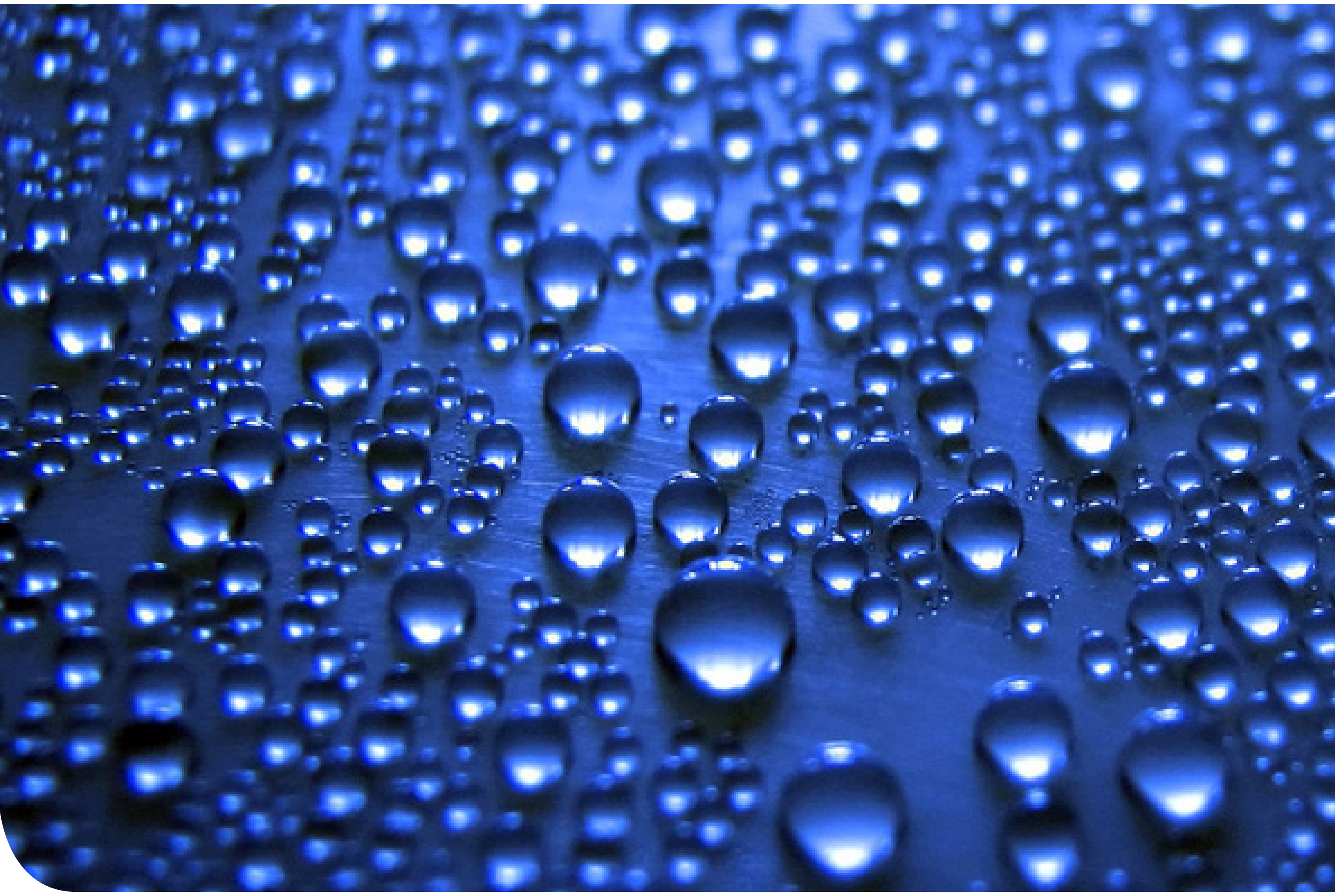


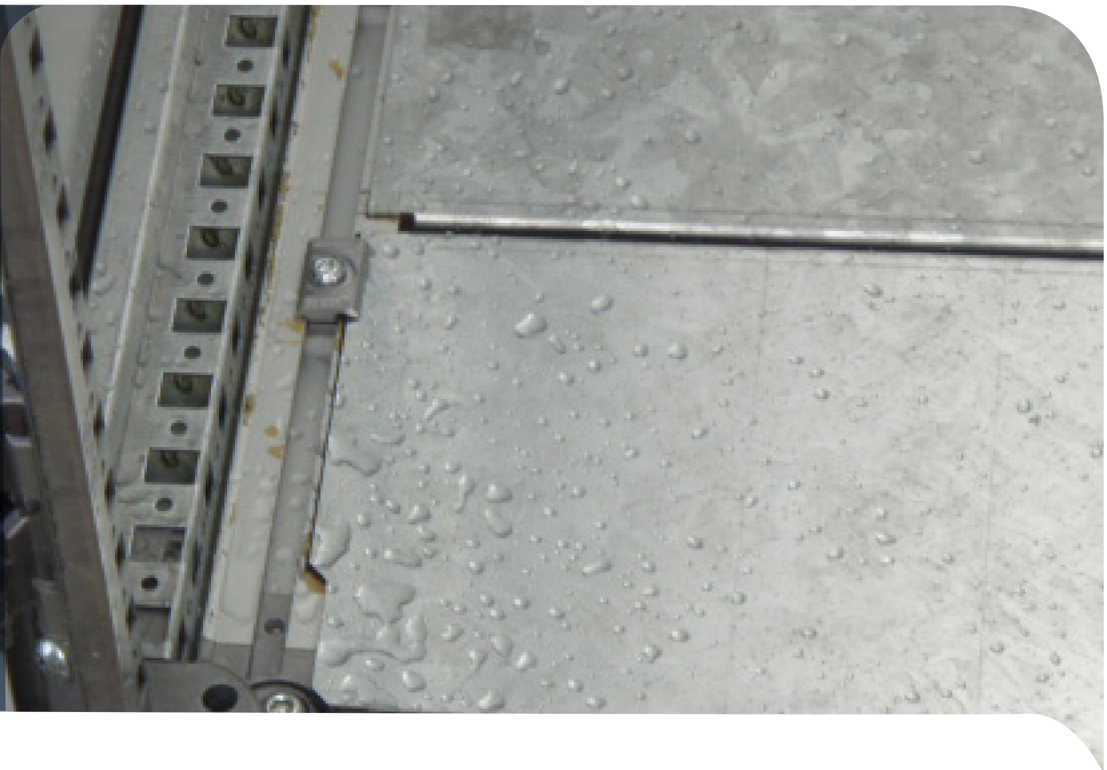
B&R Enclosures Pty Ltd

Anti-Condensation in Electrical Enclosures

Technical Paper

INTRODUCTION

When conditions are humid or the temperature in an environment suddenly drops, the water held in the air around us, cannot stay suspended as a gas anymore and must condense back into water. It does this on any cold surfaces it can find including car windows, grass, mirrors etc. The temperature at which this happens is called the DEW POINT and the water that condenses is known as condensation (or dew). This same effect can cause problems with electrical equipment as condensation can occur inside enclosures and on sensitive equipment if they are not suitably protected.



