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1 Scope of application

This technical code applies to the adhesive bonding of pipes and piping parts made of polyvinyl chloride (PVC-U) according to the DIN 8061, DIN 8062, DIN 8063 ff., DIN EN 1329-1, DIN EN ISO 1452 and DIN EN ISO 15493 standards.

2 Material

The materials are unplasticised polyvinyl chloride (homopolymer) and blends with an impact-resistant setting. The blends are characterised by a higher impact strength. The materials are utilised as semi-finished products in the form of pipes, fittings, valves, panels and sections. The adhesive bondability can be checked by visually inspecting the adhesive bonding faces of the components according to the DVS 2221 technical code (Sections 4.3.3 ff.).

3 Adhesives

As a rule, polyvinyl chloride is adhesive-bonded with solvent-based adhesives because of the good partial dissolubility of the material. The solvents diffuse into the joining faces, trigger molecular movements and, after escaping, lead to solid and permanent joints between the joining parts.

Although other adhesive bonding systems can be applied (e.g. reactive adhesives), this technical code relates to the application of adhesives which contain solvents and are based on solvents with rapid solvent action.

Solvent-based adhesives for the specified materials are solutions of PVC-U in organic solvents on the basis of tetrahydrofuran, cyclohexanone, methyl ethyl ketone and other solvents with rapid solvent action. The choice of the corresponding solvents serves to achieve the optimum partial dissolution of the adhesive bonding faces, the defined open assembly time and the setting speed appropriate for the processing. Additives such as stabilisers, thickening agents, impact strength modifying agents and colouring pigments can be used in order to obtain certain properties. If solvent-

based adhesives are applied improperly (e.g. in the event of excessive dispensing), this may exert seriously negative influences on the structure of the plastics in certain circumstances. Above all, substantial changes in the strength properties and possibly stress cracking may occur in the case of adhesive-bonded joints between parts with high mechanical stresses. These processes are promoted, in particular, by high residual stresses, e.g. in injection mouldings or thermoformed parts.

Above all, it must be ensured that only those adhesives which the manufacturer has provided for the adhesive bonding of pipes and fittings made of polyvinyl chloride and has declared correspondingly are used. Adhesives which are utilised in the field of pressurised PVC-U pipes must comply with DIN EN 14814.

When solvent-based adhesives are used, the adhesive bonding must be carried out "wet in wet", i.e. the joining parts must be joined immediately after the adhesive has been applied within the open assembly time (processing time).

The essential characteristics of these adhesive bonding systems: short waiting time and quick setting. The cured adhesive-bonded joints (see the information from the manufacturer!) have mechanical, thermal and chemical resistances comparable with those of the materials themselves.

When selecting the adhesive, it is necessary to take account of:

- dimensions and tolerances
- mechanical and thermal loads
- effects of media

4 Requirements on adhesives

The adhesives must make it possible to manufacture pipe joints between PVC-U pipes and fittings, according to the requirements resulting from the planned intended use of the piping. These include the service life, the strength behaviour, the temperature resistance, the chemical resistance and the hygienic properties demanded in the case of pipes for use with food or drinking water. These requirements are defined in various technical codes. Inquiries about the chemical resistance of adhesive-bonded joints, e.g. when using concentrated inorganic acids, should be addressed to the manufacturers of the adhesives and of the semi-finished products. During the processing, adhesives must not cause any health-related harm while complying with the OEL (occupational exposure limit).

5 Marking of the adhesive packages

In addition to the statutorily demanded information, the adhesive packages must be marked with the following minimum information:

- designation of the adhesive
- name of the manufacturer or supplier
- reference to the relevant adhesive standard
- area of application

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DVS, Technical Committee Working Group "Joining of Plastics"

- list of standards relating to thermoplastic piping systems for which the adhesive is suitable
- CE marking with an indication of the pressure class according to the standards, e.g. DIN EN 14814
- instructions for utilisation and storage
- safety precautions with regard to utilisation and storage
- batch number
- manufacturing or use-by date with an indication of the minimum shelf life of at least twelve months

6 Shelf life of the adhesives

The shelf life of an adhesive is understood to be the time in which the adhesive in an as yet unopened package can be processed without any problems after storage in stipulated storage conditions (information from the manufacturer).

