An Introduction to Pinholes and Holidays – Porosity Detection

Whether you are coating a pipeline or an oil tank; a ballast tank or a flat roof; a filing cabinet or an appliance - there are many parameters that must be monitored or controlled to ensure the coating performs over the lifetime of the product. One of these parameters is how well the coating has “covered” the surface, and if there are any “flaws” in the coating which could lead to a premature coating failure or corrosion.

Corrosion is caused by two things – a steel substrate and oxygen, while contaminants such as water can accelerate the process. The coating is there to protect the steel from oxygen and contaminants. A flaw in the coating can leave the substrate poorly protected, or in some cases completely exposed.

In the protective and industrial coatings industry, there are a number of flaws to be aware of. These include:

Runs & Sags: Where the coating moves under gravity, typically caused by over coating and low paint viscosity, leaving thin areas of cover;

Cissing: Where the coating does not stick to the substrate properly due to surface contamination from moisture, grease, or oil; leading to surface breaks in the coating that expose the substrate;

Cratering: Where air or solvent bubbles are released from the surface when the coating has partially cured, and the coating does not flow to cover the void, leaving small craters that only thinly cover the substrate;

Pinholes: Similar to cratering, air or gas bubbles burst which create small or minute holes that the coating does not cover; but unlike cratering, pinholes go all the way to the substrate, leaving it fully exposed;

Over Coating: If too much coating is applied, the top dries out quicker than the bottom, creating a skin which then shrinks as the coating beneath it dries out, cracking the skin;

and **Under Coating:** If a coating is too thin, the peaks of the surface profile are left uncovered or thinly coated, which leads to rust spots, also known as rust rash.

These flaws are referred to as Holidays, Discontinuities, or Pinholes within the coatings industry; and are often very small or invisible to the naked eye – which is where flaw detectors come in.

There are, essentially, three flaw detection methods…

1. The Low Voltage Pinhole, or Wet Sponge Technique such as the Elcometer 270, is for testing insulating coatings less than 500µm (20mils) thick on conductive substrates, and is ideal for powder coatings and other applications where you do not wish to damage the coating. However, this method only detects pinholes.

Pinholes are important to detect because they are a small hole which goes all the way to the substrate that acts like a capillary tube, drawing moisture drops down to the steel through capillary action – where liquid can flow through narrow spaces without gravity - accelerating the process of corrosion.

The wet sponge method for detecting pinholes - which is a little bit of a misnomer, as the sponge should be damp, and not wet - also works through capillary action.

When you pass a damp sponge steadily over the coated surface, the water is drawn through the holes by capillary action, and when it touches the bare substrate it completes a low voltage circuit, as the test unit is grounded to an uncoated section of the substrate being examined. When the circuit is complete, the unit alarms, letting you know where you have a pinhole.

2. The High Voltage or Holiday Detection method is where a high voltage is applied to a probe, which is passed over the coated surface.

The voltage used is dependent on the dielectric strength and thickness of the coating being tested, and/or the test method or standard you're working to; but typically the voltage should be high enough so that in areas where the coating is electrically weaker due to a flaw, there is sufficient voltage to break down the gap between the probe and the substrate. When this break down occurs, the current flows through the substrate, and back into the unit via a grounding cable, setting off an alarm to signal a flaw has been detected.

This allows you to detect flaws that don't go all the way down to the substrate, as well as voids within the coating.

However, it is vital that the voltage isn't set too high, as this could break down and damage the coating, causing the unit to alarm when there are no flaws, while creating a flaw in the process. Testing with bright blue sparks is a clear sign the voltage is too high.

So you can ensure the alarm only triggers within set parameters, when there really is a flaw, rather than triggering from a charge that is either naturally present or which builds up during the testing process - many high voltage detectors allow you adjust the sensitivity, ensuring reliable alarms.

The high voltage method comes in 2 versions – Continuous DC and Pulsed DC.

Continuous DC is where the voltage is constantly sent to the probe, and is used to test insulation coatings on conductive substrates up to 7.5mm (300mils) thick.

Elcometer has two continuous DC detectors: the Elcometer 236, where the high voltage supply is generated within the instrument and sent to the probe handle via a high voltage cable; and the Elcometer 266, where the high voltage supply is generated within the handle, and connected to the instrument via a low voltage cable, resulting in a safer way to test for flaws.

The Elcometer 266 also has an internal voltmeter, also known as a Jeep meter, ensuring the test voltage always matches the chosen voltage. There is also an optional two-stage safety switch to avoid accidental switch-on, and an in-built voltage calculator that automatically sets the correct voltage based on your standard and coating thickness value.

Pulsed DC, on the other hand, is where the energy is contained in very short pulses, typically at a speed of 30 pulses per second (30Hz). The break in energy stops the probe from building up a charge on the surface, allowing you to safely test for flaws on damp, dirty, or slightly conductive coatings. Using state of the art electronics, the Elcometer 280 Pulsed DC Holiday Detector can test coatings up to 25mm (1").

Designed to make pulsed DC high voltage detection safer, easier, and more reliable than ever before - the Elcometer 280 has an internal Jeep meter and two-stage safety switch; plus a trailing earth voltage return cable you don't have to connect to the substrate, which is perfect for quickly testing large surfaces and pipelines, without constantly having to clip and unclip a return lead every time the length runs out.

There's also the Elcometer 280 grounding mats and grounding pin, which are ideal for testing on un-grounded pipes.

And finally… **3. The UV Pinhole technique -** such as the Elcometer 260, which makes use of a fluorescent coating, which is applied to the surface as a base coat. Once the second coat is applied, any pinholes fluoresce when you shine a UV light on them, revealing their location.

Each test method is explored in much more detail in the Elcometer Pinhole and High Voltage Detector series. Simply follow the link at the end of this video, or visit Elcometer.com if you can't see the links.

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