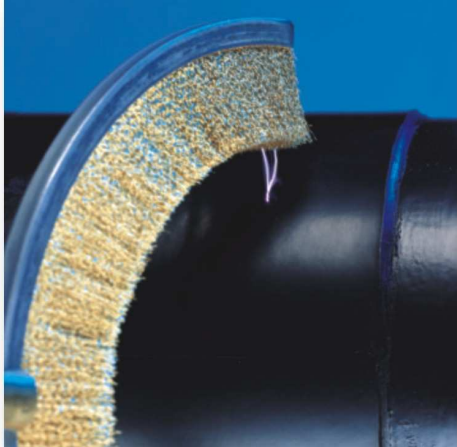


Holiday Detection with the ISOTEST®



The damage caused by corrosion results in damage costing in the order of billions annually. The resulting costs are due to interruptions of operation for elaborate cleaning-up work, or, in the case of pipe laying, the setting up of construction sites with the resulting hindrance to traffic.

In order to prevent corrosion in pipes, these are provided with a protecting coating and/or cladding during manufacture.

However, there is a risk of damage to this so-called factory covering during subsequent transport and laying work.

An additional critical factor involves protecting the welded connections by using additional coverings that are applied on site, manually as a rule. Technical knowledge and experience are crucial prerequisites for long-lasting protection against corrosion.



But only a concluding check with the aid of a high voltage can provide the certainty that no defective areas that could be found have been overlooked.

In the event of damage it also makes it possible to precisely locate it and to correct it by using suitable repair procedures.

The **aim** is the detection of

- material defects such as pores and cracks,
- other mechanical damage, and also from
- errors in applying the covering material.

Testing for defective areas for pipe laying is covered with regard to the standards in **EN 10329 und ISO 21809-3**.

1.2. High-voltage test equipment



Mains-independent portable equipment is used on construction sites. The equipment should be suitably robust and simple to operate for this kind of use. In addition, a distinction is made primarily on the basis of the **test procedure** that is used:

The testing of the covering material is done either

- with a unipolar **pulse-type high voltage**

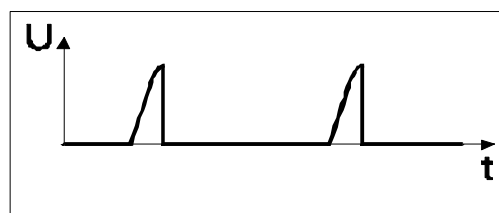


Fig. 1 - pulse-type high voltage

or

- . with **direct current**.

The testing of the covering with devices that make use of **pulse-type high voltage technology** has been introduced onto many construction sites worldwide due to its many advantages.

2. Criteria holiday testing

2.1. Stability of the test voltage even under high loadings

Large pipe diameters, moisture or dirt on the surface and also materials that are not fully conductive place tough requirements on the test equipment.

In order to generate the desired or stipulated test voltage, in such a case significantly more energy is required than when it is applied to dry or smaller test objects.

Test equipment using direct current quickly comes up against its limits under high loads. The loading is too great and the current breaks down.

The test voltage at the surface is only a fraction of the required value, even though the set voltage value still appears on the display of the test equipment!

When using test equipment that works with direct current, methods that additionally amplify the voltage that is generated are not permissible for safety reasons.

ISOTEST® test equipment based on *pulse-type high-voltage technology* has the required reserves of safety due to the technology it uses so that the set test voltage can still be assured even under heavy loads and in difficult conditions.

Two major device components are important in this context.

- a. The built-in **sphere gap**, with which the high voltages in the device are stabilised permanently.
- b. Powerful and **automatic regulation** of the test voltage that guarantees that if the test equipment is heavily loaded or stressed, for example, by moisture on the surface, the voltage can be brought down to the set value in a fraction of a second.

Important: The safety of the operator can be assured!

2.2. Material loading

When comparing the two test procedures (*direct current and pulse-type high voltage*) with reference to the loading on the material, there is also a clear advantage for carrying out tests using a *pulse-type high voltage* method.

The so-called shock factor is of special importance in this context. The **shock factor** says that if there is only a short time of application, as is the case with high-voltage pulses, for example, then the relevant material can have applied to it a voltage that is 2-3 times greater than the critical voltage leading to a breakthrough and without suffering any damage. The *pulse-type high-voltage technology* thus provides two or three times as much safety. This aspect is of importance with regard to the testing of materials whose coating thickness varies greatly and also in the event that the voltage has been accidentally set too high.

