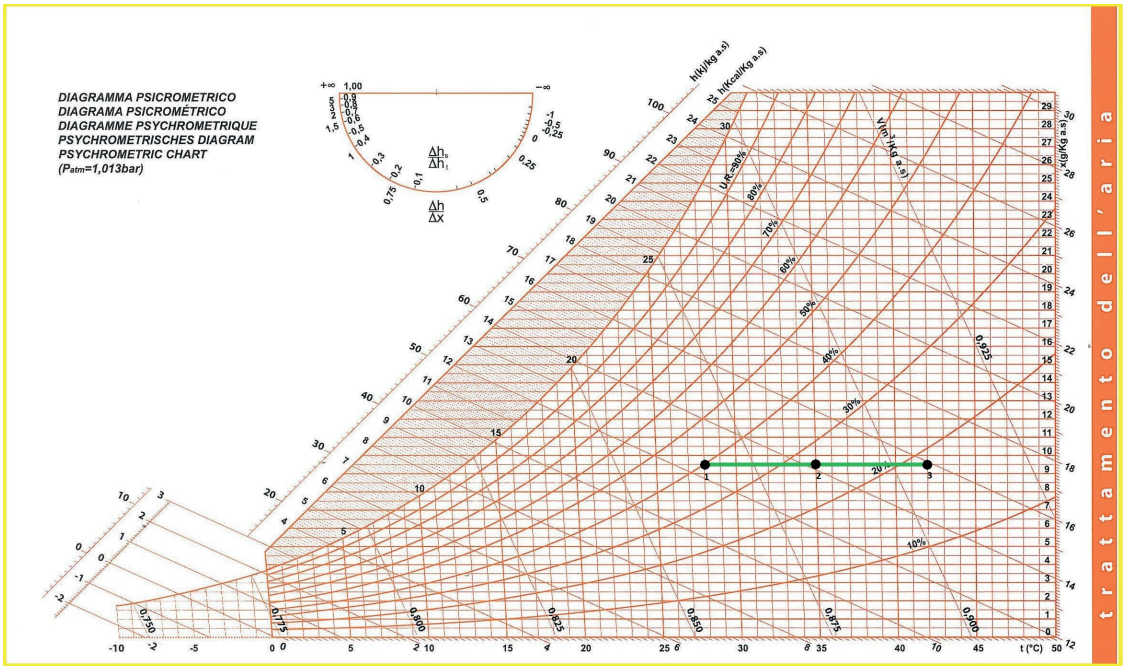
To better understand the variations in relative humidity in relation to cabinet height, we will look at a practical test performed in the laboratory, with an electrical cabinet for which an average temperature of 35°C was selected.

The specific humidity X (described in the white paper "HUMID AIR AND PSYCHROMETRIC DIAGRAM") inside the cabinet was considered at a valve of 9.5gv/kgas.

Measuring temperature and relative humidity at three different heights, we observe the following values:

1. **t_{BS},1=28°C, U.R.1=40%** (cabinet base);
2. **t_{BS},2=35°C, U.R.2=27%** (at the middle of the height of the cabinet);
3. **t_{BS},3=42°C, U.R.3=18%** (cabinet ceiling).

As we can see better in the psychrometric diagram shown below, after setting the value of specific humidity **X**, which for simplicity's sake we will consider as constant inside the electrical cabinet, powers 1, 2 and 3 are found on a horizontal line **X=9.5gv/kgas**. Moving to the right, or rather from the base to the apex of the electrical cabinet, the temperature increases and the relative humidity decreases.



1 - ASHRAE PSYCHROMETRIC DIAGRAM, atmospheric pressure: 101325Pa

The concept of stratification herein described allows us to understand where to put the temperature and relative humidity monitoring devices in the electrical cabinet, or rather, where these two parameters could be the most critical:

1. the **thermostat** should be installed where the local temperatures, at the same average internal temperature, could be the highest inside the cabinet, therefore near the ceiling;

2. it is better to place the **hygrostat** in the areas where the relative humidity has a higher probability of being at maximum level, which is at the base of the electrical cabinet.

The suggested locations for the thermostat and hygrostat allow us to guarantee that condensate will not form, and that dangerous overtemperatures will not be registered, which would risk damaging components contained in all areas of the electrical cabinet.

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