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External corrosion protection of buried pipes

Corrosion protection systems for steel pipes

DIN 30 675 Part 1

Äußerer Korrosionsschutz von erdverlegten Rohrleitungen;
Schutzmaßnahmen und Einsatzbereiche bei Rohrleitungen aus Stahl

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This standard has been jointly prepared by *DIN Deutsches Institut für Normung e.V.* and *DVGW Deutscher Verein des Gas- und Wasserfaches e.V.* (German Gas and Water Engineers' Association) and has been adopted into the DVGW Codes of practice on gas and water.

Dimensions in mm

1 Scope and field of application

This standard specifies external corrosion protection systems for buried steel pipes and gives guidelines for selection of the appropriate system as a function of the service conditions.

The specifications made here may be applied by analogy to underwater steel pipes. Provided the pipes are not to be subjected to high mechanical stresses nor to electrochemical corrosion, the properties of the water shall be deemed the same as those of soil belonging to category I. It should be noted that the risk of corrosion is greater where the pipework is subject to electrochemical corrosion (i.e. cell formation) or water-line corrosion. In these cases, the risk of corrosion and the necessary protective measures shall be assessed in accordance with DIN 50 929 Part 3.

2 Concepts

For the purposes of this standard, the concepts marked (*) are defined somewhat differently from DIN 50 900 Part 2.

For additional concepts, see DIN 50 900 Parts 1 and 2.

2.1 Aggressiveness of soil

The aggressiveness of soil is the sum of all effects that can induce free corrosion (i.e. corrosion in the absence of electrical current) in buried pipes.

2.2 Fault

A fault is localized damage of the pipe coating, which provides passive corrosion protection, where such is no longer effective.

2.3 Impressed current cathode

An impressed current cathode is used as an external source of electric current in an electrolyte (e.g. soil). It has a higher electric potential than the object it is intended to protect (such as that of the reinforcing steel embedded in concrete) and, in combination, they form a corrosion cell.

2.4 Isolating joint

An isolating joint is a joint or coupling between two lengths of pipe, inserted in order to provide electrical discontinuity between them.

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2.5 Cathodic protection (*)

Cathodic protection is an active (as opposed to passive) means of protection against corrosion. It functions by opposing the natural flow of electric current from the electrolytic environment (soil) to the metal surface. The protection potential (cf. subclause 2.9) must match or better the corrosion potential of the soil.

2.6 Anode backfill

For the purposes of this standard, anode backfill is a layer of homogeneous material belonging to soil category Ia or Ib (as specified in DIN 50 929 Part 3 or *DVGW-Arbeitsblatt* (DVGW Code of practice) GW 9) surrounding the pipe. In accordance with DIN 19 630 and DIN 4033, it includes the material on which the pipe rests and the backfill material.

2.7 Corrosion cell (*)

A corrosion cell is an electrolytic system comprising a cathode and an anode in electrical contact with an electrolyte. For the purposes of this standard, the pipe material (which is subject to the risk of corrosion) is the anode, and the cathode is inserted in the soil in which the pipe is buried in order to counteract this effect.

2.8 Passive corrosion protection

Passive corrosion protection is that provided by isolating the pipe from the aggressive environment (e.g. soil, water) by means of a protective coating.

2.9 Protection potential (*)

The protection potential is the threshold value within the protection potential range. If this value is achieved in the case of buried pipes, it may be assumed that corrosion occurs so slowly as not to be harmful.

NOTE. The subject of protection potential is covered in DIN 30 676. Further information can be found in chapter 2 of the *Handbuch des kathodischen Korrosionsschutzes* (Manual of Cathodic Corrosion Protection) [1]. The values of protection potential given there apply only to the specific type of corrosion under consideration (e.g. even or uneven attack resulting in material loss). Other values apply to other types of corrosion behaviour (e.g. stress corrosion cracking).

2.10 Stray current (*)

Stray current is that which spontaneously flows from the conductive elements of electrical installations into the surrounding soil. This term is also used to designate that which flows from the impressed current cathode to the object being protected.

2.11 Protective coating

For the purposes of this standard, a protective coating is an electrically insulating layer of material applied to the outside of metal substrates (in this case, pipes and fittings) in order to effect passive corrosion protection.

3 Design parameters

The following parameters must be taken into account when selecting a corrosion protection system for buried steel pipes.

a) The mechanical stresses expected during transport, storage, pipelaying and trench backfilling, as the soil settles, and in service.

b) The possibility of root penetration.

c) The aggressiveness of the soil in which the pipes are to be laid and that which is present during subsequent trenchwork. In accordance with DIN 50 929 Part 3 and *DVGW-Arbeitsblatt* GW 9, the following categories of soil are to be distinguished:

Ia: not aggressive;
Ib: of low aggressiveness;
II: aggressive;
III: highly aggressive.

d) Electrochemical corrosion, such as that arising from cell formation in the presence of impressed current cathodes and from the stray currents of d.c. installations.

e) The continuous service temperature.

f) The tensile stresses expected in service.

4 Corrosion protection systems

4.1 Requirements for backfill material

Residue from refuse incineration plants or power plants, and soil with carbonaceous constituents, shall not be used as backfill material in trenchwork. Recycled or granulated material shall only be used where the results of regular checks show that its properties correspond to those of soil category I.

