Coating Porosity Detection using the Elcometer 280 Pulsed DC Holiday Detector

When it comes to testing the porosity of protective coatings on pipelines, ballast tanks, bridges and other steel structures; or when you are testing for flaws in coatings on concrete; typically the high voltage porosity or holiday detection method is used.

Put simply, this is where a high voltage is applied to a probe, which is then passed over the coated surface. The voltage used to test should be high enough so that in areas where the coating is electrically weaker due to a flaw or discontinuity, there is sufficient voltage to break down the gap or insulation between the probe and the substrate.

When this break down occurs the current flows from the probe, through the substrate, and back into the holiday detector via an earth or signal return cable, completing a circuit and thereby triggering an alarm to signal a flaw has been detected.

As the high voltage method can locate any area where the coating is weaker than specified, this method allows you to detect flaws that don't go all the way down to the substrate, such as cratering for example, as well as voids within the coating.

There are essentially two high voltage direct current (or DC) technologies used for testing a coating's porosity – Continuous DC and Pulsed DC.

So what's the difference?

Continuous DC is where you set the voltage to a constant value, usually determined by the specified coating thickness, and a signal return cable is clipped directly to an uncoated section of the substrate under test. During the test, the voltage is constantly sent to the probe, and the current at the probe is low. But, when a flaw is located a spike in the current is created, which is then detected by the unit as a break down in the coating. This in turn triggers the unit's alarm. Some DC holiday detectors, such as the Elcometer 236 and Elcometer 266, will also allow you to set the level of current at which the alarm triggers, sometimes known as the sensitivity. If a holiday detector is too sensitive, it could alarm from a charge that is either naturally present or which builds up during the testing process. If it's not sensitive enough, the unit won't alarm at all, potentially missing flaws. So by setting the correct sensitivity, this ensures the unit only alarms when there really is a flaw.

Continuous DC, or DC units as they are commonly called, are typically used to test insulation coatings on conductive substrates up to 7.5mm (300mils) thick.

Whilst typically you still set a Pulsed DC unit to a voltage determined by the specified coating thickness, unlike the Continuous DC method, the voltage on Pulsed DC units is actually rapidly switching between 0 and the voltage you've set, typically at speeds of 30 pulses per second (30 Hz). This pulsing voltage not only allows you to test non-conductive coatings up to 25mm (1") thick on conductive substrates, but as the pulsing energy stops the probe from building up a charge on the surface, Pulsed DC units allow you to safely test for flaws on damp, dirty, or slightly conductive coatings, making it the ideal method for testing structures in-situ.

The pulsing voltage also means you don't have to connect the signal return cable directly to the substrate, and can instead use a trailing earth return cable or a grounding mat, depending on the conditions.

Whilst the Continuous DC method is discussed in another video – click the link in the top-right or visit Elcometer.com for more information - in this video we'll be showing you how to test using the Pulsed DC method.

Designed to make Pulsed DC high voltage detection safer, easier, and more reliable than ever before, the Elcometer 280 is a “stick type” holiday detector which is capable of up to 30 hours of continuous use depending on the voltage and load applied. The quick release battery pack can be fully charged in just four hours. We recommend fully charging before starting, to ensure uninterrupted testing.

Please note, while this video is intended as a guide for how to use the Elcometer 280, you should always refer to the instruments’ instruction book before use, and always take extreme care when using high voltage equipment.

With the Elcometer 280 switched off, insert the signal return lead plug into the socket.

For the most ideal conditions, you should clip the other end of the earth return lead to an uncoated section of the substrate being tested. When testing on concrete, either hammer a masonry nail or conducting spike into the concrete, or use any exposed uncoated rebar or uncoated metal pipework, and connect the earth return cable to it. This makes your earth signal return contact.

But whilst a crocodile clip is the ideal way to test, as you are effectively applying a pulsing voltage between 0 and the applied voltage, Pulsed DC units such as the Elcometer 280 can be used with a trailing earth cable which doesn’t have to be connected to the substrate, making it perfect for quickly testing large surfaces and pipelines, without constantly having to clip and unclip the return lead every time the length runs out. As long as the substrate itself is grounded, and is on ground which is wet enough to conduct electricity, you can test this way. In some instances you can simply use a grounding mat as a ‘larger’ trailing lead, aiding in the grounding when in drier conditions.

However if you do not have access to an uncoated area of the substrate or when the ground itself is dry, you can use the Elcometer 280 grounding mat and grounding pin to couple the substrate to the unit's ground. Simply wrap the conductive rubber mat around the coated pipe, and connect it to both the grounding pin, which is secured into the ground, and the signal return lead. The rubber mat then works as a capacitor, creating your earth signal return contact.

When testing coatings on concrete, if the concrete substrate doesn’t have enough moisture in it to conduct electricity, then it’s unlikely you will be able to test using a Continuous DC detector. However, there is a way you can test using a Pulsed DC detector. Simply place the trailing earth return cable against the bare concrete, and place a damp cloth or wet sand-filled paper bag on top of it. This simultaneously makes a secure contact point for your earth return cable, and adds moisture to the concrete, aiding the conductivity of electricity.

Next, fit the probe you’re going to test with. Elcometer has a wide range of probes for different applications and coating types. There’s a separate video on choosing the right probe for your application, later in the series.

With your chosen probe fitted, switch on the Elcometer 280, and select the voltage you wish to test with. The voltage you should use is dependent on the dielectric strength and thickness of the coating being tested, and/or the test method or standard you’re working to. The instruction book for the Elcometer 280 includes a detailed guide for working out your ideal test voltage. If you are working to a specific test method or standard, the correct voltage levels can be worked out using established Codes of Practice.

However, the Elcometer 280 makes working out your test voltage easier than ever before, with its in-built voltage calculator. Simply choose your test standard, enter the specified coating thickness, and gauge will automatically calculate and set the correct voltage.

Furthermore, the Elcometer 280 has an internal jeep tester, ensuring your chosen voltage matches your actual test voltage.

To ensure safe testing, voltage isn't sent to the probe until the two-stage safety switch is activated, which avoids accidental switch-on, and automatically cuts power to the probe should you lose grip of the handle.

Place the live probe on the test surface and move it over the work area at a constant speed, as defined by the test method or standard you are working to - keeping the probe in contact with the surface at all times.

If you need to move to a new location to test, and you are connected to the substrate via a clip or grounding mat, always switch off the instrument before disconnecting any cables.

In the next part of the Elcometer Pinhole and High Voltage Detector series, we'll be showing you the range of probes you can use with Elcometer's Continuous DC and Pulsed DC holiday detectors, and how to work out which one is best for your application.

You can click the pop-out in the top right to go to the next video in the series, select one of the icons at the end of the video, or simply visit Elcometer.com if you can't see the links.

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