DEW POINT DEFINITION

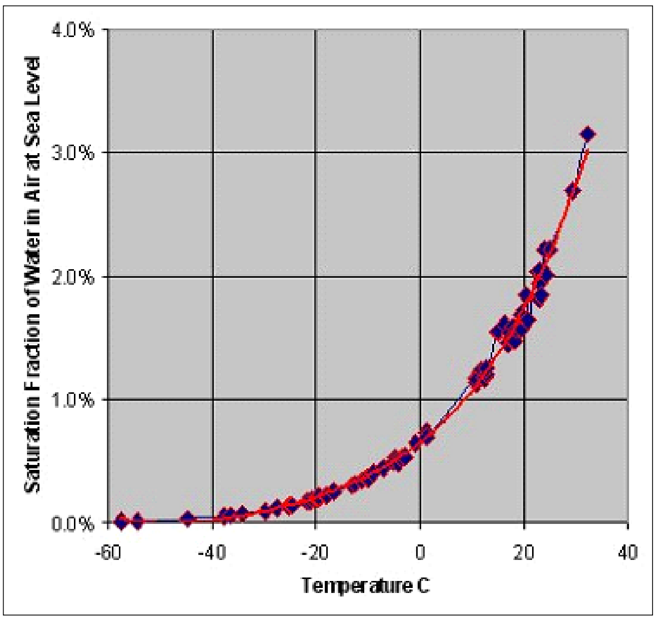
The dew point is the temperature at which air is saturated with moisture and cannot hold any more. The dew point is the temperature at which full saturation of air with water occurs, ie when the relative humidity is 100%. If air comes into contact with a surface cooler than the dew point, then dew or condensation is formed on the surface. This is why dew often forms at night or early morning: As the temperature of the air falls, the amount of water vapour the air can hold also decreases. Excess water vapour then condenses into very small droplets on whatever it touches.

HOW CONDENSATION HAPPENS

We should assume that air pressure is always the same, and that all these changes happen in open air at constant conditions. Air can only absorb a certain amount of moisture in the form of water vapour. When the air cools the amount of water the air can absorb is reduced (see graph 1). The excess water vapour condenses onto any cool (below the dew point) surface it can find as dew.

For example:
If the air temperature is 20°C, then based on graph 1 the saturation of water vapour in the air is 1.8%. If the air were to cool, then the saturation point decreases, thus forcing the excess water vapour to condense. This is what happens when you take a bottle out of the fridge. Initially it has no condensation or dew on it and the bottle is dry, but within a short time the air around the bottle cools below the dew point and the water in the air then forms condensation on the bottle. In high humidity conditions (where there is a lot of water in the air) this happens very easily, as a slight cooling of the air, while in very dry low humidity conditions this effect may not even be noticed.

The same happens inside an enclosure. In the morning the air temperature is low and with equipment switched off, there is no heat being generated inside the enclosure, giving an ideal surface for dew to form on the inside of the enclosure. Once the water vapour has formed into water droplets, it then takes some time for the water to re-evaporate as the day gets warmer.



Graph 1: Saturation Fraction of Water In Air at Sea Level

HOW TO STOP CONDENSATION

To stop condensation or dew from forming inside an enclosure, the following steps may be useful:

1. Increase the temperature to above the dew point.

The most effective method is to install an anticondensation heater controlled by a humidistat. As the ambient air temperature cools down, so does the air inside the enclosure and it becomes more saturated with water. If the temperature goes below the dew point then the water vapour starts to condense on the inside of the enclosure. The humidistat detects the increase in humidity and switches on an anticondensation heater to stop the enclosure temperature going below the dew point. The major advantage of a humidistat over a thermostat is that if the humidity is low and cold then it will not switch the heater on, which over time will save a considerable amount of energy. B&R offers fan forced anticondensation heaters and humidistats that are DIN rail mountable. Ideally these anti-condensation heaters need to be fitted as close to the top of the enclosure as possible.

2. Decreasing humidity

Another method used is decreasing humidity. This can be done with de-humidifiers.

a. The first type is a mechanical/refrigerative dehumidifier. This is the most common type and usually works by drawing moist air over a refrigerated coil with a small fan. Since this increases the saturation of water vapour, it allows it to condense on to the coils, where it drips into a collecting bucket or via a pipe out of the enclosure. This method however is somewhat more difficult to implement.

b. A second type is an electronic dehumidifier which uses a Peltier heat pump to generate a cool surface for condensing the water vapour from the air. This type of dehumidifier has the benefit of being very quiet when in use as there is no mechanical compressor. This design is mainly used for very small dehumidifiers, with its simple design and low cost parts. It can also be useful on electrical enclosures.

   Note: implementation is still significantly more difficult than a anti-condensation heater as a collecting bucket or outlet pipe would need to be installed.

c. A third dehumidifier is a dry chemical dehumidifier. The disadvantage of these dehumidifiers is that they need to be replaced regularly and therefore require both ongoing maintenance and waste disposal.