4.2 Protective coatings

Pipe coatings may be applied at the works, at the storage site, or in situ. Table 1 specifies environments (i.e. soil categories) for pipes coated with polyethylene, thermoset plastics or bitumen. The thickness of polyethylene and bitumen coatings shall be in compliance with the normal thicknesses specified in DIN 30 670 and DIN 30 673, respectively, that of thermoset plastic coatings being in compliance with DIN 30 671. Table 2 specifies environments for pipes protected by wrapping tapes and heat-fused materials in accordance with DIN 30 672 Part 1, as a function of the stress classes specified therein. Table 3 specifies environments for buried valves protected in accordance with DIN 30 677 Parts 1 and 2.

The continuous service temperatures given in tables 1 to 3 are those at which adequate corrosion protection is provided by a coating alone (cf. subclause 2.8). The information given does not apply to the corrosion resistance of the steel where the coating has faults, nor to its performance under extreme service conditions (cf. subclause 4.5).

Where the pipes will be subjected to high mechanical stresses, the coatings selected shall be particularly resistant to impact and indentation, such as polyethylene and bitumen coatings of increased thickness as specified in the relevant standards. In addition, the following measures may be taken:

a) provision of wrapping tape about the coating;

b) provision of a protective mat about the pipe that does not adversely affect cathodic protection;

c) coating with fibre cement mortar.

Such measures are usually not necessary where the pipes are buried in sand or in soil which does not contain stones.

Where root penetration is likely to affect pipe protection, polyethylene or thermoset plastic coatings, or wrapping tape with a cover or inlay of plastic film in combination with fibre cement mortar, shall be used.

In the case of long, electrically conducting pipelines (e.g. welded steel pipelines), extensive concentration cells may form. Where the probability of corrosion is high (cf. DIN 50 929 Part 3) and where cathodic protection is not provided, the entire pipeline shall be buried in material as defined in subclause 2.6.

Table 1: Environments (soil categories) for coated steel pipes

Type of coating		Continuous service temp., in °C	Soil categories[1])
PE as in	DIN 30 670		
	Type N	Up to 50	I, II, III
	Type S	Up to 70	I, II, III
EP as in	DIN 30 671	Up to 30	I, II, III
EP as in	DIN 30 671	Up to 50	I, II
EP as in	DIN 30 671	Up to 70	I
PUR as in	DIN 30 671		
	Type N	Up to 30	I, II
	Type S	Up to 30	I, II, III
	Type N or S	Up to 50	I, II
	Type N or S	Up to 70	I
PUR tar as in	DIN 30 671		
	Type N	Up to 30	I, II
	Type S	Up to 30	I, II, III
	Type N or S	Up to 50	I, II
	Type N or S	Up to 70	I
Bitumen as in	DIN 30 673		
	Normal	Up to 40	I, II
	Reinforced	Up to 40	I, II, III

[1]) Where required (cf. subclause 4.5), the pipe shall also be provided with cathodic protection as specified in DIN 30 676. In this case, the coatings used are suitable for use with soil of any category, assuming normal (i. e. not heavy-duty) service conditions (cf. subclause 4.3).

Table 2: Environments (soil categories) for coating systems as specified in DIN 30 672 Part 1

Stress class	Continuous service temp., in °C[3])	Soil categories[1])
A[2])	Up to 30	I, II, III
B	Up to 30	I, II, III
B	Up to 50	I
C	Up to 30 or 50	I, II, III

For [1]), see table 1.

[2]) In accordance with *DVGW-Arbeitsblätter* G 462 Part 2 and G 463, stress class A coatings shall not be applied in situ, except on pipes or fittings with an uneven surface, in which case several layers of wrapping tape (cf. subclause 2.2.1 of DIN 30 672 Part 1), used in combination with a protective mat, are to be applied.

[3]) In the case of pipes used at fluctuating service temperatures up to 70 °C, thermoset plastic coatings (e.g. liquid epoxy resin), used in combination with a suitable heat-fused material with epoxy primer, shall be applied for now. It is also advisable to isolate the pipe from the soil by means of a protective mat. A standard on coatings applied in situ for continuous service temperatures up to 70 °C is currently in preparation.

4.3 Cathodic protection

Use of cathodic protection (cf. DIN 30 676) considerably improves the corrosion protection of buried pipes. Where the protection criteria specified in DIN 30 676 are satisfied, even where the coating has faults, and where such is verified in accordance with DIN 50 925*), then unalloyed and low-alloy steel pipes used at continuous service temperatures of well under 50 °C shall be deemed as being fully protected from corrosion. For this reason, the relevant standards and literature specify the use of cathodic protection where particular safety requirements are to be met. The distribution of current and the protective-current requirements are a function of the quality of the protective coatings in accordance with subclause 4.2. Where suitable coatings are selected, the effects from external systems are negligible, and the reliable performance of the cathodic protection is ensured.

Where the effects from high-voltage installations are to be considered, the requirements specified in *AfK-Empfehlung* (AfK Recommendation) No. 3 shall be taken into account.

*) At present at the stage of draft.