While the material has the voltage applied to it during the entire time of the testing when working with *direct current*, the length of time of this action can be reduced to a few milliseconds when working with *high-voltage pulses*.

2.3. Certainty of a correct test

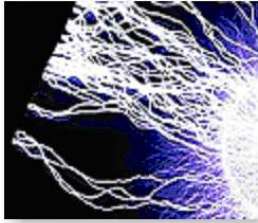
The simple example of a candle helps to explain why in all cases you are far safer when carrying out tests using *pulse-type high-voltage technology*.

If you pass your finger quickly (!) through the flame of a candle, you will not hurt yourself. But things are different if you expose your finger to the high temperature for a longer period of time. What this means, related to the high-voltage test, is this: Due to the short duration of application (when using *pulse-type high-voltage technology*), a significantly higher loading can be applied to a material than when it is applied continuously for a longer period (as is the case with *direct current*).

This context means that when using test equipment working with *pulse-type high-voltage technology* that there can be certainty of flawless non-destructive testing, even if the thickness of the coating is less than that specified by the manufacturer or if the wrong voltage value had been set accidentally.

But *pulse-type technology* also has decisive advantages in the event of a test voltage that is too low or when testing coatings that are extremely thick.

Sliding Discharges



Sliding discharges are a welcome and helpful side-effect of high-voltage testing using *pulses*. Sliding discharges are the sparks that occur during the high-voltage test. They can be up to several centimetres long and spread out in all directions over the surface around the test electrodes being used. This can be seen especially well in darkness.

Spreading out in all directions means that this is a very secure way of testing since multiple testing can be done. The material is not only tested at the points where the test electrodes are at that moment, but also the area in a section that had already been painted or which is still to be tested. Defective founds can thus not only be found when they are directly underneath the test electrodes but also in an area of up to several centimetres around the electrodes, even deep inside the material!

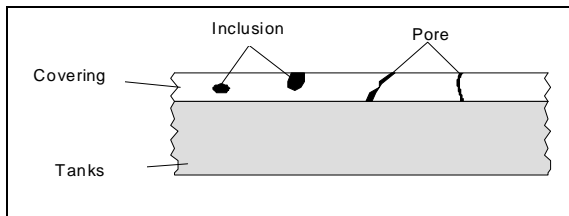


Fig. 2. – Pores running diagonally, etc.

By using sliding discharges it is also possible to find pores at a distance from the test electrodes that is greater than the value that is theoretically possible from the set test voltage.

The occurrence of sliding discharges depends on a number of factors:

- on the covering and coating material to be tested,
- on the moistness of the air and the pipe surface,
- on the amount of the voltage and what is to be emphasized,
- on the voltage **type** (see Fig.1)

As opposed to *pulse-type current*, *direct current* has only a slight tendency to form sliding discharges.

Thus, for the same test voltage, equipment working with the *pulse-type current* method offers considerably more safety when testing.

2.4. Safety of the tester

The test equipment should not constitute a risk to the operator in the event of accidental contact with parts that are carrying a high voltage.

ELMED ISOTEST® test equipment has a safety button with an **emergency stop function**. This safety measure guarantees a high level of additional protection for the tester in the event of contact with the high voltage. The high voltage is switched off when the emergency stop button is activated and a warning sound gives notice of the danger.

A further important point when considering safety is the occurrence of **residual charges**.



Safety button of the ISOTEST® test equipment

When testing with *direct current*, the pipes, vessels or other parts can become electrically charged due to the prolonged application of the voltage.

In this case the pipe behaves like an energy store (condenser) that tries to discharge itself to earth via a possible connection. If the grounding is poor or even absent altogether, then this connection can be the tester himself!

This danger of electric shock can be excluded due to the significantly shorter time of application of the voltage to the vessel when using *pulse-type high-voltage technology*. However, the precondition for this is flawless **grounding** of the test equipment and the test object at all times.

2.5. Grounding



Correct grounding of the high-voltage test equipment is an essential prerequisite for any high-voltage test. The electrical circuit is completed as a result of the grounding, i.e., firstly the connection of the test equipment to the non-insulated electrically live part of the pipe and secondly the part of the pipe to the conductive ground (ground potential). No electrical device can function without a closed electrical circuit.



When testing with high-voltage equipment, a connection to the ground potential must be made in all cases by using suitable accessories. The safety of the high-voltage testing and the safety of the operator depend to a very great extent on the quality of the grounding of the test equipment that is used.