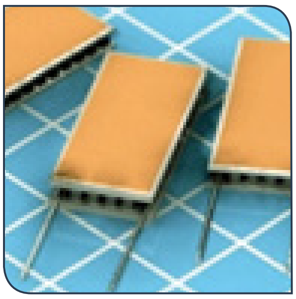
SIZING ANTICONDENSATION HEATERS

For extreme conditions and typical enclosure dimensions, the following table gives the recommended anticondensation sizes for a given enclosure's air volume. For extreme conditions or enclosures with unusual aspect ratios, consult B&R for advice.

Enclosure volume [m3]	Heater Wattage [Watts]	Heater Catalogue Number
<1m3	50W	TX-WID05ZXOP
>1m3 but <2m3	100W	TX-WID10BLOC
>2m3 but <3m3	150W	TX-WID15BLOC
>3m3 but <4m3	200W	TX-WID20BLOC
>4m3 but <5m3	300W	TX-WID30BLOC
	Humidistat	TX-AAWHS10


Fan Forced Heaters

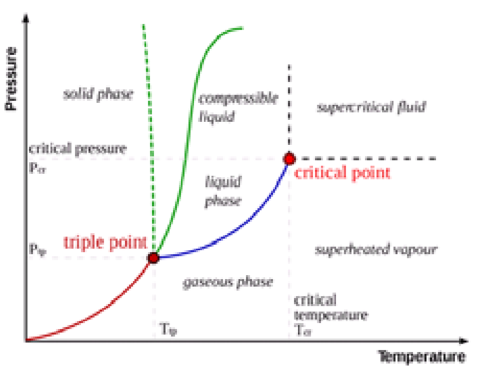

Humidistats


Pelter cells shown without control equipment


Dry chemical dehumidifier

FURTHER EXPLANATIONS

Air pressure also has an effect on the dew point. The higher the air pressure the easier it is for the water vapour to condense. For a given temperature and humidity, if the pressure is increased then water vapour can condense into dew. Outside air pressure changes quickly, the seals in an IP66 enclosure can make the enclosures reaction to those changes slower, leading to a slight pressure differential between the enclosure and outside environment. This can have the effect of causing water vapour to condense on the inside of the enclosure. A solution to this problem would be to vent the enclosure to ensure equal pressure. Venting can sometimes be a problem as it may compromise the IP rating of the enclosure but this can be solved with "Goretex"™ vents which allow air to pass through but not liquids. Some sites even have a policy to open enclosure doors to ventilate them during very low humidity days so as to trap as little moisture in the enclosure as possible. This may not eliminate condensation but it does effectively reduce the mass of water inside the enclosure, in turn limiting the possibility for condensation to form.



A typical phase diagram. The dotted line gives the anomalous behavior of water. The green lines mark the freezing point and the blue line the boiling point, showing how they vary with pressure.

CALCULATIONS

Calculating the dew point.
Dew point can be read from the graph opposite or a simple approximation calculation formula shown below.

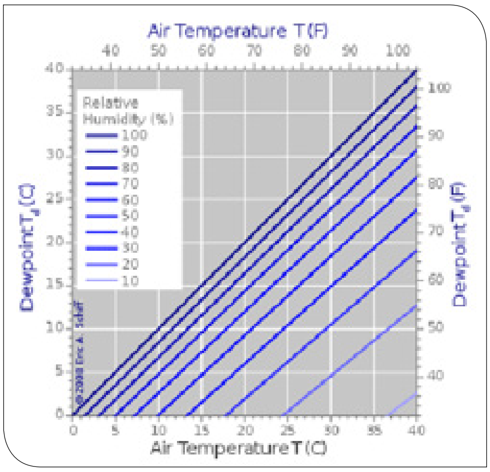
An approximation formula for calculating Dew point is:

$$T_d = T - \frac{100 - RH}{5}$$

Where Td is the dew point, T is the air temperature (C) and RH is the relative humidity (%).

For example:
if the current humidity is 50% and the ambient air temperature is 20°C then the Dew point is:
10°C {20-(100-50)/5)=10}.

Relative humidity and temperature values for an area can usually be obtained from the Bureau of Meteorology or on-site measurement.



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