The adhesives must possess a sufficient shelf life in the event of normal storage (min. twelve months). The shelf life depends not only on the composition of the adhesive but also on the type of packaging and other external influences, above all the storage temperature. The adhesive manufacturer guarantees a minimum shelf life in its technical documents.

Irrespective of this, the processor must always check the processability of the adhesive!

7 Adhesive bonding instructions

All the adhesives and adhesive systems have specific processing conditions. Therefore, only generally applicable indications can be given here.

The manufacturers or the pipe system suppliers deliver the adhesives and the appropriate cleaning agents in the ready-to-use condition. Consumption quantities can be found in the technical bulletins or can be requested from the manufacturer. Neither dilution nor any miscellaneous changes are permissible. This also applies to the cleaning agents. In principle, attention must be paid to the adhesive bonding instructions from the adhesive or pipe system manufacturer. The pipes and the fittings must be dry and free from grease or dirt. It is necessary to check the processability of the adhesive. After the stirring, it must run off the diagonally held rod uniformly and without any lumps.

The adhesive bonding should only be carried out at processing temperatures between 5°C and 40°C. In the event of any deviations, these processing temperatures must be achieved by taking additional suitable measures. The open assembly time of the adhesives decreases at higher temperatures and/or with lower adhesive film thicknesses. The open assembly time is the period between the adhesive application and the joining of the parts.

The following procedure is generally used in order to achieve an optimum adhesive-bonded joint:

- The dimensional accuracy of pipes and fittings must be checked.
- The pipes to be adhesive-bonded are shortened to the required length.
- The pipes must be cut off at a right angle to the pipe axis.
- The pipe ends are bevelled at an angle of approx. 15° on the outside (see Fig. 1 and Table 1) and are deburred on the inside.

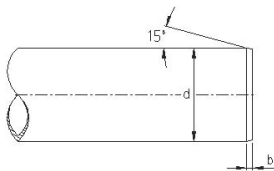


Figure 1. PVC-U pipe joint, dimension b.

Table 1. PVC-U pipe joints – Stipulations for the dimension b.

Pipe outside diameter mm	Dimensions for b approx. mm
Up to 16	1 – 2
20 – 50	2 – 3
63 – 225	3 – 6
250 – 400	6 – 8

The insert depth of the sleeve is marked on the pipe end so that the required adhesive application and the complete insertion of the pipe into the sleeve can be checked.

The adhesive bonding faces at the pipe end and in the sleeve of the fittings are cleaned thoroughly. Clean, unused, absorbent, non-fraying and non-colouring paper and the cleaning agent stipulated by the adhesive or pipe system manufacturer are used for this purpose. The paper must be replaced after every cleaning operation.

The cleaned adhesive bonding faces must be dried off before the adhesive application and must no longer be touched.

Before the adhesive is used, its processability must be checked. Using a brush with a suitable size (see the recommendation from the manufacturer!), the adhesive is applied to the whole of the joint area in the sleeve and to the pipe according to the information from the manufacturer.

Immediately after the adhesive application, the pipe is pushed into the sleeve as far as the mark without any twisting or pulling, is aligned if necessary and is fixed there for a few seconds. A uniform adhesive surplus on the outside and a small, closed adhesive ring inside the pipe indicate that the adhesive bonding was carried out over the whole area.

Any surplus adhesive is immediately removed with paper so that a small throat is formed on the outside of the pipe.

The adhesive-bonded joint must not be subjected to any mechanical loads during the waiting time until the further processing. The duration of the waiting time is oriented to the adhesive bonding system, to the pipe diameter and to the processing temperature. It is included in the information from the adhesive manufacturer. The same applies to the setting time until the pressure test. The pipes must not be closed during the drying phase. It is necessary to avoid any adhesive accumulations in the joint area.

In the case of large dimensions (from d200/d225), attention must be paid to the special indications made by the adhesive and component suppliers.

8 Testing of adhesives

An overview of the available test procedures for adhesives is given below. They are carried out by the adhesive manufacturers.

8.1 Test procedures

Table 1. Overview of the test procedures.

Solids content	DIN EN 827
Viscosity	DIN EN 12092
Film properties	DIN EN ISO 9311-1
Tensile strength	DIN EN ISO 9311-2
Internal compressive strength	DIN EN ISO 9311-3

8.1.1 Solids content

8.1.1.1 Preliminary remark

The solids content of the adhesive is determined by the content of dissolved PVC-U and by the quantity of other solid constituents in the adhesive.