Basically speaking, a distinction can be made between three forms of grounding:

- direct grounding
- indirect grounding
- capacitive grounding

Direct grounding – the direct conductive connection between the test equipment and the non-insulated part of the pipe to be tested. This is the most reliable form of grounding and is to be preferred to any alternatives.

ISOTEST® test equipment has an additional safety mechanism with a warning tone that makes it impossible to operate it without the grounding cable being plugged in and in this way also prevents tests from being carried out that do not give a usable result.

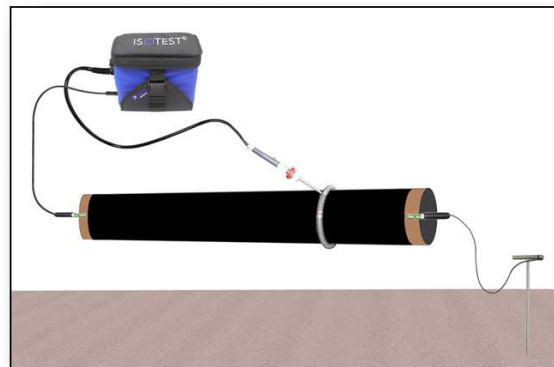


Fig. 3: Direct grounding in pipe laying

The use of an grounding sleeve has proved its worth in cases where a conductive connection to the test object cannot be reached or that it must remain fully insulated without interruption. It is recommended that this is used also on poorly conductive or extremely dry ground. The **grounding sleeve** consists of a special type of conductive rubber and represents a form of **capacitive grounding** that can only be achieved by using *pulse-type high-voltage testing technology*.



The appropriate size of sleeve is wound around the pipe to be tested and pulled tight. One side has to be connected with the ground (grounding cable with grounding rod), and the other side has to be connected to the test equipment. The testing can then be carried out in the usual way.

2.6. The correct test voltage



The choice of the test voltage depends on two factors:

- the type of covering material to be tested, and
- the thickness of the coating

For pipe laying the test voltage has been defined in, among others, DIN EN 10329, ISO 21809-3, NACE RP 0274¹, NACE RP 0490² and further German standards.

¹ NACE RP0274 = High Voltage Electrical Inspection of Pipeline Coatings prior to Installation.

² NACE RP0490 = Holiday Detection of Fusion Bonded Epoxy External Pipeline Coatings of 10-30 mils (0,25mm - 0,76mm)

The following rule of thumb takes into consideration the physical circumstances and has proven its worth over many years when used with multi-layer covering systems to calculate the test voltage:

$$5 \text{ kV initial voltage} + 5 \text{ kV/mm}$$

For a 3mm PE covering the above formula gives the following result:
 $5 \text{ kV} + 3 \times 5 \text{ kV} = 20 \text{ kV}$

Given the test voltage that has been found in this way, pores running diagonally, and especially in the area of coatings applied subsequently, can be detected with certainty. It is also to test the effect of "patching up" and similar repairs.

We regard the markedly lower voltage values stated in various standards as being minimum standards. They do not ensure guaranteed detection of pores in all test situations.

2.7. Selection of test electrodes



The correct choice of test electrodes depends in the first instance on the diameter of the pipe to be tested. All the test electrodes listed below are available for almost all pipe diameters and in various widths.

Gaps that can be produced by half-round brushes due to very dirty or bent bristles place the entire test at risk. The same applies to spirals that are hanging or if overly narrow ones were chosen.

- If the pipe is still lying or hanging freely, the test can be done with a **spiral electrode** around the complete circumference of the pipe. This is also the easiest and quickest way to test longer sections of pipe.



Holiday Detection with the ISO TEST®

- If the pipe has already been laid in the trench, the half-round brush is a suitable alternative in this case.



- The flat brush can be used for flat surfaces, outlets and slide valves.



- In addition to the electrodes for the testing of the outer circumference, there are additional types of test electrodes for thin or delicate coatings, in which the brush set is replaced by a special type of conductive rubber.



- Fanlike brush electrodes made of stainless steel are used universally for the testing of vessels, valves and fittings.



- Brush electrodes with 2x stainless steel brush sets and nylon reinforcement in the middle section allow guaranteed testing of the inside of the pipe.



- In the pore test the brush electrodes are pulled through the pipe with the aid of a high-voltage extension cable. High-voltage extension cables are available in lengths of 4m and 7m.

