September 2011

DVS – DEUTSCHER VERBAND FÜR SCHWEISSEN UND VERWANDTE VERFAHREN E.V.

# Non-destructive tests on tanks, apparatus and piping made of thermoplastics – Testing with electrical high voltage

DVS
Technical Code DVS 2206-4

*Replaces DVS 2206 dated November 1975*

**Contents:**



## 1 Scope of application

This technical code applies to the testing of welded joints on components, piping, apparatus and tanks as well as sealing sheets and composite structures made of thermoplastics.

The test serves to find continuous pores or cracks. The test with electrical high voltage does not replace either a leak test according to the DVS 2206-2 technical code or the DVS 2225-2 technical code or an evaluation according to the DVS 2202-1 technical code.

This technical code is not applicable to electrically dissipative plastics.

## 2 Materials

The technical code refers to the testing of the welded joints between the following plastics:

– PE
– PP
– PVC
– fluoroplastics

## 3 Test procedure

This test procedure is based on the principle of the gas discharge when electrical high voltage is applied to a discharge section. The prerequisites for its application are an electrically insulating material as well as an electrically conductive counterelectrode. Continuous imperfections give rise to a sparkover between the electrodes which is visible and audible.

### 3.1 Testing devices

The following high-voltage testing devices are utilised:

– **Testing devices with alternating voltage**
These devices do not need any earthing of the counterelectrode and do not permit any exact limitation of the voltage peaks according to their level and duration.

– **Testing devices with pulsed direct voltage**
They are suitable for all areas of application but require the earthing of the counterelectrode.

– **Testing devices with constant direct voltage**
The constant direct voltage may lead to electrical charging and to a permanent change in the electrical properties of the tested plastics and may thus produce testing errors. These devices are not recommended for the applications dealt with in this technical code.

### 3.2 Execution of the test

The weld region must be dry and free from contaminations. These may form a coat and thus affect the test. It must be ensured that the entire weld cross-section has cooled down to the ambient temperature before the beginning of the test. The acoustic and optical perception of an imperfection must be guaranteed during the testing. It must be ensured that the testing electrode is in contact with the surface to be tested throughout the testing operation. The test may only be carried out by experienced personnel.

Commercially available testing devices may be equipped with various electrode shapes (e.g. brush, pointed electrode, spherical electrode, wire net scrim etc.). The electrodes must be selected according to the weld geometry.

The testing speed should be adjusted depending on the weld geometry and the wall thickness. It may be as much as 500 mm per second on a plane weld. It should be considerably lower than this at positions with difficult accessibility (e.g. nozzles) or in the case of higher wall thicknesses (> 10 mm). Lengthy dwelling (> 5 s) of the testing electrode at one position is impermissible since this may lead to a decrease in the breakdown strength right up to the destruction of the material.

The following table applies to the test on components in the new condition. The specified values should be viewed as guide values.

**Table 1. Guide values for testing voltages.**

| Wall thickness | Test voltage in kV * | |
|---|---|---|
| (mm) | PE, PP and fluoroplastics | PVC |
| up to 3 | 10 | 15 - 20 |
| > 3 - 6 | 15 - 25 | 20 - 30 |
| > 6 - 20 | 25 - 35 | 30 - 40 |
| > 20 - 5 | 35 | > 40 |
| * The values were established with spherical electrodes. | | |



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If wide electrodes (e.g. brush electrodes) are used, it must be borne in mind that a drop in the set voltage may arise across the electrode width.

Deviating testing voltages are chosen in the case of lap welds between sealing sheets since the possible spark path between the electrode and the counterelectrode deviates from the wall thickness considerably (values for testing voltages, see the DVS 2225-1 technical code and the DVS 2225-4 technical code).

The flashover distance is the distance between the electrode and the counterpole as from which a sparkover occurs. In this respect, exclusively air may be between the electrode and the counterpole. Since the flashover distance (spark path in free air) increases along with the air humidity, it must be determined with the chosen electrode in air before the beginning of the test. The flashover distance must be greater than the maximum possible continuity path (component thickness). Moreover, it must not be so high that it results in a breakdown through the component.

Experience from practice shows that components may have changed their dielectric properties after a lengthy operating time depending on the operating medium. Therefore, the testing voltages specified in Table 1 must be reduced considerably. Before the test, deposits must be removed from the weld region which must be dry.

Before the beginning of the test, the type and scope of the reporting must be stipulated between the parties involved. The reporting must include, at least, the utilised device type, the testing voltage, the electrode type, the scope of testing, the flashover distance, the name of the tester, the place, the date and the test result.

## 4 Limits of the test procedure

The only cracks or holes detected are those which are continuous and also run nearly vertically to the weld. It must be ensured that the counterelectrode is not completely embedded in the welding filler material. It must be fixed in such a way that any impairment of the weld quality is excluded.

Testing devices available on the market at the moment have a max. testing voltage of approx. 55 kV. The wall thickness to be tested is limited by this. (Pay attention to Table 1 and the operating instructions for the devices!)

Defects in welds such as lack of fusion, isolated pores and voids etc. cannot be recognised with this test procedure.

## 5 Safety notes

It is necessary to comply with the applicable ordinances, VDE guidelines and employers' liability insurance association regulations as well as with the stipulations of the manufacturers.

Before the devices are used, it must be checked that they are in the proper condition.

When the device is operated, it must be ensured that neither the operator nor any external personnel comes into direct contact with the testing electrode. With regard to the testing, attention must be paid to suitable clothing. It must be ensured that only experienced personnel is authorised to operate the device. In any case, the device must not be operated by any people who wear a hearing aid, are fitted with a pacemaker or have survived a heart attack.

Ozone and electromagnetic radiation are released during the test. Attention must therefore be paid to sufficient ventilation and to a sufficient safe distance away from electronic devices.

The devices must not be operated in an easily inflammable atmosphere since the spark may give rise to an explosion.

## 6 Bibliography


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| DIN EN 13121-3 | Above-ground tanks and vessels made of glass-fibre-reinforced plastics – Part 3: Design and manufacture |
| DIN EN 14879-4 | Coatings and linings made of organic materials for the protection of industrial installations against corrosion caused by aggressive media – Part 4: Linings for components made of metallic materials |
| Technical code DVS 2202-1 | Defects in welded joints between thermoplastics – Characteristics, description and assessment |
| Technical code DVS 2206-2 | Non-destructive tests on tanks, apparatus and piping made of thermoplastics – Dimensional checking and visual inspection |
| Technical code DVS 2225-1 | Joining of sealing sheets made of polymeric materials in earthwork and water engineering – Welding, adhesive bonding and vulcanisation |
| Technical code DVS 2225-2 | Joining of sealing sheets made of polymeric materials in earthwork and water engineering – Site tests |
| Technical code DVS 2225-4 | Welding of sealing sheets made of polyethylene (PE) for the sealing of dumps and contaminated sites |
| Technical code DVS 2225-5 | Welding of sealing sheets made of thermoplastics in tunnel construction |
| Relevant VDE guidelines e.g. VDE 0113 | Electrical equipment of machines |