An Introduction to Climatic Testing – What, Why, & How?

When it comes to applying a coating; whether in a shipyard, in a construction yard, or even in a warehouse; even if you have successfully controlled and monitored the surface cleanliness, surface profile, and both the wet and dry film thickness, if the climatic conditions are wrong at the time of application, this could cause the coating to fail – regardless of the success of the other parameters.

That's why it's vital to monitor a range of climatic parameters before and during the application process, to ensure your coating can have a successful service life.

So what climatic parameters do we measure, why do we measure them, and how?

WHAT CLIMATIC CONDITIONS DO WE MEASURE?

The key climatic parameters include:

- Surface temperature (Ts), the temperature of the surface to be painted;
- Air temperature (Ta), the temperature of the air surrounding the surface to be painted;
- % Relative Humidity (RH), the amount of water vapour present in the air compared to the maximum possible, expressed as a percentage;
- Wet bulb temperature (Twb), the air temperature as read by a thermometer that's covered in water-soaked fabric over which air is passed;
- Dry bulb temperature (Tdb), the temperature that is usually thought of as air temperature;
- Dewpoint (Td), the temperature at which moisture condenses on a surface, calculated from the air temperature and % Relative Humidity;
- And the Delta T (TΔ), the difference between the surface temperature (Ts) and the dewpoint temperature (Td).

Yes, that is a lot of temperatures.

WHY DO WE MEASURE CLIMATIC CONDITIONS?

While it's important to monitor all of these parameters, special attention should be paid to surface temperature and relative humidity, as most paint data sheets will specify acceptable ranges of these parameters in which the paint can be applied. If either the surface temperature or relative humidity are outside the range specified by the coating manufacturer, the coating should not be applied until environmental conditions have changed to be within the acceptable ranges.

However, by far the most important parameter of all is the Delta T, as it tells you the difference between the surface temperature and the dewpoint temperature. The smaller the difference, the more likely that moisture (or dew) will have condensed on the surface.

To demonstrate this here is a glass of water with ice in. Because the cold glass is placed in a warm, humid, environment, condensation has formed on the outside of the glass. The same would be true of a substrate to be painted – if the surface temperature is close to or below the dewpoint temperature, which as mentioned before is calculated from the air temperature and relative humidity, moisture or dew will be present on the surface.

So in our example here the Ts is 19°C, the Td is 18°C, so the difference between them, the Delta T, is 1°C. This means moisture or dew will be present on the surface, and if you were to apply a coating over this condensed moisture, it would result in one or multiple flaws in the coating, and ultimately coating failure. That's why the Delta T is the primary climate parameter within the coatings industry, as it tells you the difference between the surface temperature and the dewpoint temperature. It is generally accepted within the industry that the Delta T should be at least 3°C (5°F) or higher for the coating to be applied. And don't forget, the structure you are painting may have the sun on one side, and be in shade on the other, meaning the climatic conditions, and ultimately the Delta T, will vary in different areas of the surface being painted.

HOW DO WE MEASURE CLIMATIC CONDITIONS?

So, how do you actually measure and calculate the key climatic parameters? Well, there are two main methods you can follow…

Method 1: Traditional/Analogue

The traditional method requires multiple pieces of equipment to complete.

The first piece required is the whirling hygrometer, also known as a sling psychrometer, and it is used to measure the wet bulb and dry bulb temperatures. These temperatures are then used to work out the dewpoint and relative humidity. Elcometer provides two types of hygrometer, but they work in pretty much the same way.

Hygrometers consist of two liquid filled thermometers positioned side-by-side in a rotating body. One thermometer is covered with a fabric "sock" or "wick" connected to a reservoir (this measures your wet bulb temperature), while the other is uncovered (this measures your dry bulb temperature).

While the dry bulb thermometer is measuring what is thought of as ambient air temperature, the wet bulb thermometer is used to calculate relative humidity. To explain, let's say you dipped your finger into moderately warm water, and then waved it back-and-forth in the air. As you wave your finger, you'll notice that it feels colder. This is the water on your finger evaporating into the air. The less humid the environment, the quicker the water evaporates, and as a result the colder your finger will feel. The difference between the dry bulb and wet bulb temperatures, known as the wet bulb depression because typically the wet bulb temperature is lower for the reason I've just explained, is then used to calculate the relative humidity.

To prepare the wet bulb thermometer, distilled water is added to the reservoir of the hygrometer, and this saturates the wick. In the case of the Elcometer 116C Sling Hygrometer, you are actually instructed to fully submerge the thermometer bulbs in distilled water first to ensure the wick is saturated, and then fill up the reservoir. Once the wick is fully saturated with distilled water, you then whirl (or spin around) the hygrometer above your head for between 20 to 40 seconds, at an approximate speed of three revolutions per second, or 180 revolutions per minute.

As the hygrometer whirls through the air, the water on the fabric evaporates, cooling the thermometer bulb, working in the same way perspiration cools the skin when it evaporates, like in the example from before. The rate at which the water evaporates, and as a result the amount of cooling on the bulb, is defined by the level of humidity in the air. The lower the humidity, the greater the cooling; while the higher the humidity, the lesser the cooling effect on the bulb, because when there's more moisture in the air the water won't evaporate from the wick as quickly. The dry bulb thermometer, on the other hand, is measuring the ambient air temperature.

When whirling the hygrometer, to reduce the effects of your own body temperature, hold the hygrometer in front of you, facing the wind. On a still day, we recommend slowly walking forwards whilst whirling.

After the 20 to 40 second whirl, the thermometers are quickly read, noted, and then the hygrometer is spun again. After another 20 to 40 seconds, once again read the thermometers. If both results are exactly the same, these are your wet and dry bulb temperatures. If they aren't the same, you need to repeat the process until you get two matching, stable results in a row for both your wet and dry bulb temperatures.

Once you have your results, typically conversion tables are then used to determine the relative humidity and dewpoint temperature, like the ones supplied with the Elcometer 116 Hygrometers. Alternatively, the Elcometer 114 Dewpoint Calculator provides a quick and easy way to determine these values, and we show you how it works in our Elcometer 114 video.

However, there's an even easier method to convert your wet and dry bulb readings into dewpoint and relative humidity, using the free ElcoCalc™ App for Android and Apple mobile devices. Simply select the climate tab, choose your temperature units, enter your dry and wet bulb measurements, and ElcoCalc™ does the rest.

Whilst the whirling hygrometer has given us all of these climatic conditions, you are still missing the all-important Delta T measurement, and to calculate this, you still need a surface temperature measurement – something a hygrometer can't provide, meaning you'll need a separate surface thermometer. This could be a magnetic thermometer for working in intrinsically safe environments (such as the Elcometer 113), a digital thermometer with a surface temperature probe (such as the Elcometer 212 or 213), or an IR digital laser thermometer for measuring substrates that are on a moving production line or are extremely high temperatures (such as the Elcometer 214).

Once you have your surface temperature, subtract your dewpoint temperature from it, and you have the Delta T.

While this method has been long used in the industry for monitoring climatic conditions, it does have some disadvantages. For example, whilst whirling hygrometers provide a good indication of the atmospheric conditions, due to their design, they can't provide the localised conditions at the surface of the substrate to be painted. Also environmental conditions change whilst the paint is being applied, and this is not the most convenient of methods to continuously repeat to ensure conditions remain acceptable, as it is quite time consuming. Not to mention the method requires multiple pieces of equipment, using tables and conversion charts, and manually calculating results.

Surely there's a quicker and simpler way to do this, without sacrificing on accuracy. That's where the second method comes in.

Method 2: Elcometer 319 Dewpoint Meter

The Elcometer 319 Dewpoint Meter is a digital gauge that can monitor and record all of the key climatic parameters simultaneously, telling you if conditions are suitable for painting. What's more it can continuously monitor and log the conditions as you paint, and instantly alarm if one of the parameters falls outside of the specified range.

Equipped with an air temperature and humidity probe, a surface temperature probe, and a k-type connector, which allows you to connect additional external probes such as magnetic surface temperature probes or liquid temperature probes; the Elcometer 319 is an all-in-one solution for measuring the key climatic conditions. Why use several pieces of equipment, when you only need one? And because you are able to hold the gauge against the substrate, or even attach it to the surface using the integrated magnets, you can now measure the climatic conditions of the localised area around the substrate being painted, so you can obtain more relevant readings.

So, how does it work?

Simply switch on the gauge, and, just like you need the thermometers of a hygrometer to acclimatise to an environment, allow the sensors of the Elcometer 319 some time to acclimatise to your environment - especially if the gauge has been brought from a cold environment to a hot environment (say, from an air conditioned office out into direct sunlight for example), or vice-versa.

Be sure to keep your fingers away from the sensors at the top of the gauge at all times to avoid your body heat affecting the results, and when using the in-built surface temperature probe, hold securely against the surface until the Ts reading has stabilised. How do you know the reading has stabilised? Typically when the arrow next to the Ts reading disappears. In fact if any of the parameters trend up or down, the gauge clearly displays this using these arrows, so it's easy to keep track of how the environment is changing, or indeed, not changing.

Then it's just a simple case of checking the readings on screen are within specification.

So, let's refer back to the coating specification we showed you earlier. The Delta T should be at least 3°C (5°F), the relative humidity should not exceed 85%, and the air temperature should be at least 10°C (50°F). Looking at the screen here, all of the values fall within this specification, and the coating may be applied.

An advantage of using the Elcometer 319 Model T, is its ability to continuously monitor and record the conditions as you paint using its Interval Logging feature, taking a reading automatically at rate of your choice at a time between 1 second and 24 hours. If you wish to continuously log the surface temperature, we recommend using an external surface temperature probe with this feature, so it remains securely attached to the surface without needing to be held.

What's more you can set high and low limits on any and all parameters, so the Elcometer 319 instantly alarms whenever a parameter exceeds specification.

And, once the inspection is done, every reading of every climatic parameter can be transferred via USB or Bluetooth to ElcoMaster®, Elcometer's free data management software for Android and Apple mobile devices, or PC, allowing you to further analyse the data and create professional inspection reports instantly.

Thanks to ElcoMaster® it's even possible to remotely monitor the Elcometer 319 live, while it's logging the conditions, creating a mobile climate station. And by setting limits within ElcoMaster®, the moment one of the parameters falls out of specification, as long as you're connected or within Bluetooth range, you'll be able to see instantly.

For more detail on how to complete either of the methods shown in this video, make sure you check out our Elcometer 116 Whirling Hygrometer and Elcometer 319 Dewpoint Meter standalone videos, which include more tips and features to help you successfully monitor climatic conditions.

For more information on Elcometer's entire range of climate monitoring equipment, simply visit Elcometer.com or click on one of the links on-screen.

And please, don't forget to subscribe to all of the Elcometer channels, to be notified of any new videos.